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(54) **SYSTEMS AND METHODS FOR ALLOCATING DEVELOPMENT OF A DEVICE APPLICATION**

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G06Q 10/0639	(2006.01)

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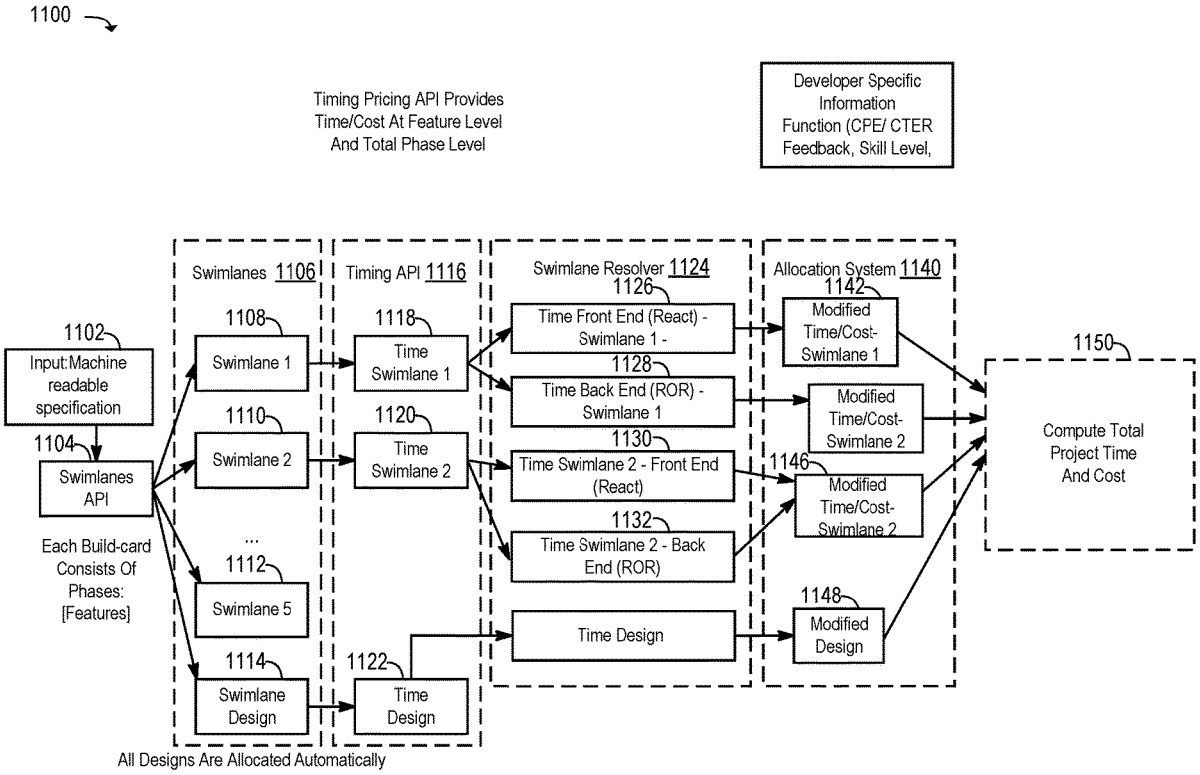
(57) **ABSTRACT**

Systems, methods, and computer readable storage mediums for developing a device application are disclosed. An exemplary embodiment is a method for developing device applications. The method includes receiving a set of features of a 1st device application and determining one or more subsets of the set of features where each subset is capable of operating independently of the other subsets in the 1st device application area. The method further includes determining a production time for each subset. For each subset, the method includes tasking a developer to complete the subset at a time based on the production time.



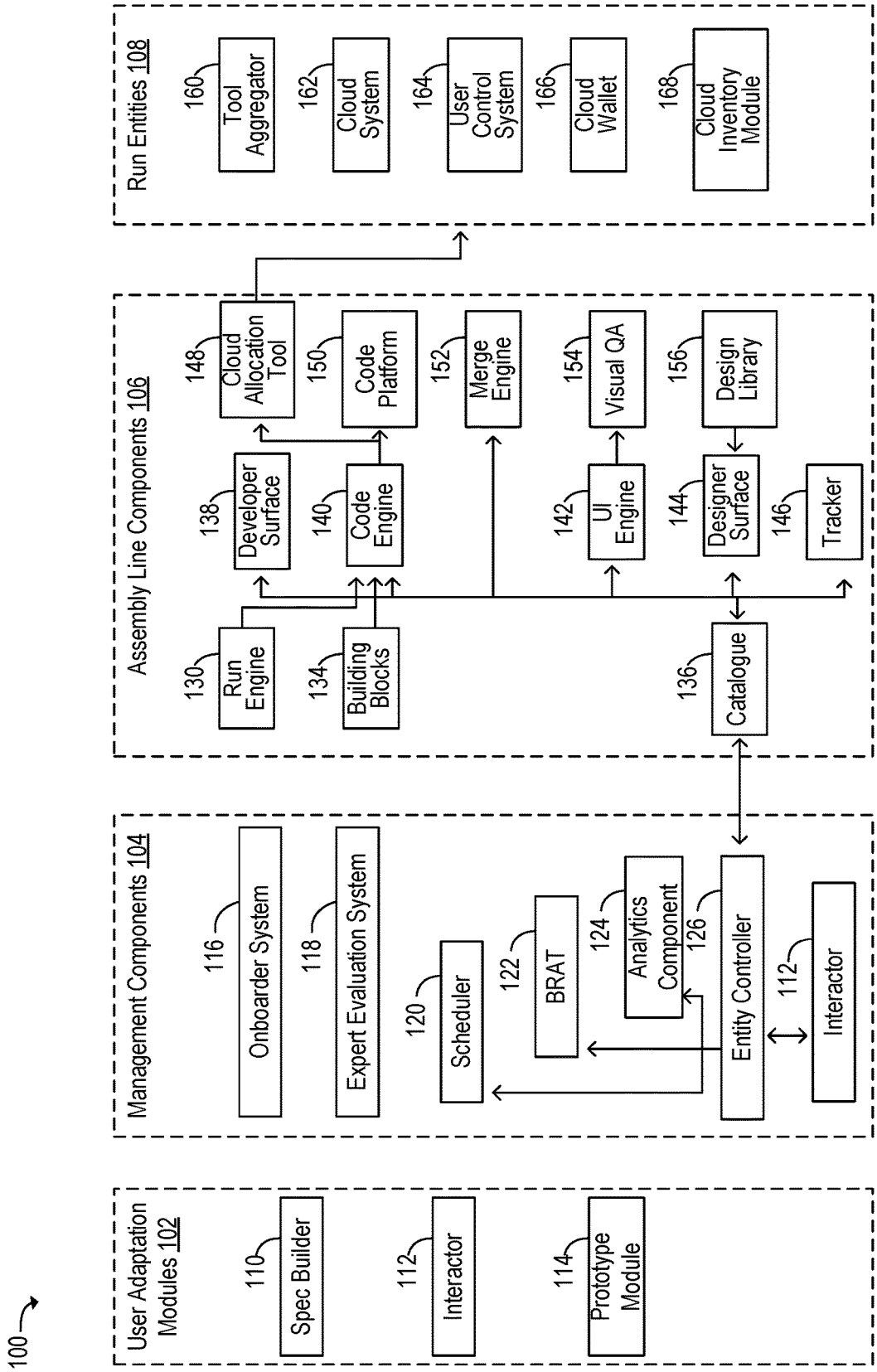

100
User Adaptation Modules 102
110
Spec Builder
112
Interactor
114
Prototype Module
Management Components 104
116
Onboarder System
118
Expert Evaluation System
120
Scheduler
122
BRAT
124
Analytics Component
126
Entity Controller
112
Interactor
Assembly Line Components 106
130
Run Engine
134
Building Blocks
136
Catalogue
138
Developer Surface
140
Code Engine
142
UI Engine
144
Designer Surface
146
Tracker
148
Cloud Allocation Tool
150
Code Platform
152
Merge Engine
154
Visual QA
156
Design Library
Run Entities 108
160
Tool Aggregator
162
Cloud System
164
User Control System
166
Cloud Wallet
168
Cloud Inventory Module

Fig. 1

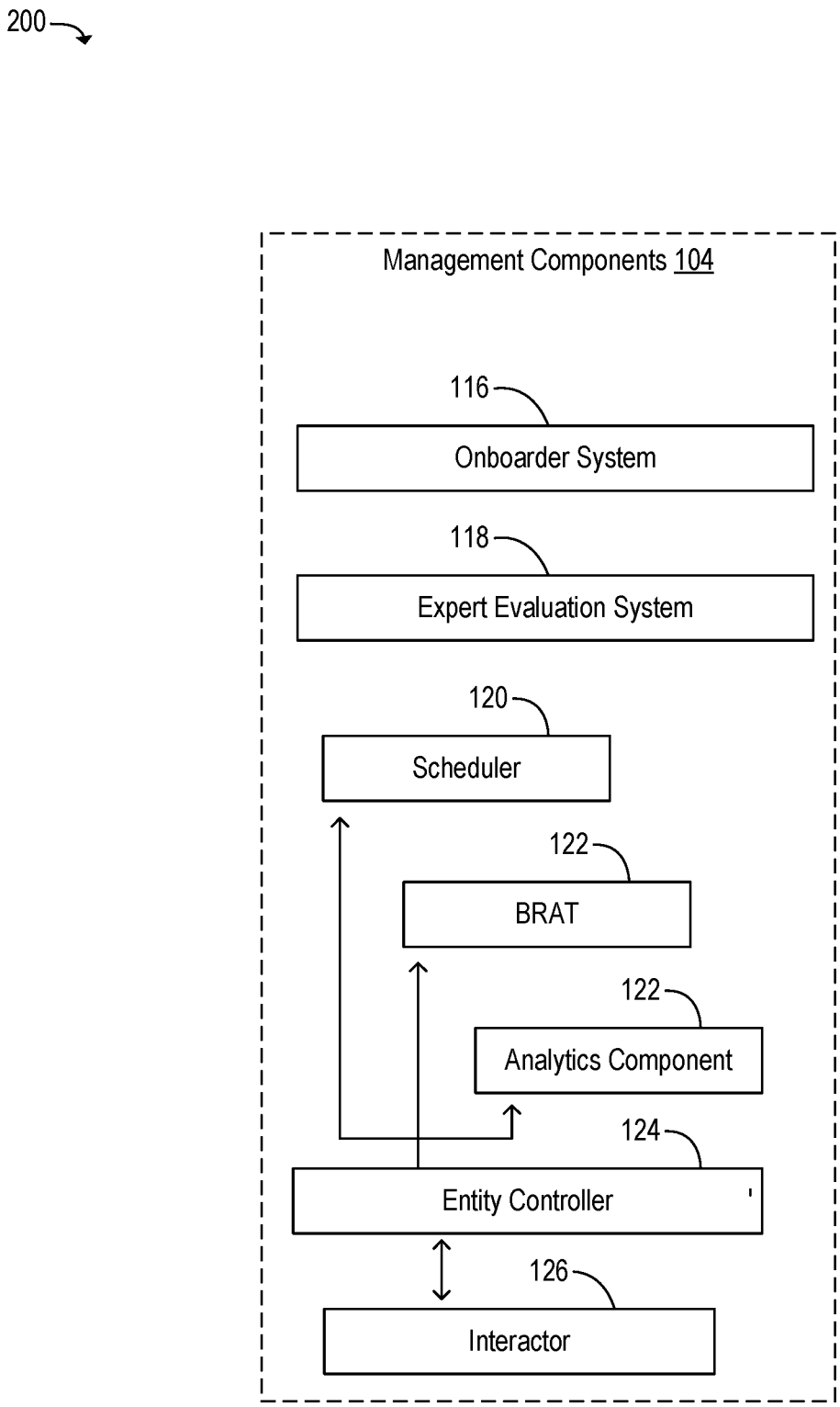

200
Management Components 104
116
Onboarder System
118
Expert Evaluation System
120
Scheduler
122
BRAT
122
Analytics Component
124
Entity Controller
126
Interactor

Fig. 2

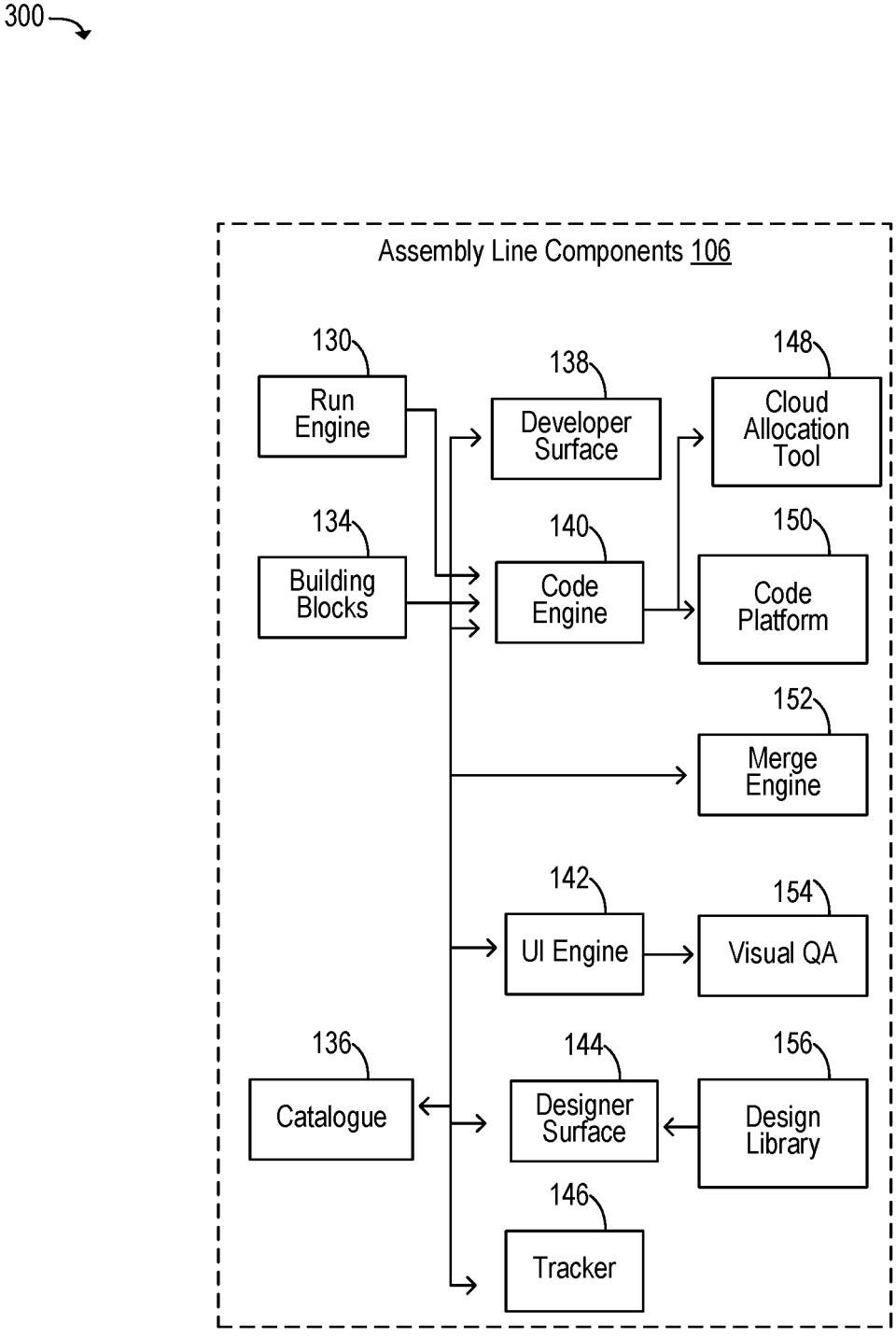

300
Assembly Line Components 106
130
Run Engine
138
Developer Surface
148
Cloud Allocation Tool
134
Building Blocks
140
Code Engine
150
Code Platform
152
Merge Engine
142
UI Engine
154
Visual QA
136
Catalogue
144
Designer Surface
156
Design Library
146
Tracker

Fig. 3

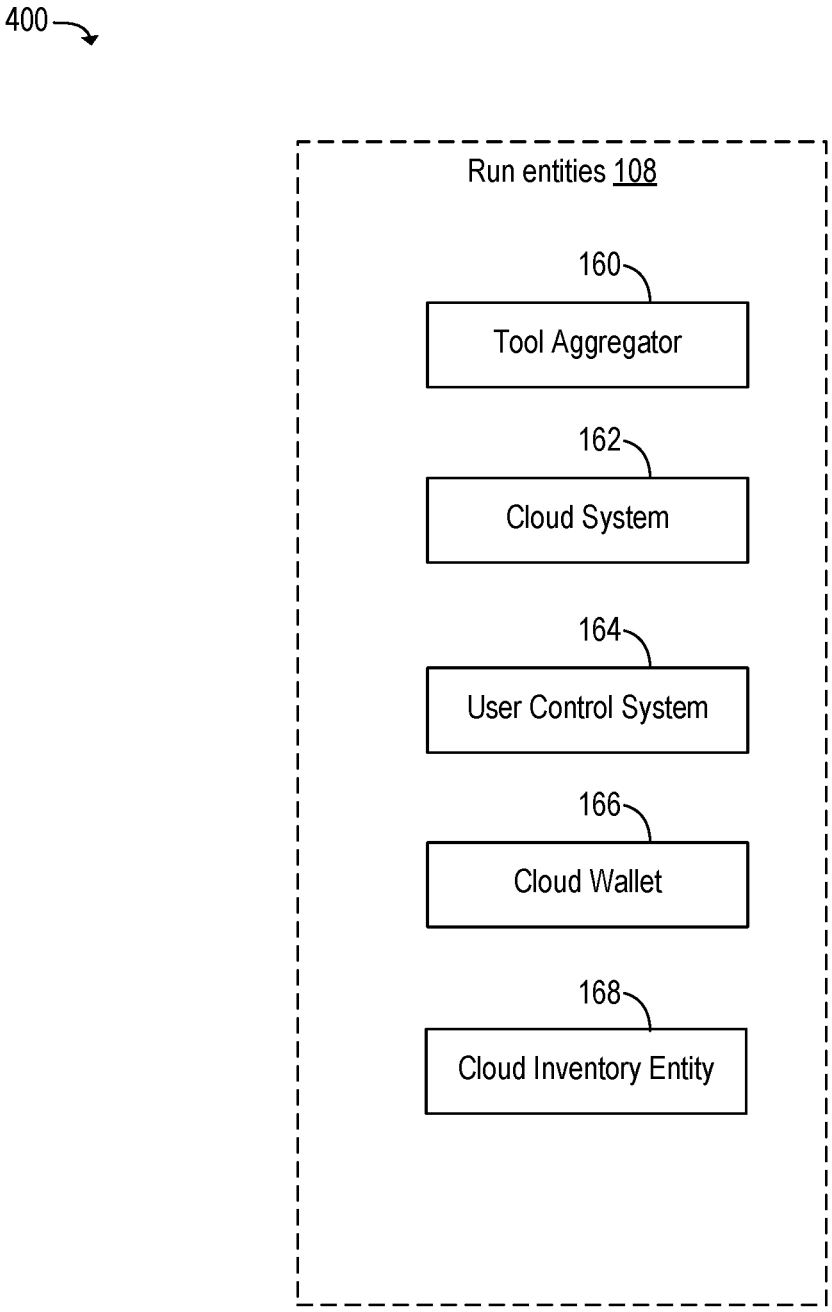

400
Run entities 108
160
Tool Aggregator
162
Cloud System
164
User Control System
166
Cloud Wallet
168
Cloud Inventory Entity

Fig. 4

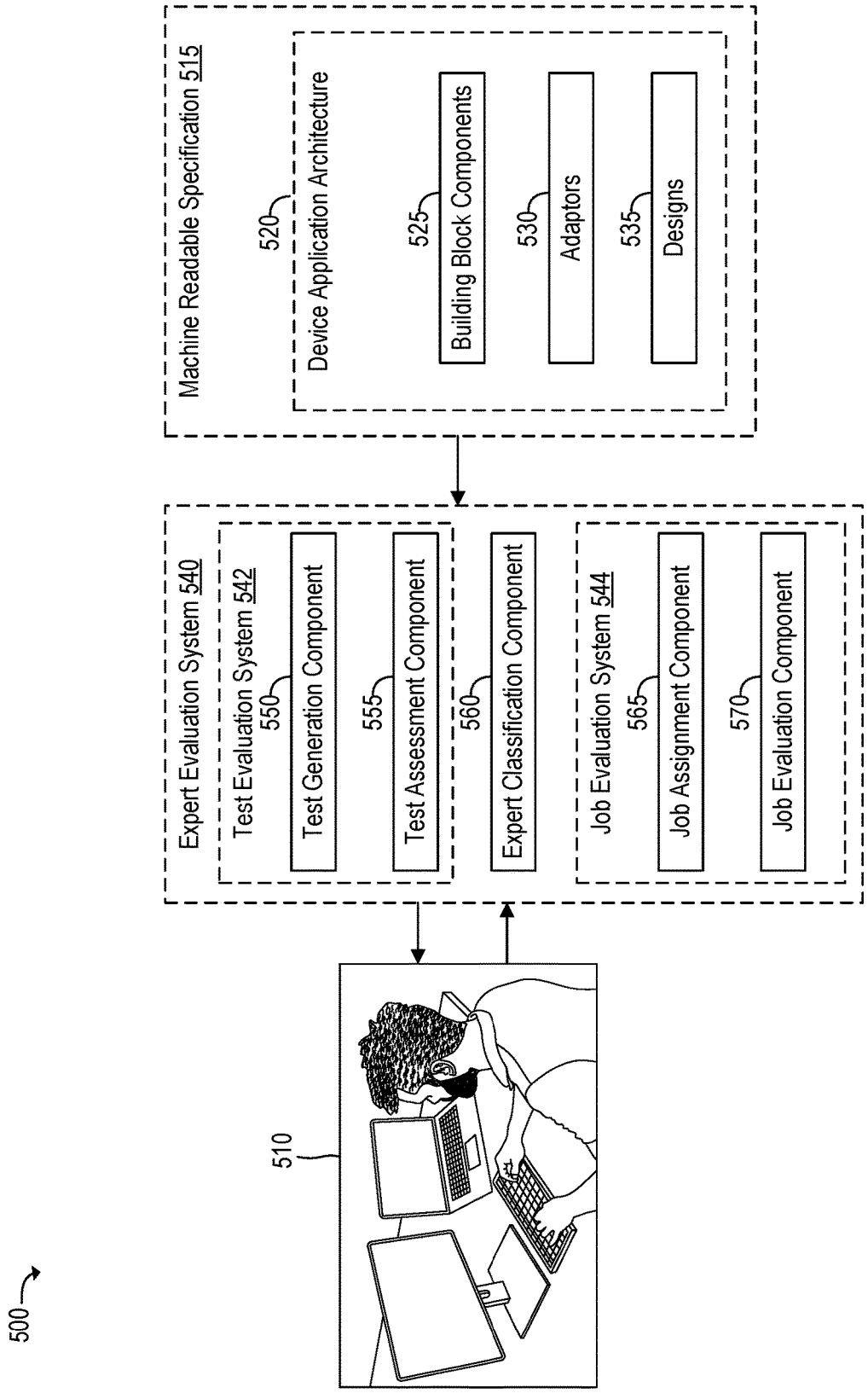

500
510
Machine Readable Specification 515
520
Device Application Architecture
525
Building Block Components
530
Adaptors
535
Designs
Expert Evaluation System 540
Test Evaluation System 542
550
Test Generation Component
555
Test Assessment Component
560
Expert Classification Component
Job Evaluation System 544
565
Job Assignment Component
570
Job Evaluation Component

Fig. 5A

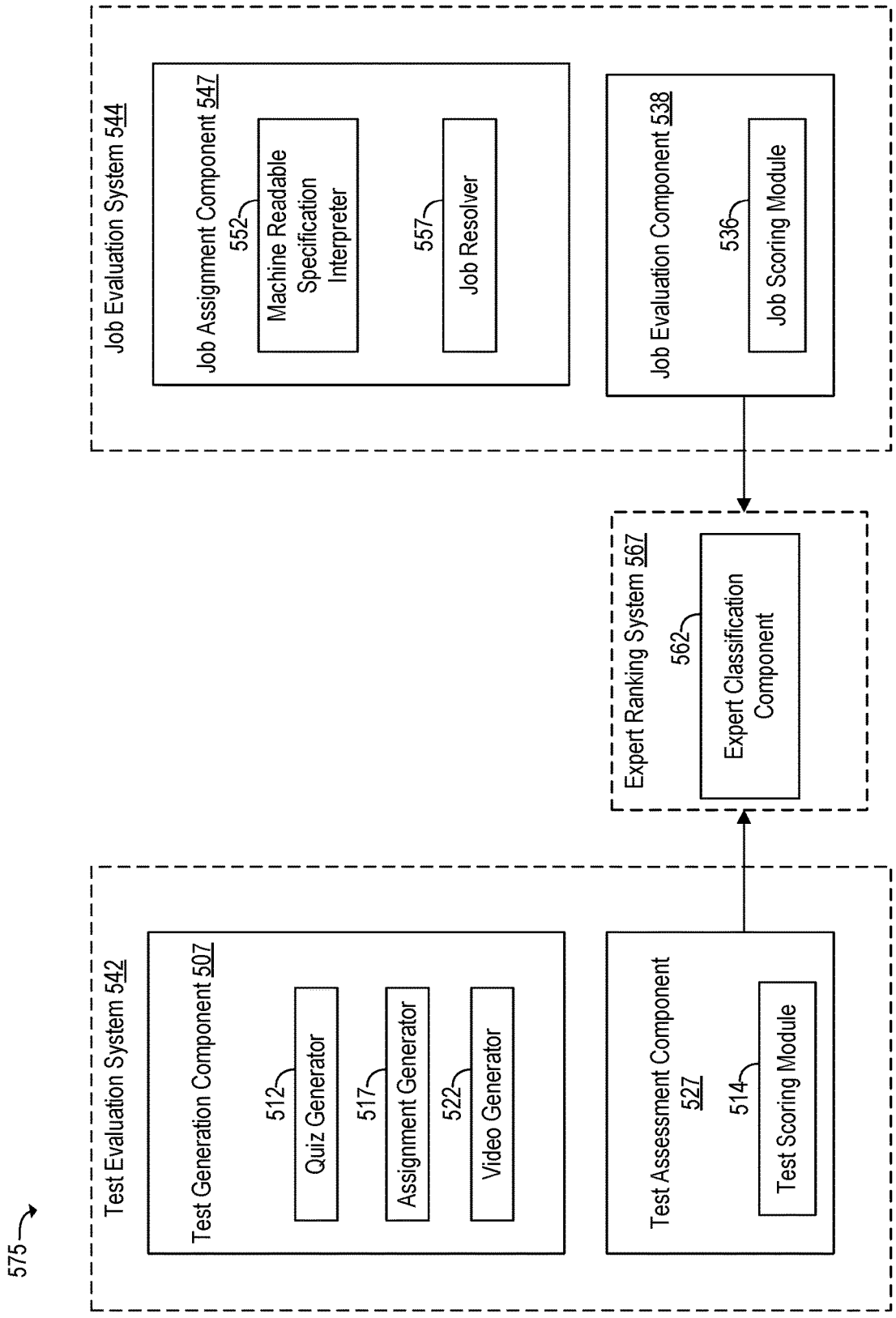

575
Test Evaluation System 542
Test Generation Component 507
512
Quiz Generator
517
Assignment Generator
522
Video Generator
Test Assessment Component 527
514
Test Scoring Module
Expert Ranking System 567
562
Expert Classification Component
Job Evaluation System 544
Job Assignment Component 547
552
Machine Readable Specification Interpreter
557
Job Resolver
Job Evaluation Component 538
536
Job Scoring Module

Fig. 5B

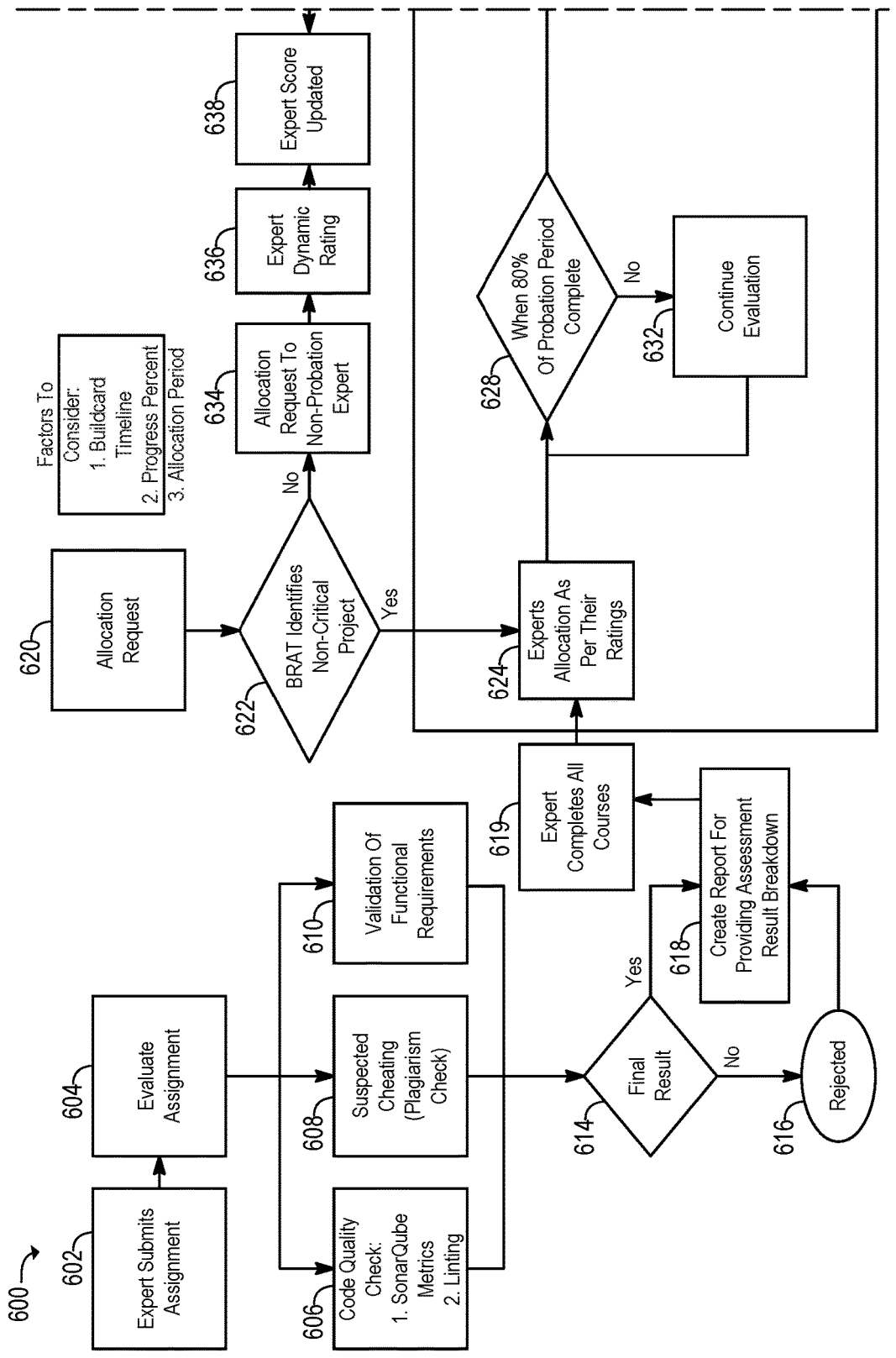

600
602
Expert Submits Assignment
604
Evaluate Assignment
606
Code Quality Check:
1. SonarQube Metrics
2. Linting
608
Suspected Cheating (Plagiarism Check)
610
Validation Of Functional Requirements
614
Final Result
No
616
Rejected
Yes
618
Create Report For Providing Assessment Result Breakdown
619
Expert Completes All Courses
620
Allocation Request
622
BRAT Identifies Non-Critical Project
No
Yes
Factors To Consider:
1. Buildcard Timeline
2. Progress Percent
3. Allocation Period
624
Experts Allocation As Per Their Ratings
628
When 80% Of Probation Period Complete
No
632
Continue Evaluation
634
Allocation Request To Non-Probation Expert
636
Expert Dynamic Rating
638
Expert Score Updated

Fig. 6A

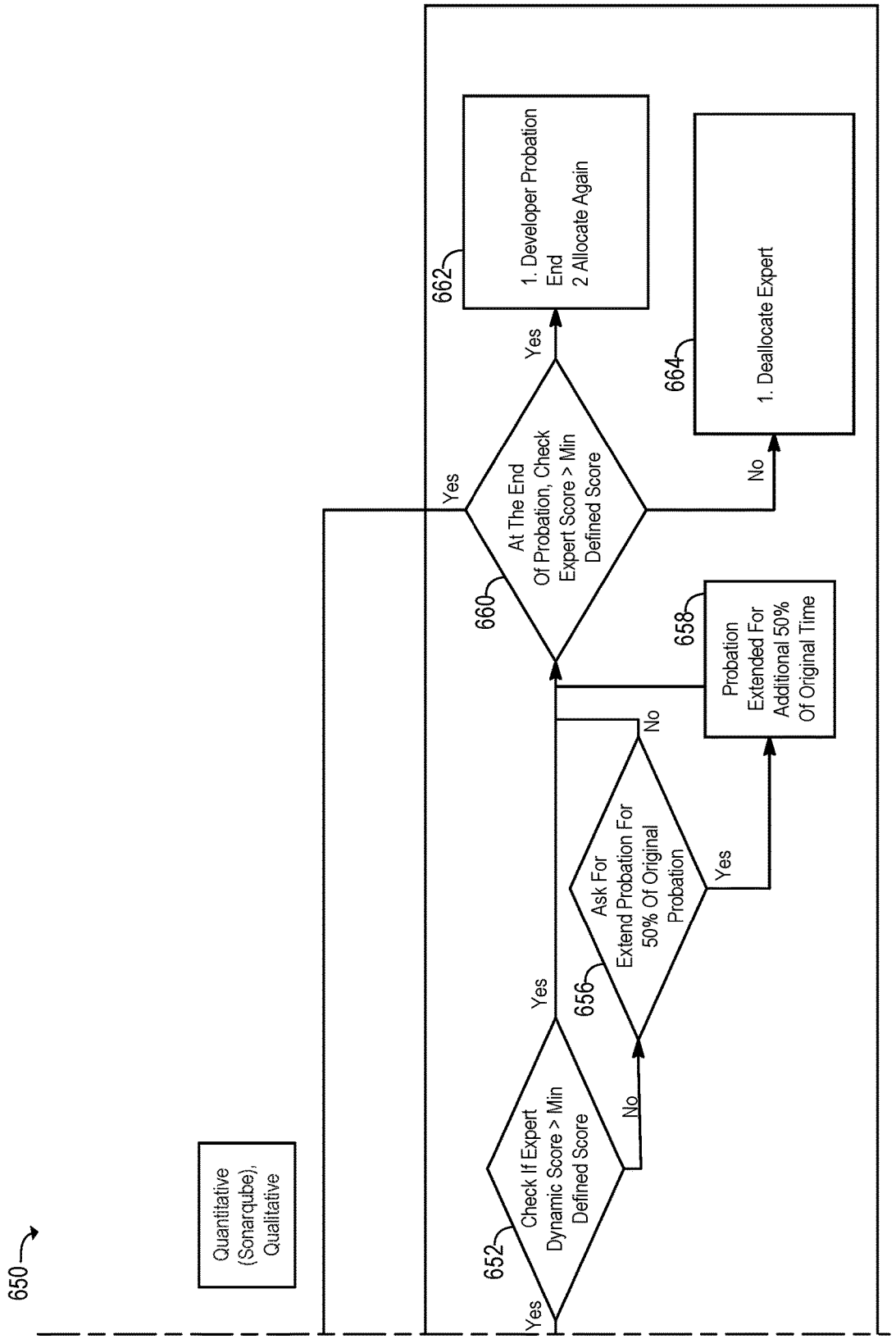

650
Quantitative (Sonarqube), Qualitative
652
Check If Expert Dynamic Score > Min Defined Score
Yes
No
656
Ask For Extend Probation For 50% Of Original Probation
Yes
No
658
Probation Extended For Additional 50% Of Original Time
660
At The End Of Probation, Check Expert Score > Min Defined Score
Yes
No
662
1. Developer Probation End 2 Allocate Again
664
1. Deallocate Expert

Fig. 6B

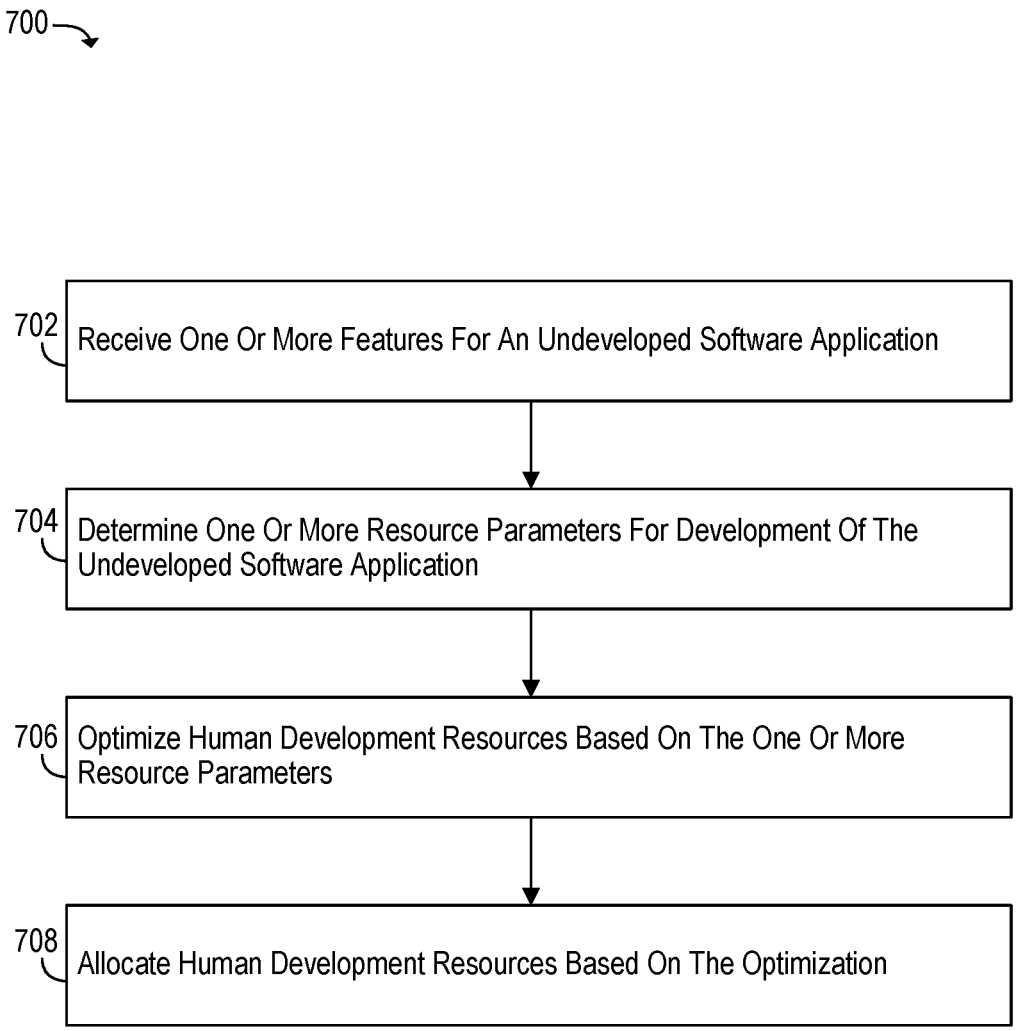

700
702
Receive One Or More Features For An Undeveloped Software Application
704
Determine One Or More Resource Parameters For Development Of The Undeveloped Software Application
706
Optimize Human Development Resources Based On The One Or More Resource Parameters
708
Allocate Human Development Resources Based On The Optimization

Fig. 7

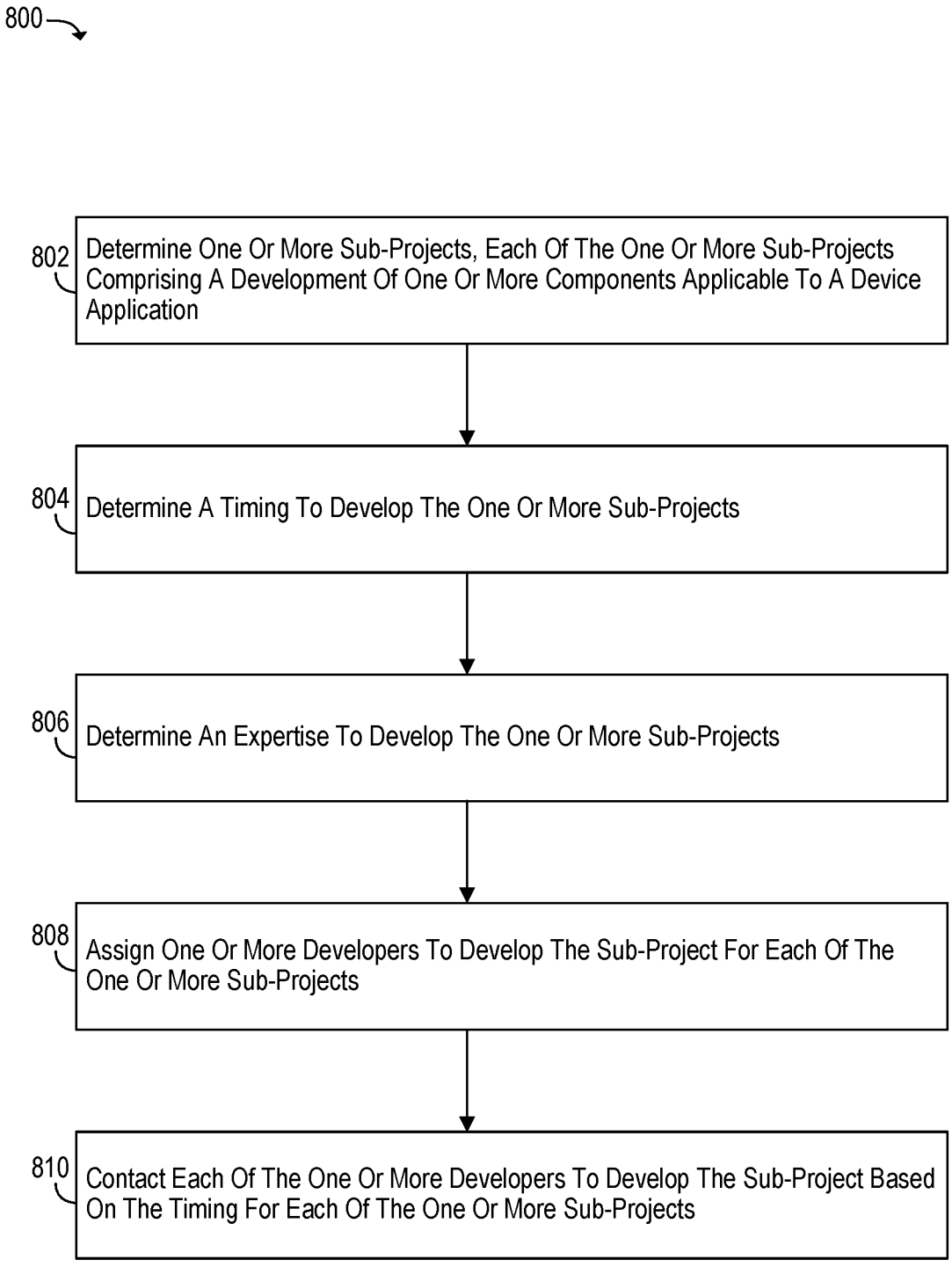

800
802
Determine One Or More Sub-Projects, Each Of The One Or More Sub-Projects Comprising A Development Of One Or More Components Applicable To A Device Application
804
Determine A Timing To Develop The One Or More Sub-Projects
806
Determine An Expertise To Develop The One Or More Sub-Projects
808
Assign One Or More Developers To Develop The Sub-Project For Each Of The One Or More Sub-Projects
810
Contact Each Of The One Or More Developers To Develop The Sub-Project Based On The Timing For Each Of The One Or More Sub-Projects

Fig. 8

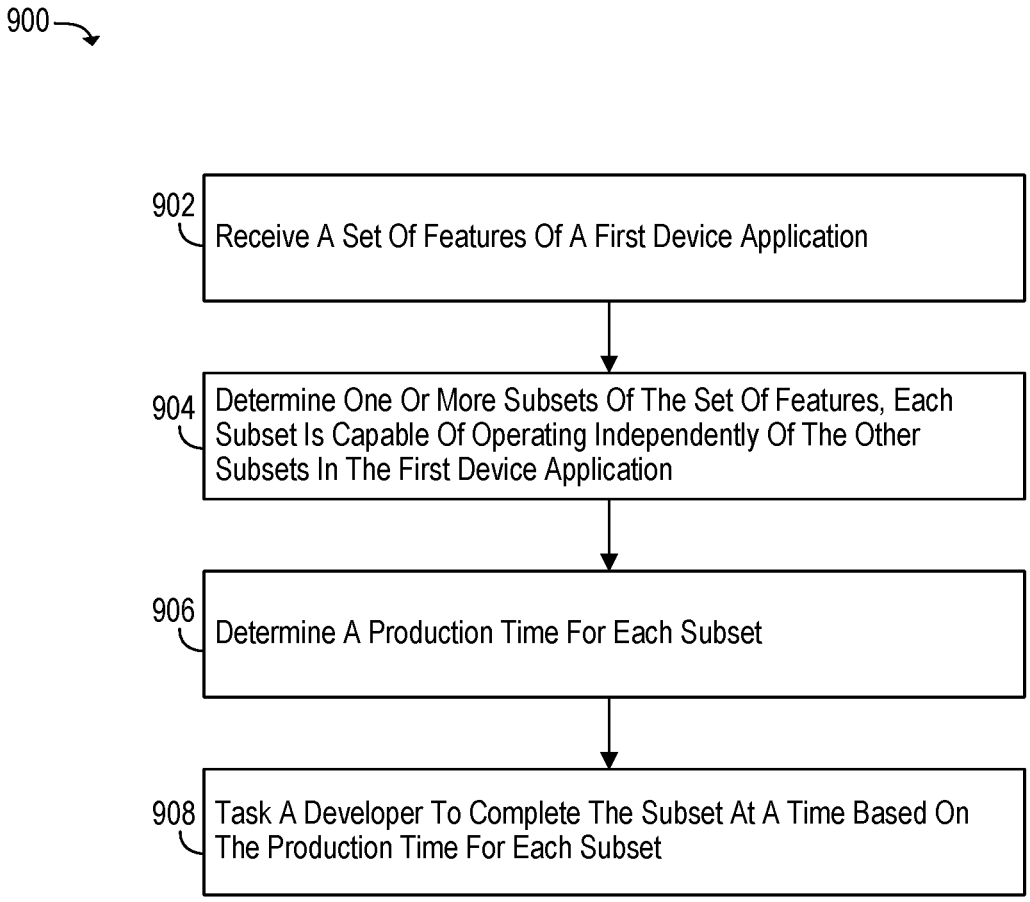

900
902
Receive A Set Of Features Of A First Device Application
904
Determine One Or More Subsets Of The Set Of Features, Each Subset Is Capable Of Operating Independently Of The Other Subsets In The First Device Application
906
Determine A Production Time For Each Subset
908
Task A Developer To Complete The Subset At A Time Based On The Production Time For Each Subset

Fig. 9

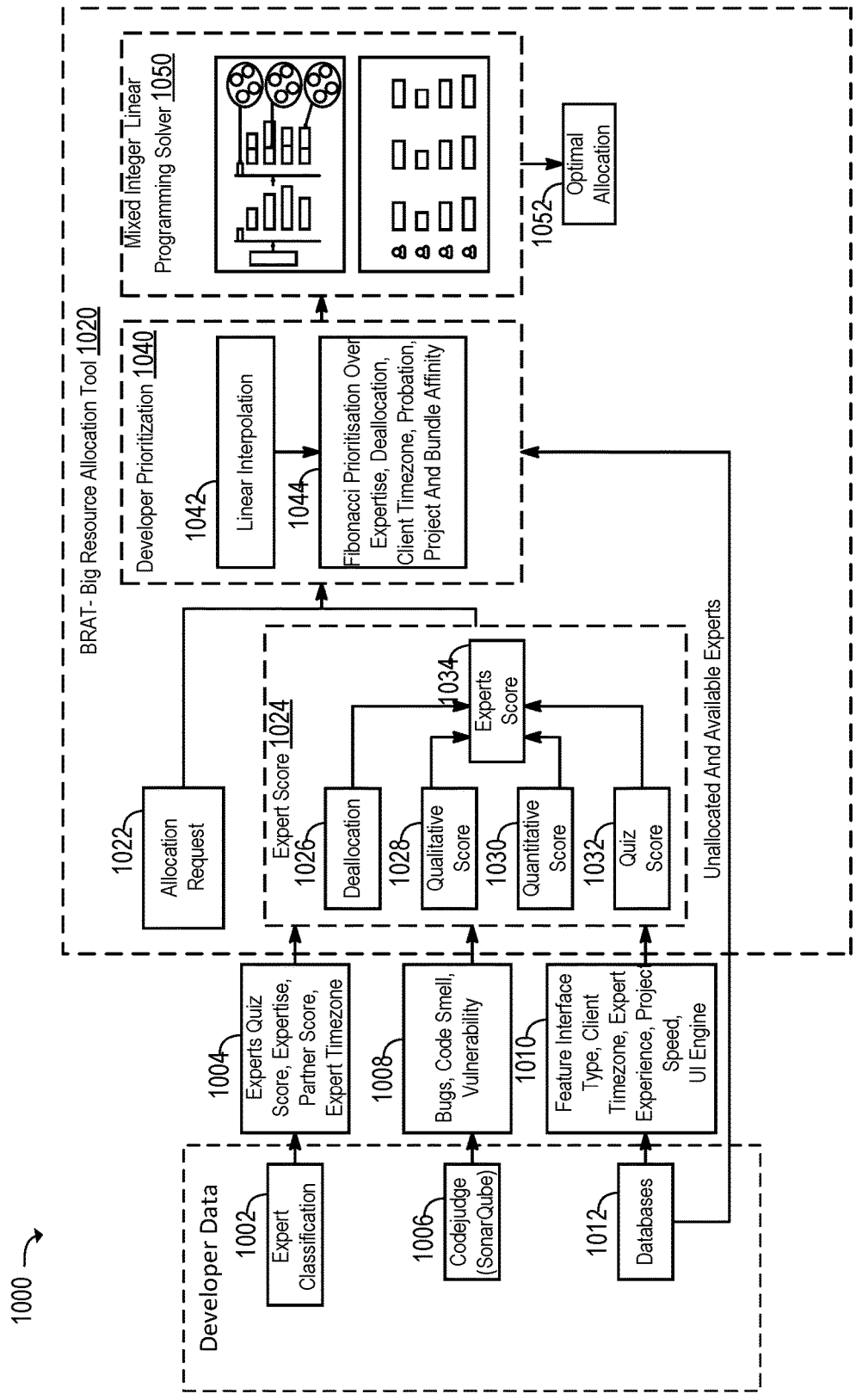

1000
Developer Data
1002
Expert Classification
1004
Experts Quiz Score, Expertise, Partner Score, Expert Timezone
1006
Codejudge (SonarQube)
1008
Bugs, Code Smell, Vulnerability
1010
Feature Interface Type, Client Timezone, Expert Experience, Project Speed, UI Engine
1012
Databases
BRAT- Big Resource Allocation Tool 1020
1022
Allocation Request
Expert Score 1024
1026
Deallocation
1028
Qualitative Score
1030
Quantitative Score
1032
Quiz Score
1034
Experts Score
Unallocated And Available Experts
Developer Prioritization 1040
1042
Linear Interpolation
1044
Fibonacci Prioritisation Over Expertise, Deallocation, Client Timezone, Probation, Project And Bundle Affinity
Mixed Integer Linear Programming Solver 1050
1052
Optimal Allocation

Fig. 10

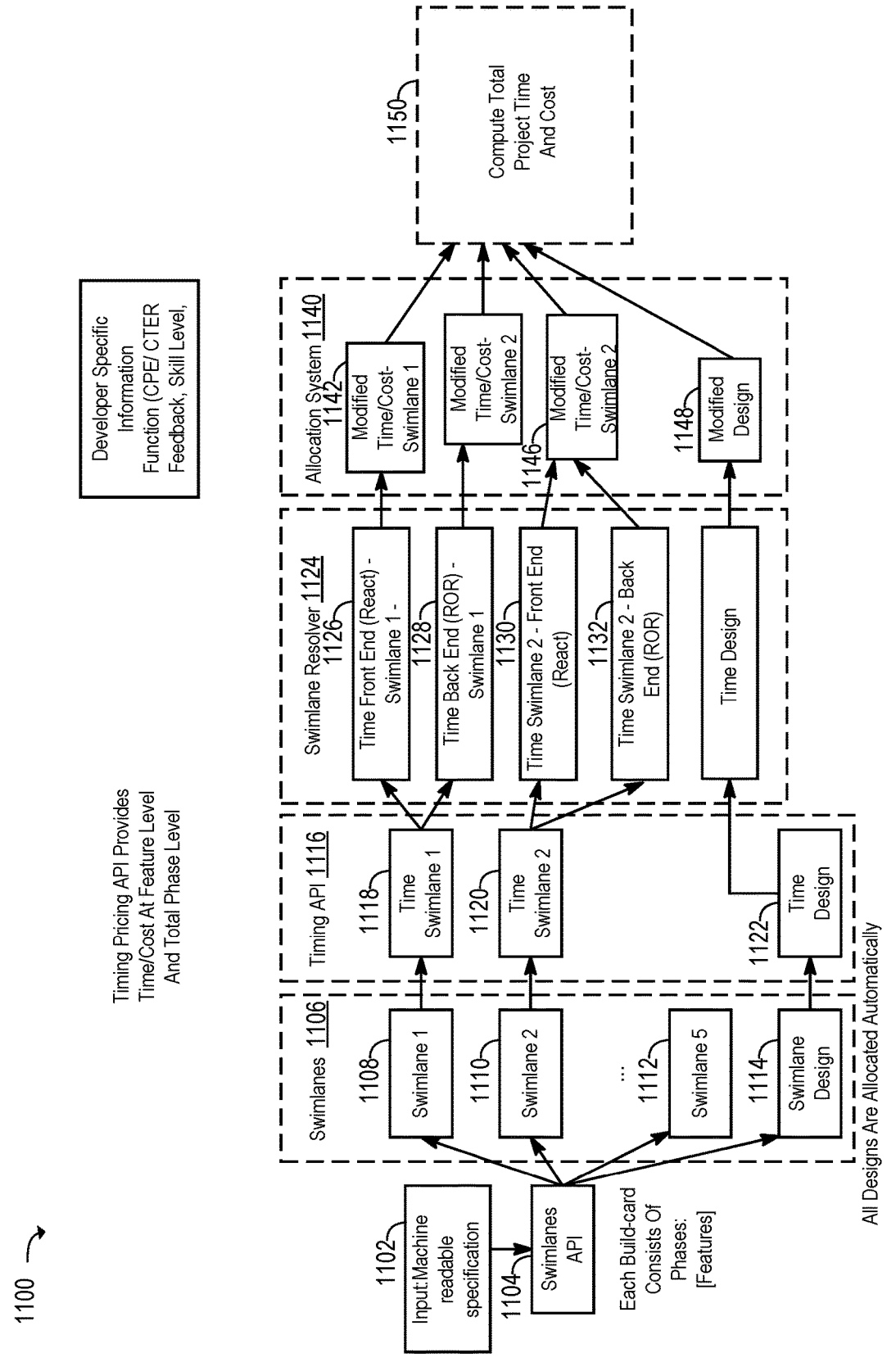

1100
1102
Input:Machine readable specification
1104
Swimlanes API
Each Build-card Consists Of Phases: [Features]
Swimlanes 1106
1108
Swimlane 1
1110
Swimlane 2
...
1112
Swimlane 5
1114
Swimlane Design
All Designs Are Allocated Automatically
Timing API 1116
1118
Time Swimlane 1
1120
Time Swimlane 2
1122
Time Design
Timing Pricing API Provides Time/Cost At Feature Level And Total Phase Level
Developer Specific Information Function (CPE/ CTER Feedback, Skill Level,
Swimlane Resolver 1124
1126
Time Front End (React) - Swimlane 1 -
1128
Time Back End (ROR) - Swimlane 1
1130
Time Swimlane 2 - Front End (React)
1132
Time Swimlane 2 - Back End (ROR)
Time Design
Allocation System 1140
1142
Modified Time/Cost-Swimlane 1
Modified Time/Cost-Swimlane 2
1146
Modified Time/Cost-Swimlane 2
1148
Modified Design
1150
Compute Total Project Time And Cost

Fig. 11

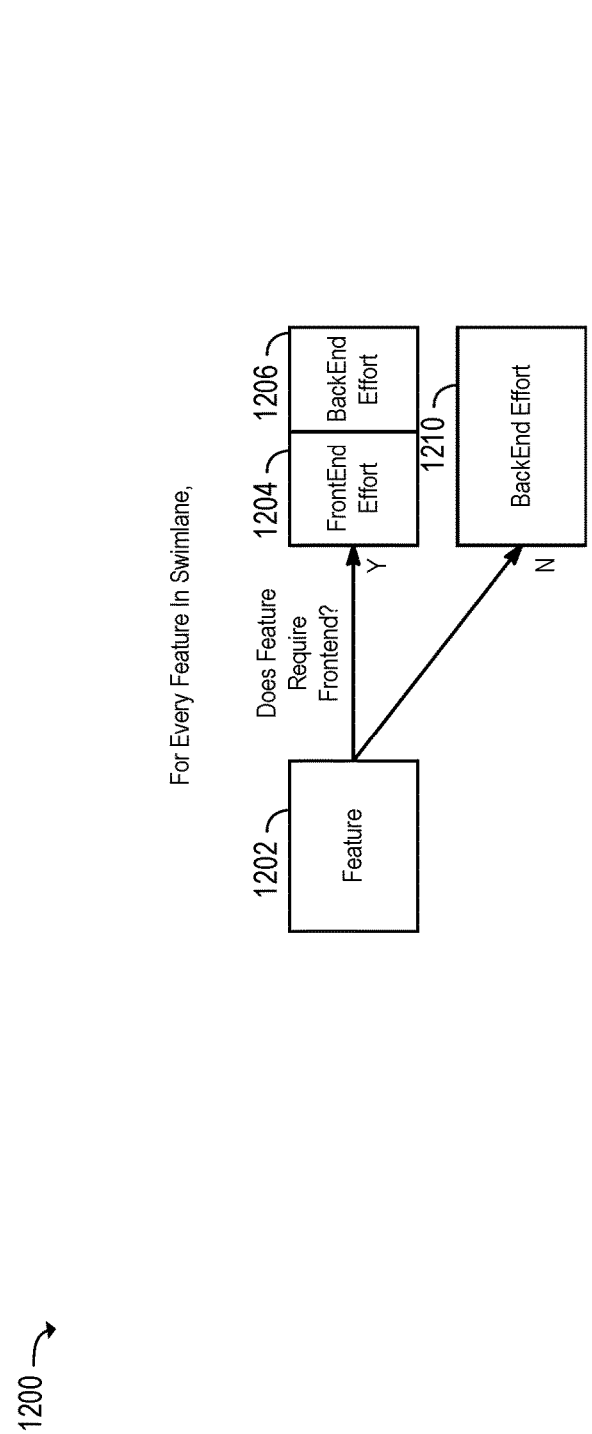


Fig. 12A

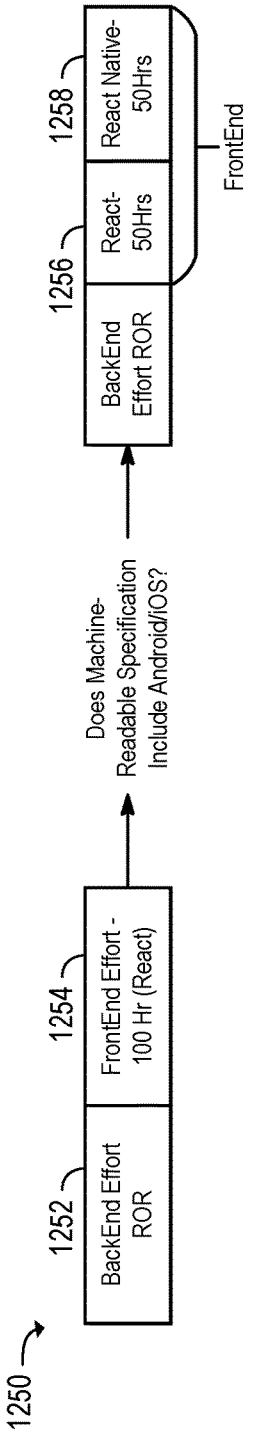


Fig. 12B

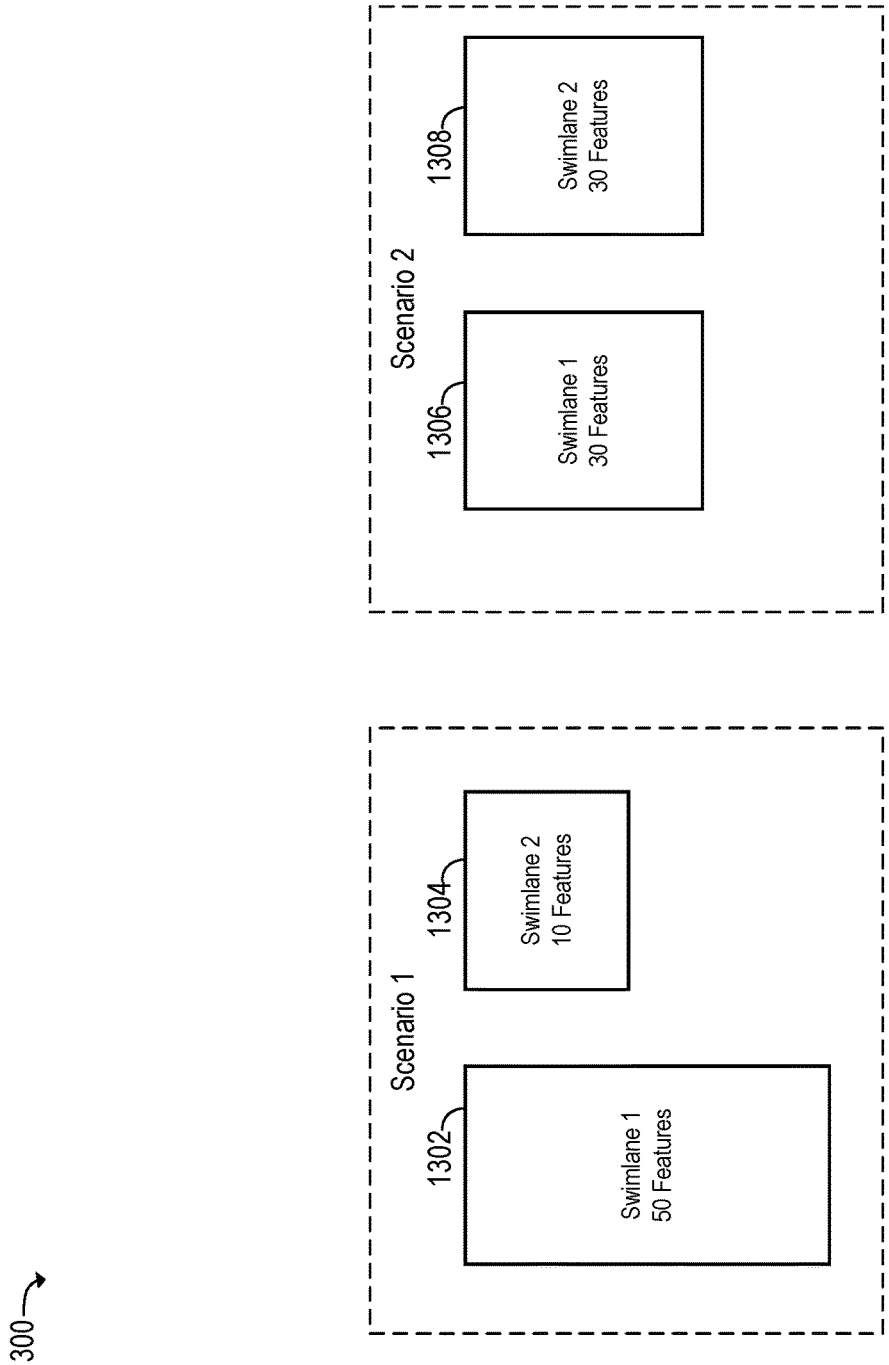

1300
Scenario 1
1302
Swimlane 1
50 Features
1304
Swimlane 2
10 Features
Scenario 2
1306
Swimlane 1
30 Features
1308
Swimlane 2
30 Features

Fig. 13

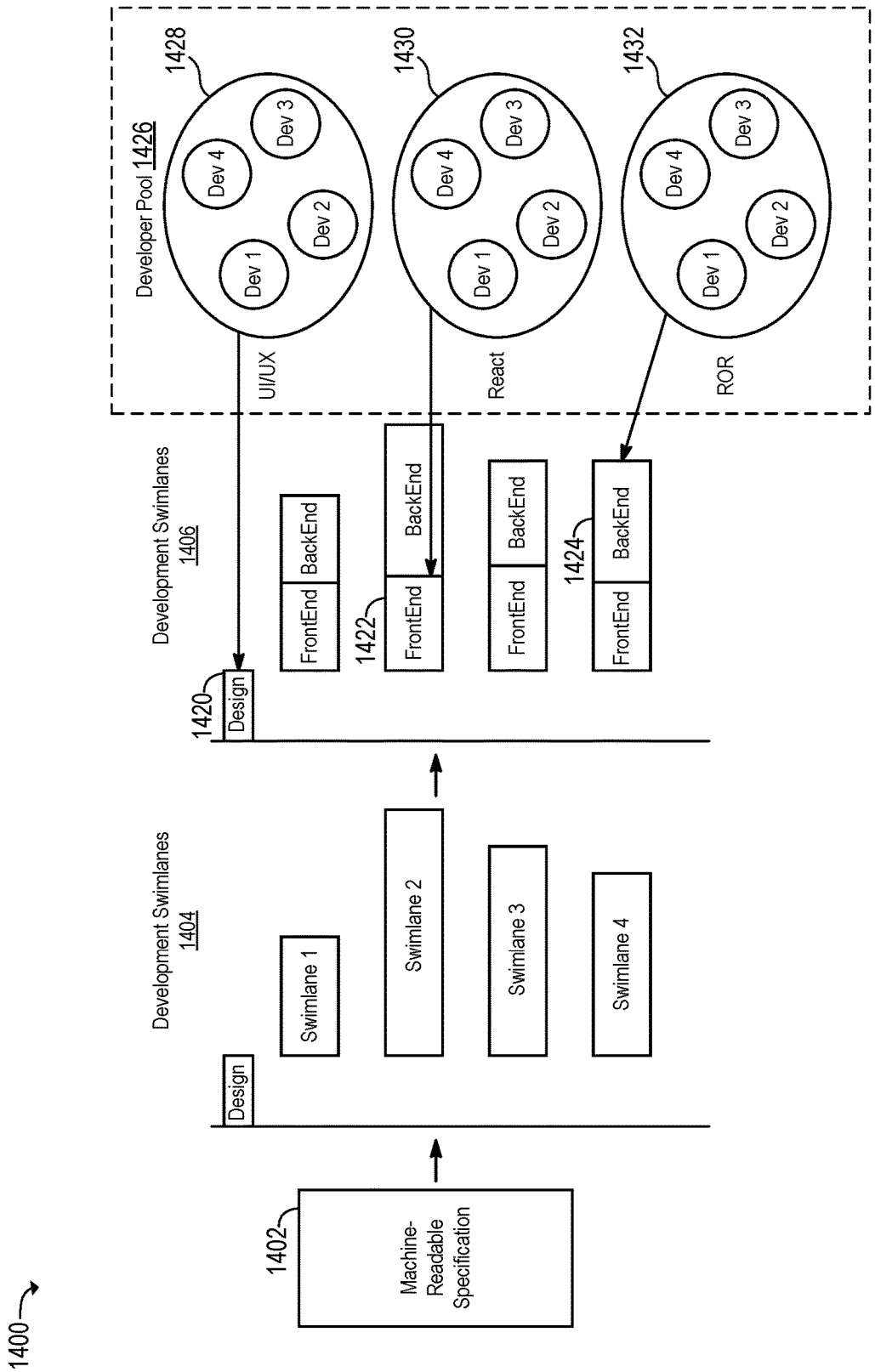

1400
1402
Machine-Readable Specification
Development Swimlanes 1404
Design
Swimlane 1
Swimlane 2
Swimlane 3
Swimlane 4
Development Swimlanes 1406
1420
Design
FrontEnd
BackEnd
1422
FrontEnd
BackEnd
FrontEnd
BackEnd
1424
FrontEnd
BackEnd
Developer Pool 1426
1428
Dev 1
Dev 2
Dev 3
Dev 4
UI/UX
1430
Dev 1
Dev 2
Dev 3
Dev 4
React
1432
Dev 1
Dev 2
Dev 3
Dev 4
ROR

Fig. 14

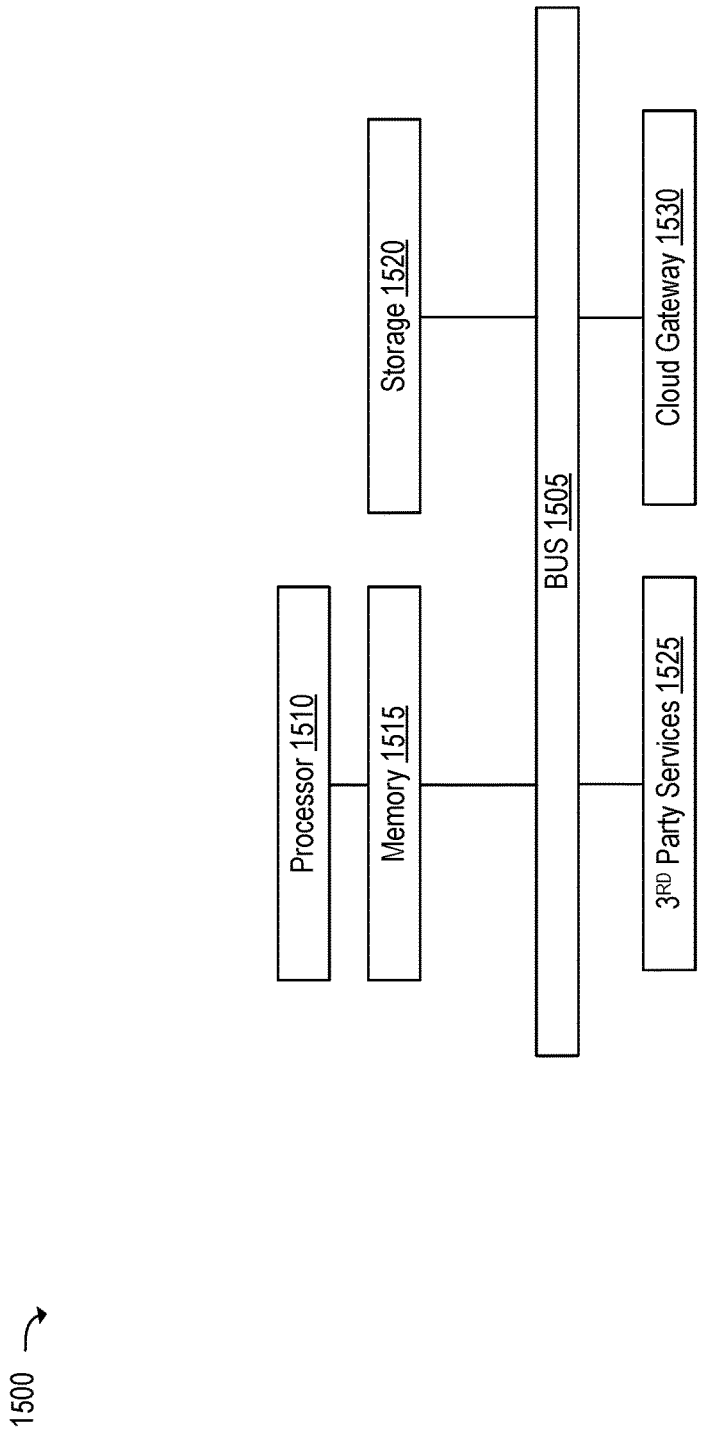

1500
Processor 1510
Memory 1515
Storage 1520
BUS 1505
3RD Party Services 1525
Cloud Gateway 1530

Fig. 15

SYSTEMS AND METHODS FOR ALLOCATING DEVELOPMENT OF A DEVICE APPLICATION

FIELD OF THE INVENTION

[0001] This disclosure relates to software automation, machine learning AI, and project management.

BACKGROUND

[0002] It is expected that a hired individual, be they an employee or an independent contractor, is qualified for the job to which they are hired. However, verifying a hiree's qualifications may be challenging. For instance, employees may have embellished or exaggerated on their resumes. And employees who have accurate resumes may still have skills they have atrophied to the point that they are no longer competent to do the same work. Further, employee skills may change over time. For instance, employees gain experience and know-how as they work. On the other hand, some employees' work product may decline for various reasons such as burnout or life changes.

[0003] Even when the skill level of employees are known, it may be challenging to optimally use the employees' skills to best advantage. In the field of application development, it may be difficult to organize an optimum division of work based on project goals and employee skills.

[0004] There is a need in the art for a better way of ascertaining a level of skill for an employee when they are hired and during employment. There is a further need for a way of utilizing the employee based on their level of skill.

SUMMARY

[0005] Systems, methods, and computer readable storage mediums for developing a device application are disclosed. An exemplary embodiment is a method for allocating resources to develop a software application. The method includes receiving one or more features for an undeveloped software application and determining one or more resource parameters for development of the undeveloped software application. The method further includes optimizing human development resources based on the one or more resource parameters and allocating human development resources based on the optimization. The one or more parameters may include a development expertise. The one or more parameters may further include an area of expertise. Allocating the human development resources may include determining a competence of one or more developers and assigning a subset of the one or more features to each of the one or more developers based on the competence being greater than or equal to the development expertise and the area of expertise. Allocating the human development resources may further include determining a production time for each subset of the one or more features where assigning the subset of the one or more features to each of the one or more developers is performed at a time that is optimized based on the production time for the subset. Receiving the one or more features may include resolving the one or more features from a machine readable specification. Allocating the human development resources may include contacting one or more developers by an automated computer system.

[0006] Another general aspect is a computer system that is configured to develop a device application. The computer system includes a processor coupled to a memory where the processor is configured to receive one or more features for an undeveloped software application and determine one or more resource parameters for development of the undeveloped software application. The processor is further configured to optimize human development resources based on the one or more resource parameters and allocate human development resources based on the optimization. The one or more parameters may include a development expertise. The one or more parameters may further include an area of expertise. The allocation of human development resources may include the processor configured to determine a competence of one or more developers and assign a subset of the one or more features to each of the one or more developers based on the competence being greater than or equal to the development expertise and the area of expertise. The allocation of human development resources may include the processor configured determine a production time for each subset of the one or more features where the processor is configured to assign the subset of the one or more features to each of the one or more developers at a time that is optimized based on the production time for the subset. The reception of the one or more features may include the processor being configured to resolve the one or more features from a machine readable specification.

[0007] An exemplary embodiment is a computer readable storage medium having data stored therein representing software executable by a computer. The software includes instructions that, when executed, cause the computer readable storage medium to perform receiving one or more features for an undeveloped software application and determining one or more resource parameters for development of the undeveloped software application. The instructions further cause the computer readable storage medium to perform optimizing human development resources based on the one or more resource parameters and allocating human development resources based on the optimization. The one or more parameters may include a development expertise. The one or more parameters may further include an area of expertise. Allocating the human development resources may include determining a competence of one or more developers and assigning a subset of the one or more features to each of the one or more developers based on the competence being greater than or equal to the development expertise and the area of expertise. Allocating the human development resources may further include determining a production time for each subset of the one or more features where assigning the subset of the one or more features to each of the one or more developers is performed at a time that is optimized based on the production time for the subset. Allocating the human development resources may include contacting one or more developers by an automated computer system.

[0008] Another general aspect is a method for developing components for a device application. The method includes determining one or more subprojects where each of the one or more subprojects include a development of one or more components applicable to a device application and determining a timing to develop the one or more subprojects. The method further includes determining an expertise to develop the one or more subprojects. For each of the one or more subprojects, the method further includes assigning one or more developers to develop the subproject and contacting each of the one or more developers to develop the subproject based on the timing. The method further includes determining a competence of each of the one or more developers

prior to determining the one or more developers where the competence of each developer is greater or equal to the expertise for the subproject to which they were assigned. Determining a competence for each developer may include determining a score for the developer based on a job that was assigned to the developer where determining comprises evaluating the job automatically with a computer system. Determining one or more subprojects may include resolving the subprojects from a machine readable specification. The method may further include determining a production time for each of the one or more subprojects based on the expertise where assigning the one or more developers is based on the production time. The assigning may be optimized to complete a first development application, which incorporates at least one of the one or more components, based on time. The assigning may be further optimized to complete a second development application, which incorporates at least one of the one or more components, based on time.

[0009] An exemplary embodiment is a computer system configured to develop a device application. The computer system includes a processor coupled to a memory. The processor is configured to determine one or more subprojects, each of the one or more subprojects includes a development of one or more components applicable to a device application and determining a timing to develop the one or more subprojects. The processor is further configured to determine an expertise to develop the one or more subprojects. For each of the one or more subprojects, the processor is further configured to perform an assignment of one or more developers to develop the subproject and contact each of the one or more developers to develop the subproject based on the timing. The processor may be further configured to determine a competence of each of the one or more developers prior to determining the one or more developers where the competence of each developer is greater or equal to the expertise to for the subproject to which they were assigned. Determining the competence for each developer may include a processor configured to determine a score for the developer based on a job that was assigned to the developer and evaluate the job automatically with the computer system. Determining the one or more subprojects may include the processor being configured to resolve the subprojects from a machine readable specification. The processor may be further configured to determine a production time for each of the one or more subprojects based on the expertise where the processor is configured to perform the assignment of the one or more developers based on the production time. The assignment may be optimized to complete a first development application, which incorporates at least one of the one or more components, based on time. The assignment may be further optimized to complete a second development application, which incorporates at least one of the one or more components, based on time.

[0010] Another general aspect is a computer readable storage medium having data stored therein representing software executable by a computer. The software includes instructions that, when executed, cause the computer readable storage medium to perform determining one or more subprojects where each of the one or more subprojects include a development of one or more components applicable to a device application and determining a timing to develop the one or more subprojects. The instructions further cause the computer readable storage medium to perform determining an expertise to develop the one or more subprojects. For each of the one or more subprojects, the instructions further cause the computer readable storage medium to perform assigning one or more developers to develop the subproject and contacting each of the one or more developers to develop the subproject based on the timing. The instructions may further cause the computer readable storage medium to perform determining a competence of each of the one or more developers prior to determining the one or more developers where the competence of each developer is greater or equal to the expertise for the subproject to which they were assigned. Determining the competence for each developer may include determining a score for the developer based on a job that was assigned to the developers where determining includes evaluating the job automatically. Determining one or more subprojects may include resolving the subprojects from a machine readable specification. The instructions may further cause the computer readable storage medium to perform determining a production time for each of the one or more subprojects based on the expertise where assigning the one or more developers is based on the production time. The assigning may be optimized to complete a 1st development application, which incorporates at least one of the one or more components, based on time.

[0011] An exemplary embodiment is a method for developing device applications. The method includes receiving a set of features of a 1st device application and determining one or more subsets of the set of features where each subset is capable of operating independently of the other subsets in the 1st device application area. The method further includes determining a production time for each subset. For each subset, the method includes tasking a developer to complete the subset at a time based on the production time. The method may further include determining internal dependencies for each subset where the production time is determined based on the internal dependencies. The method may further include determining a difficulty of developing each feature of the set of features where tasking the developer includes correlating and expertise of the developer to the difficulty. The expertise of the developer may be determined by an automated valuation where the automated evaluation includes determining a score for the developer and assigning to the developer a job based on a machine readable specification. The machine readable specification may include one or more jobs are completable by the developer. The automated evaluation may further include receiving a completed job based on one of the one or more jobs and updating the score based on an assessment of the completed job. The score may be a classification that corresponds to a classification of the job. The method may further include determining the classification of the job based on the machine readable specification. Tasking the developer may include automatically contacting, by a computer system, the developer to communicate a job to complete the subset.

[0012] Another general aspect is a computer system configured to develop a device application. The computer system includes a processor coupled to a memory where the processor is configured to receive a set of features of a 1st device application and determine one or more subsets of the set of features where each subset is capable of operating independently of the other subsets in the 1st device application. The processor is further configured to determine a production time for each subset. For each subset, the pro-

cessor is further configured to task a developer to complete the subset at a time based on the production time. The processor may be further configured to determine internal dependencies for each subset where the production time is determined based on the internal dependencies. The processor may be further configured to determine a difficulty of developing each feature of the set of features where tasking a developer comprises the processor configured to correlate and expertise of the developer to the difficulty. The expertise of the developer may be determined by an automated evaluation where the automated evaluation includes a processor being further configured to determine a score for the developer and assign, to developers, a job based on a machine-readable specification. The machine readable specification may include one or more jobs that are completable by the developer. The automated evaluation may further include receiving a completed job based on one of the one or more jobs and updating the score based on an assessment of the completed job. The score may be a classification that corresponds to a classification of the job. The processor may be further configured to determine the classification of the job based on machine-readable specification. Tasking the developer may include the process of being configured to automatically contact the developer to communicate a job to complete the subset.

[0013] An exemplary embodiment is a computer readable storage medium having data stored therein representing software executable by a computer. The software may include instructions that when executed, cause a computer readable storage medium to perform receiving a set of features of a 1^{st} device application and determining one or more subsets of the set of features. Each subset may be capable of operating independently of the other subsets in the 1^{st} device application. The instructions may further cause the computer readable storage medium to perform determining a production time for each subset. For each subset, the instructions may further cause the computer readable storage medium to task a developer to complete the subset at a time based on the production time. The instructions may further cause the computer readable storage medium to perform determining internal dependencies for each subset where the production time is determined based on the internal dependencies. The instructions may further cause the computer readable storage medium to perform determining a difficulty of developing each feature of the set of features where tasking the developer includes correlating an expertise of the developer to the difficulty. The instructions may further cause the computer readable storage medium to perform determining a score for the developer, assigning to the developer, a job based on her machine-readable specification where this machine-readable specification comprises one or more jobs that are completable by the developer, receiving a completed job based on the one or more jobs, and updating the score based on an assessment of the completed job. The score may be a classification that corresponds to a classification of the job.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a software building system illustrating the components that may be used in an embodiment of the disclosed subject matter.

[0015] FIG. **2** is a schematic illustrating an embodiment of the management components of the disclosed subject matter.

[0016] FIG. **3** is a schematic illustrating an embodiment of an assembly line and surfaces of the disclosed subject matter.

[0017] FIG. **4** is a schematic illustrating an embodiment of the run entities of the disclosed subject matter.

[0018] FIG. **5**A is a schematic of an embodiment of the disclosed system for evaluating a developer.

[0019] FIG. **5**B is a schematic of an embodiment of the expert evaluation system.

[0020] FIGS. **6**A-**6**B are a flow diagram of an embodiment of the disclosed system for allocating resources to develop a device application.

[0021] FIG. **7** is a flow diagram of an embodiment of the disclosed subject matter.

[0022] FIG. **8** is a flow diagram of another embodiment of the disclosed subject matter.

[0023] FIG. **9** is a flow diagram of yet another embodiment of the disclosed subject matter.

[0024] FIG. **10** is a flow diagram of an embodiment of a system for allocating developers to a job.

[0025] FIG. **11** is a flow diagram of an embodiment for allocating developers based on a machine readable specification.

[0026] FIGS. **12**A-**12**B are schematics of embodiments for assessing effort required for a feature.

[0027] FIG. **13** is a schematic of an exemplary embodiment for allocating resources to a job.

[0028] FIG. **14** is another schematic of an exemplary embodiment for allocating resources to a job.

[0029] FIG. **15** is a schematic illustrating the computing components that may be used to implement various features of embodiments described in the disclosed subject matter.

DETAILED DESCRIPTION

[0030] The disclosed subject matter is a system, method, and computer readable storage medium for allocating developer resources to development of a device application. The term device application, as used herein, refers to an application that runs on an electronic device. Examples of electronic devices that may run device applications include, but are not limited to mobile phones, desktop computers, laptop computers, television sets, IoT devices, console devices such as Xbox, airline media systems, and car media players. Individuals that may work on a device application include, but are not limited to developers of code that is configured to run a device application, designers of various aspects of the device application such as a user interface, and quality engineers who test functionality of a device application. As used herein, the term developer may refer to all such individuals.

[0031] In an exemplary embodiment, the disclosed subject matter allocates one or more developer resources to one or more jobs associated with development of a device application. For example, a device application may require development of a feature to include a relational database. The disclosed subject matter may allocate an optimum developer to complete the feature. In various embodiments, the disclosed subject matter may allocate multiple developers to work on different portions of a device application. For example, the disclosed subject matter may allocate a designer to generate designs for a device application. Further, the disclosed subject matter may allocate one or more developers to develop a first series of components for the device application. The disclosed subject matter may further

allocate one or more other developers to develop a second series of components for the device application. The disclosed subject matter may resolve the first series of components from the second series of components based on the two series of components being capable of operating independently of one another. Thus the two series of components may be completed and tested in any order.

[0032] In an exemplary embodiment, the disclosed resource allocating system determines a time to allocate jobs to developers. For example, an evaluation system may determine a score for the developer which may indicate a speed at which the developer will likely complete a job. Accordingly, the system may allocate the job to the developer based on the speed at which the developer works in order to complete the job by a specific time.

[0033] The disclosed system may allocate developers to develop features for more than one device application where some of the features may be used by at least two device applications. For example, if a first feature is required for two separate device applications, the disclosed system may allocate a job to develop the feature once and share the feature between the two device applications.

[0034] In various embodiments, the disclosed system may test developers to determine an expertise of the developer prior to allocating jobs to the developer. The expertise of the developer may include an area of expertise. Areas of expertise for device application development include but are not limited to backend development, front-end development, mobile app security, user interface design, cross-platform development, mobile application testing, and mobile application deployment. Developers may be classified or ranked for each area of expertise.

[0035] This goes subject matter may include a system that reads the machine-readable specification to resolve one or more jobs and determine a difficulty of the one or more jobs. The system may further allocate the resolved jobs to developers based on the difficulty of the jobs and the expertise of the developers. The system may time the allocation based on a speed at which the developer works, a time at which a job needs to be completed, and any dependencies associated with the job. For example, a first feature may be dependent on the second feature. In one instance a backend of a device application may be dependent on the front-end. Thus, the front-end would need to be completed before the backend. Accordingly, the disclosed system would time the allocation such that the front-end is completed before development of the backend begins.

[0036] Referring to FIG. **1**, FIG. **1** is a schematic of a software building system **100** illustrating the components that may be used in an embodiment of the disclosed subject matter. The software building system **100** is an AI-assisted platform that comprises entities, circuits, modules, and components that enable the use of state-of-the-art algorithms to support producing custom software.

[0037] A user may leverage the various components of the software building system **100** to quickly design and complete a software project. The features of the software building system **100** operate AI algorithms where applicable to streamline the process of building software. Designing, building and managing a software project may all be automated by the AI algorithms.

[0038] To begin a software project, an intelligent AI conversational assistant may guide users in conception and design of their idea. Components of the software building system **100** may accept plain language specifications from a user and convert them into a computer readable specification that can be implemented by other parts of the software building system **100**. Various other entities of the software building system **100** may accept the computer readable specification or buildcard to automatically implement it and/or manage the implementation of the computer readable specification.

[0039] The embodiment of the software building system **100** shown in FIG. **1** includes user adaptation modules **102**, management components **104**, assembly line components **106**, and run entities **108**. The user adaptation modules **102** entities guide a user during all parts of a project from the idea conception to full implementation. user adaptation modules **102** may intelligently link a user to various entities of the software building system **100** based on the specific needs of the user.

[0040] The user adaptation modules **102** may include specification builder **110**, an interactor **112** system, and the prototype module **114**. They may be used to guide a user through a process of building software and managing a software project. Specification builder **110**, the interactor **112** system, and the prototype module **114** may be used concurrently and/or link to one another. For instance, specification builder **110** may accept user specifications that are generated in an interactor **112** system. The prototype module **114** may utilize computer generated specifications that are produced in specification builder **110** to create a prototype for various features. Further, the interactor **112** system may aid a user in implementing all features in specification builder **110** and the prototype module **114**.

[0041] Spec builder **110** converts user supplied specifications into specifications that can be automatically read and implemented by various objects, instances, or entities of the software building system **100**. The machine readable specifications may be referred to herein as a buildcard. In an example of use, specification builder **110** may accept a set of features, platforms, etc., as input and generate a machine readable specification for that project. Specification builder **110** may further use one or more machine learning algorithms to determine a cost and/or timeline for a given set of features. In an example of use, specification builder **110** may determine potential conflict points and factors that will significantly affect cost and timeliness of a project based on training data. For example, historical data may show that a combination of various building block components create a data transfer bottleneck. Specification builder **110** may be configured to flag such issues.

[0042] The interactor **112** system is an AI powered speech and conversational analysis system. It converses with a user with a goal of aiding the user. In one example, the interactor **112** system may ask the user a question to prompt the user to answer about a relevant topic. For instance, the relevant topic may relate to a structure and/or scale of a software project the user wishes to produce. The interactor **112** system makes use of natural language processing (NLP) to decipher various forms of speech including comprehending words, phrases, and clusters of phases

[0043] In an exemplary embodiment, the NLP implemented by interactor **112** system is based on a deep learning algorithm. Deep learning is a form of a neural network where nodes are organized into layers. A neural network has a layer of input nodes that accept input data where each of the input nodes are linked to nodes in a next layer. The next

layer of nodes after the input layer may be an output layer or a hidden layer. The neural network may have any number of hidden layers that are organized in between the input layer and output layers.

[0044] Data propagates through a neural network beginning at a node in the input layer and traversing through synapses to nodes in each of the hidden layers and finally to an output layer. Each synapse passes the data through an activation function such as, but not limited to, a Sigmoid function. Further, each synapse has a weight that is determined by training the neural network. A common method of training a neural network is backpropagation. Backpropagation is an algorithm used in neural networks to train models by adjusting the weights of the network to minimize the difference between predicted and actual outputs. During training, backpropagation works by propagating the error back through the network, layer by layer, and updating the weights in the opposite direction of the gradient of the loss function. By repeating this process over many iterations, the network gradually learns to produce more accurate outputs for a given input.

[0045] Various systems and entities of the software building system **100** may be based on a variation of a neural network or similar machine learning algorithm. For instance, input for NLP systems may be the words that are spoken in a sentence. In one example, each word may be assigned to separate input node where the node is selected based on the word order of the sentence. The words may be assigned various numerical values to represent word meaning whereby the numerical values propagate through the layers of the neural network.

[0046] The NLP employed by the interactor **112** system may output the meaning of words and phrases that are communicated by the user. The interactor **112** system may then use the NLP output to comprehend conversational phrases and sentences to determine the relevant information related to the user's goals of a software project. Further machine learning algorithms may be employed to determine what kind of project the user wants to build including the goals of the user as well as providing relevant options for the user.

[0047] The prototype module **114** can automatically create an interactive prototype for features selected by a user. For instance, a user may select one or more features and view a prototype of the one or more features before developing them. The prototype module **114** may determine feature links to which the user's selection of one or more features would be connected. In various embodiments, a machine learning algorithm may be employed to determine the feature links. The machine learning algorithm may further predict embeddings that may be placed in the user selected features.

[0048] An example of the machine learning algorithm may be a gradient boosting model. A gradient boosting model may use successive decision trees to determine feature links. Each decision tree is a machine learning algorithm in itself and includes nodes that are connected via branches that branch based on a condition into two nodes. Input begins at one of the nodes whereby the decision tree propagates the input down a multitude of branches until it reaches an output node. The gradient boosted tree uses multiple decision trees in a series. Each successive tree is trained based on errors of the previous tree and the decision trees are weighted to return best results.

[0049] The prototype module **114** may use a secondary machine learning algorithm to select a most likely starting screen for each prototype. Thus, a user may select one or more features and the prototype module **114** may automatically display a prototype of the selected features.

[0050] The software building system **100** includes management components **104** that aid the user in managing a complex software building project. The management components **104** allow a user that does not have experience in managing software projects to effectively manage multiple experts in various fields. An embodiment of the management components **104** include the onboarding system **116**, an expert evaluation system **118**, scheduler **120**, BRAT **122**, analytics component **124**, entity controller **126**, and the interactor **112** system.

[0051] The onboarding system **116** aggregates experts so they can be utilized to execute specifications that are set up in the software building system **100**. In an exemplary embodiment, software development experts may register into the onboarding system **116** which will organize experts according to their skills, experience, and past performance. In one example, the onboarding system **116** provides the following features: partner onboarding, expert onboarding, reviewer assessments, expert availability management, and expert task allocation.

[0052] An example of partner onboarding may be pairing a user with one or more partners in a project. The onboarding system **116** may prompt potential partners to complete a profile and may set up contracts between the prospective partners. An example of expert onboarding may be a systematic assessment of prospective experts including receiving a profile from the prospective expert, quizzing the prospective expert on their skill and experience, and facilitating courses for the expert to enroll and complete. An example of reviewer assessments may be for the onboarding system **116** to automatically review completed portions of a project. For instance, the onboarding system **116** may analyze submitted code, validate functionality of submitted code, and assess a status of the code repository. An example of expert availability management in the onboarding system **116** is to manage schedules for expert assignments and oversee expert compensation. An example of expert task allocation is to automatically assign jobs to experts that are onboarded in the onboarding system **116**. For instance, the onboarding system **116** may determine a best fit to match onboarded experts with project goals and assign appropriate tasks to the determined experts.

[0053] The expert evaluation system **118** continuously evaluates developer experts. In an exemplary embodiment, the expert evaluation system **118** rates experts based on completed tasks and assigns scores to the experts. The scores may provide the experts with valuable critique and provide the onboarding system **116** with metrics with it can use to allocate the experts on future tasks.

[0054] Scheduler **120** keeps track of overall progress of a project and provides experts with job start and job completion estimates. In a complex project, some expert developers may be required to wait until parts of a project are completed before their tasks can begin. Thus, effective time allocation can improve expert developer management. Scheduler **120** provides up to date estimates to expert developers for job start and completion windows so they can better manage their own time and position them to complete their job on time with high quality.

[0055] The big resource allocation tool (BRAT **122**) is capable of generating optimal developer assignments for every available parallel workstream across multiple projects. BRAT **122** system allows expert developers to be efficiently managed to minimize cost and time. In an exemplary embodiment, the BRAT **122** system considers a plethora of information including feature complexity, developer expertise, past developer experience, time zone, and project affinity to make assignments to expert developers. The BRAT **122** system may make use of the expert evaluation system **118** to determine the best experts for various assignments. Further, the expert evaluation system **118** may be leveraged to provide live grading to experts and employ qualitative and quantitative feedback. For instance, experts may be assigned a live score based on the number of jobs completed and the quality of jobs completed.

[0056] The analytics component **124** is a dashboard that provides a view of progress in a project. One of many purposes of the analytics component **124** dashboard is to provide a primary form of communication between a user and the project developers. Thus, offline communication, which can be time consuming and stressful, may be reduced. In an exemplary embodiment, the analytics component **124** dashboard may show live progress as a percentage feature along with releases, meetings, account settings, and ticket sections. Through the analytics component **124** dashboard, dependencies may be viewed and resolved by users or developer experts.

[0057] The entity controller **126** is a primary hub for entities of the software building system **100**. It connects to scheduler **120**, the BRAT **122** system, and the analytics component **124** to provide for continuous management of expert developer schedules, expert developer scoring for completed projects, and communication between expert developers and users. Through the entity controller **126**, both expert developers and users may assess a project, make adjustments, and immediately communicate any changes to the rest of the development team.

[0058] The entity controller **126** may be linked to the interactor **112** system, allowing users to interact with a live project via an intelligent AI conversational system. Further, the Interactor **112** system may provide expert developers with up-to-date management communication such as text, email, ticketing, and even voice communications to inform developers of expected progress and/or review of completed assignments.

[0059] The assembly line components **106** comprise underlying components that provide the functionality to the software building system **100**. The embodiment of the assembly line components **106** shown in FIG. **1** includes a run engine **130**, building block components **134**, catalogue **136**, developer surface **138**, a code engine **140**, a UI engine **142**, a designer surface **144**, tracker **146**, a cloud allocation tool **148**, a code platform **150**, a merge engine **152**, visual QA **154**, and a design library **156**.

[0060] The run engine **130** may maintain communication between various building block components within a project as well as outside of the project. In an exemplary embodiment, the run engine **130** may send HTTP/S GET or POST requests from one page to another.

[0061] The building block components **134** are reusable code that are used across multiple computer readable specifications. The term buildcards, as used herein, refer to machine readable specifications that are generated by specification builder **110**, which may convert user specifications into a computer readable specification that contains the user specifications and a format that can be implemented by an automated process with minimal intervention by expert developers.

[0062] The computer readable specifications are constructed with building block components **134**, which are reusable code components. The building block components **134** may be pretested code components that are modular and safe to use. In an exemplary embodiment, every building block component **134** consists of two sections-core and custom. Core sections comprise the lines of code which represent the main functionality and reusable components across computer readable specifications. The custom sections comprise the snippets of code that define customizations specific to the computer readable specification. This could include placeholder texts, theme, color, font, error messages, branding information, etc.

[0063] Catalogue **136** is a management tool that may be used as a backbone for applications of the software building system **100**. In an exemplary embodiment, the catalogue **136** may be linked to the entity controller **126** and provide it with centralized, uniform communication between different services.

[0064] Developer surface **138** is a virtual desktop with preinstalled tools for development. Expert developers may connect to developer surface **138** to complete assigned tasks. In an exemplary embodiment, expert developers may connect to developer surface from any device connected to a network that can access the software project. For instance, developer experts may access developer surface **138** from a web browser on any device. Thus, the developer experts may essentially work from anywhere across geographic constraints. In various embodiments, the developer surface uses facial recognition to authenticate the developer expert at all times. In an example of use, all code that is typed by the developer expert is tagged with an authentication that is verified at the time each keystroke is made. Accordingly, if code is copied, the source of the copied code may be quickly determined. The developer surface **138** further provides a secure environment for developer experts to complete their assigned tasks.

[0065] The code engine **140** is a portion of a code platform **150** that assembles all the building block components required by the build card based on the features associated with the build card. The code platform **150** uses language-specific translators (LSTs) to generate code that follows a repeatable template. In various embodiments, the LSTs are pretested to be deployable and human understandable. The LSTs are configured to accept markers that identify the customization portion of a project. Changes may be automatically injected into the portions identified by the markers. Thus, a user may implement custom features while retaining product stability and reusability. In an example of use, new or updated features may be rolled out into an existing assembled project by adding the new or updated features to the marked portions of the LSTs.

[0066] In an exemplary embodiment, the LSTs are stateless and work in a scalable Kubernetes Job architecture which allows for limitless scaling that provide the needed throughput based on the volume of builds coming in through a queue system. This stateless architecture may also enable support for multiple languages in a plug & play manner.

[0067] The cloud allocation tool **148** manages cloud computing that is associated with computer readable specifications. For example, the cloud allocation tool **148** assesses computer readable specifications to predict a cost and resources to complete them. The cloud allocation tool **148** then creates cloud accounts based on the prediction and facilitates payments over the lifecycle of the computer readable specification.

[0068] The merge engine **152** is a tool that is responsible for automatically merging the design code with the functional code. The merge engine **152** consolidates styles and assets in one place allowing experts to easily customize and consume the generated code. The merge engine **152** may handle navigations that connect different screens within an application. It may also handle animations and any other interactions within a page.

[0069] The UI engine **142** is a design-to-code product that converts designs into browser ready code. In an exemplary embodiment, the UI engine **142** converts designs such as those made in Sketch into React code. The UI engine may be configured to scale generated UI code to various screen sizes without requiring modifications by developers. In an example of use, a design file may be uploaded by a developer expert to designer surface **144** whereby the UI engine automatically converts the design file into a browser ready format.

[0070] Visual QA **154** automates the process of comparing design files with actual generated screens and identifies visual differences between the two. Thus, screens generated by the UI engine **142** may be automatically validated by the visual QA **154** system. In various embodiments, a pixel to pixel comparison is performed using computer vision to identify discrepancies on the static page layout of the screen based on location, color contrast and geometrical diagnosis of elements on the screen. Differences may be logged as bugs by scheduler **120** so they can be reviewed by expert developers.

[0071] In an exemplary embodiment, visual QA **154** implements an optical character recognition (OCR) engine to detect and diagnose text position and spacing. Additional routines are then used to remove text elements before applying pixel-based diagnostics. At this latter stage, an approach based on similarity indices for computer vision is employed to check element position, detect missing/spurious objects in the UI and identify incorrect colors. Routines for content masking are also implemented to reduce the number of false positives associated with the presence of dynamic content in the UI such as dynamically changing text and/or images.

[0072] The visual QA **154** system may be used for computer vision, detecting discrepancies between developed screens, and designs using structural similarity indices. It may also be used for excluding dynamic content based on masking and removing text based on optical character recognition whereby text is removed before running pixel-based diagnostics to reduce the structural complexity of the input images.

[0073] The designer surface **144** connects designers to a project network to view all of their assigned tasks as well as create or submit customer designs. In various embodiments, computer readable specifications include prompts to insert designs. Based on the computer readable specification, the designer surface **144** informs designers of designs that are expected of them and provides for easy submission of designs to the computer readable specification. Submitted designs may be immediately available for further customization by expert developers that are connected to a project network.

[0074] Similar to building block components **134**, the design library **156** contains design components that may be reused across multiple computer readable specifications. The design components in the design library **156** may be configured to be inserted into computer readable specifications, which allows designers and expert developers to easily edit them as a starting point for new designs. The design library **156** may be linked to the designer surface **144**, thus allowing designers to quickly browse pretested designs for user and/or editing.

[0075] Tracker **146** is a task management tool for tracking and managing granular tasks performed by experts in a project network. In an example of use, common tasks are injected into tracker **146** at the beginning of a project. In various embodiments, the common tasks are determined based on prior projects, completed, and tracked in the software building system **100**.

[0076] The run entities **108** contain entities that all users, partners, expert developers, and designers use to interact within a centralized project network. In an exemplary embodiment, the run entities **108** include tool aggregator **160**, cloud system **162**, user control system **164**, cloud wallet **166**, and a cloud inventory module **168**. The tool aggregator **160** entity brings together all third-party tools and services required by users to build, run and scale their software project. For instance, it may aggregate software services from payment gateways and licenses such as Office **365**. User accounts may be automatically provisioned for needed services without the hassle of integrating them one at a time. In an exemplary embodiment, users of the run entities **108** may choose from various services on demand to be integrated into their application. The run entities **108** may also automatically handle invoicing of the services for the user.

[0077] The cloud system **162** is a cloud platform that is capable of running any of the services in a software project. The cloud system **162** may connect any of the entities of the software building system **100** such as the code platform **150**, developer surface **138**, designer surface **144**, catalogue **136**, entity controller **126**, specification builder **110**, the interactor **112** system, and the prototype module **114** to users, expert developers, and designers via a cloud network. In one example, cloud system **162** may connect developer experts to an IDE and design software for designers allowing them to work on a software project from any device.

[0078] The user control system **164** is a system requiring the user to have input over every feature of a final product in a software product. With the user control system **164**, automation is configured to allow the user to edit and modify any features that are attached to a software project regardless as to the coding and design by developer experts and designer. For example, building block components **134** are configured to be malleable such that any customizations by expert developers can be undone without breaking the rest of a project. Thus, dependencies are configured so that no one feature locks out or restricts development of other features.

[0079] Cloud wallet **166** is a feature that handles transactions between various individuals and/or groups that work on a software project. For instance, payment for work performed by developer experts or designers from a user is facilitated by cloud wallet **166**. A user need only set up a

single account in cloud wallet **166** whereby cloud wallet handles payments of all transactions.

[0080] A cloud allocation tool **148** may automatically predict cloud costs that would be incurred by a computer readable specification. This is achieved by consuming data from multiple cloud providers and converting it to domain specific language, which allows the cloud allocation tool **148** to predict infrastructure blueprints for customers' computer readable specifications in a cloud agnostic manner. It manages the infrastructure for the entire lifecycle of the computer readable specification (from development to after care) which includes creation of cloud accounts, in predicted cloud providers, along with setting up CI/CD to facilitate automated deployments.

[0081] The cloud inventory module **168** handles storage of assets on the run entities **108**. For instance, building block components **134** and assets of the design library are stored in the cloud inventory entity. Expert developers and designers that are onboarded by onboarding system **116** may have profiles stored in the cloud inventory module **168**. Further, the cloud inventory module **168** may store funds that are managed by the cloud wallet **166**. The cloud inventory module **168** may store various software packages that are used by users, expert developers, and designers to produce a software product.

[0082] Referring to FIG. **2**, FIG. **2** is a schematic **200** illustrating an embodiment of the management components **104** of the software building system **100**. The management components **104** provide for continuous assessment and management of a project through its entities and systems. The central hub of the management components **104** is entity controller **126**. In an exemplary embodiment, core functionality of the entity controller **126** system comprises the following: display computer readable specifications configurations, provide statuses of all computer readable specifications, provide toolkits within each computer readable specification, integration of the entity controller **126** with tracker **146** and the onboarding system **116**, integration code repository for repository creation, code infrastructure creation, code management, and expert management, customer management, team management, specification and demonstration call booking and management, and meetings management.

[0083] In an exemplary embodiment, the computer readable specification configuration status includes customer information, requirements, and selections. The statuses of all computer readable specifications may be displayed on the entity controller **126**, which provides a concise perspective of the status of a software project. Toolkits provided in each computer readable specification allow expert developers and designers to chat, email, host meetings, and implement 3rd party integrations with users. Entity controller **126** allows a user to track progress through a variety of features including but not limited to tracker **146**, the UI engine **142**, and the onboarding system **116**. For instance, the entity controller **126** may display the status of computer readable specifications as displayed in tracker **146**. Further, the entity controller **126** may display a list of experts available through the onboarding system **116** at a given time as well as ranking experts for various jobs.

[0084] The entity controller **126** may also be configured to create code repositories. For example, the entity controller **126** may be configured to automatically create an infrastructure for code and to create a separate code repository for each branch of the infrastructure. Commits to the repository may also be managed by the entity controller **126**.

[0085] Entity controller **126** may be integrated into scheduler **120** to determine a timeline for jobs to be completed by developer experts and designers. The BRAT **122** system may be leveraged to score and rank experts for jobs in scheduler **120**. A user may interact with the various entity controller **126** features through the analytics component **124** dashboard. Alternatively, a user may interact with the entity controller **126** features via the interactive conversation in the interactor **112** system.

[0086] Entity controller **126** may facilitate user management such as scheduling meetings with expert developers and designers, documenting new software such as generating an API, and managing dependencies in a software project. Meetings may be scheduled with individual expert developers, designers, and with whole teams or portions of teams.

[0087] Machine learning algorithms may be implemented to automate resource allocation in the entity controller **126**. In an exemplary embodiment, assignment of resources to groups may be determined by constrained optimization by minimizing total project cost. In various embodiments a health state of a project may be determined via probabilistic Bayesian reasoning whereby a causal impact of different factors on delays using a Bayesian network are estimated.

[0088] Referring to FIG. **3**, FIG. **3** is a schematic **300** illustrating an embodiment of the assembly line components **106** of the software building system **100**. The assembly line components **106** support the various features of the management components **104**. For instance, the code platform **150** is configured to facilitate user management of a software project. The code engine **140** allows users to manage the creation of software by standardizing all code with pretested building block components. The building block components contain LSTs that identify the customizable portions of the building block components **134**.

[0089] The machine readable specifications may be generated from user specifications. Like the building block components, the computer readable specifications are designed to be managed by a user without software management experience. The computer readable specifications specify project goals that may be implemented automatically. For instance, the computer readable specifications may specify one or more goals that require expert developers. The scheduler **120** may hire the expert developers based on the computer readable specifications or with direction from the user. Similarly, one or more designers may be hired based on specifications in a computer readable specification. Users may actively participate in management or take a passive role.

[0090] A cloud allocation tool **148** is used to determine costs for each computer readable specification. In an exemplary embodiment, a machine learning algorithm is used to assess computer readable specifications to estimate costs of development and design that is specified in a computer readable specification. Cost data from past projects may be used to train one or more models to predict costs of a project.

[0091] The developer surface **138** system provides an easy to set up platform within which expert developers can work on a software project. For instance, a developer in any geography may connect to a project via the cloud system **162** and immediately access tools to generate code. In one

example, the expert developer is provided with a preconfigured IDE as they sign into a project from a web browser.

[0092] The designer surface **144** provides a centralized platform for designers to view their assignments and submit designs. Design assignments may be specified in computer readable specifications. Thus, designers may be hired and provided with instructions to complete a design by an automated system that reads a computer readable specification and hires out designers based on the specifications in the computer readable specification. Designers may have access to pretested design components from a design library **156**. The design components, like building block components, allow the designers to start a design from a standardized design that is already functional.

[0093] The UI engine **142** may automatically convert designs into web ready code such as React code that may be viewed by a web browser. To ensure that the conversion process is accurate, the visual QA **154** system may evaluate screens generated by the UI engine **142** by comparing them with the designs that the screens are based on. In an exemplary embodiment, the visual QA **154** system does a pixel to pixel comparison and logs any discrepancies to be evaluated by an expert developer.

[0094] Referring to FIG. **4**, FIG. **4** is a schematic **400** illustrating an embodiment of the run entities **108** of the software building system. The run entities **108** provides a user with 3rd party tools and services, inventory management, and cloud services in a scalable system that can be automated to manage a software project. In an exemplary embodiment, the run entities **108** is a cloud-based system that provides a user with all tools necessary to run a project in a cloud environment.

[0095] For instance, the tool aggregator **160** automatically subscribes with appropriate 3rd party tools and services and makes them available to a user without a time consuming and potentially confusing set up. The cloud system **162** connects a user to any of the features and services of the software project through a remote terminal. Through the cloud system **162**, a user may use the user control system **164** to manage all aspects of a software project including conversing with an intelligent AI in the interactor **112** system, providing user specifications that are converted into computer readable specifications, providing user designs, viewing code, editing code, editing designs, interacting with expert developers and designers, interacting with partners, managing costs, and paying contractors.

[0096] A user may handle all costs and payments of a software project through cloud wallet **166**. Payments to contractors such as expert developers and designers may be handled through one or more accounts in cloud wallet **166**. The automated systems that assess completion of projects such as tracker **146** may automatically determine when jobs are completed and initiate appropriate payment as a result. Thus, accounting through cloud wallet **166** may be at least partially automated. In an exemplary embodiment, payments through cloud wallet **166** are completed by a machine learning AI that assesses job completion and total payment for contractors and/or employees in a software project.

[0097] Cloud inventory module **168** automatically manages inventory and purchases without human involvement. For example, cloud inventory module **168** manages storage of data in a repository or data warehouse. In an exemplary embodiment, it uses a modified version of the knapsack algorithm to recommend commitments to data that it stores in the data warehouse. Cloud inventory module **168** further automates and manages cloud reservations such as the tools providing in the tool aggregator **160**.

[0098] Referring to FIG. **5**, FIG. **5** is a schematic **500** of an embodiment of the disclosed system for evaluating a developer **510**. The developer **510** may be any individual that contributes to the development of a device application. The developer **510** may be a software developer, a designer, a quality engineer, or the like. The disclosed system may be used to classify one or more developers that are working on a device application. The classification may be used to assess the quality of work that employees are capable of performing. In various embodiments, the classification may be further used to match employees or developers to jobs that they are capable of performing.

[0099] In various embodiments, the disclosed subject matter may include a machine readable specification **515** for a device application. The machine-readable specification **515** may include information necessary to define one or more jobs that can be performed by the developer to contribute to the device application. For instance, the machine-readable specification **515** may include details necessary to build a building block component for the device application.

[0100] The disclosed system may include an expert evaluation system **540** that is capable of evaluating a developer **510** and evaluating jobs completed by the developer **510**. In the exemplary embodiment shown in the schematic **500**, the expert evaluation system **540** includes a test evaluation system **542**, an expert classification component **560**, and a job evaluation system **544**.

[0101] The test evaluation system **542** may be used to test a developer **510** to determine the developer's **510** ability level. For instance, the test evaluation system **542** may give the developer **510** one or more tests for the developer to complete. Once completed, the test evaluation system **542** may grade the one or more tests to classify the developer **510**. The test evaluation system **542** may include a test generation component **550** and a test assessment component **555**. The test generation component **550** may be configured to generate one or more tests for the developer **510**. In an exemplary embodiment, the test generation component **550** may generate one or more quizzes based on a developer's experience. The developer's experience may be determined based on a resume, an interview with the developer, or the like. An example of a quiz may be a test comprising one or more questions for which there is at least one correct answer. In addition to quizzes, the test generation component **550** may generate one or more assignments for the developer. An example of an assignment may be a task to complete a building block component. Another example of an assignment may be a task to design a user interface for a screen. Another example of a task may be to quality test a device application. An assignment for a developer that is a quality engineer may include conducting an analysis of a device application to identify defects or bugs in the device application. Another assignment for a developer that is a quality engineer may include making one or more improvements to a functionality of a device application or portion of a device application.

[0102] The test evaluation system **542** may transmit one or more quizzes or assignments that are generated by the test generation component **550** to the developer **510** for the developer to complete. Once completed, the developer **510** may transmit the completed quiz or assignment back to the

test evaluation system **542**. The test assessment component **555** may evaluate the completed quiz or assignment to determine a score or rank for the developer **510**. For example, the test assessment component **555** may determine whether the developer **510** answered questions in the one or more quizzes correctly. In addition to grading quizzes, the test assessment component **555** may also evaluate assignments that are completed by the developer **510**. For example, the test assessment component **555** may evaluate a completed assignment for various criteria to determine a score for the completed assignment. For instance, the test assessment component **555** may use a machine learning algorithm to evaluate a quality of an assignment to develop a software component or device application. An example of a machine learning algorithm is a neural network. In the example given above, the machine learning algorithm may evaluate a structure of the completed assignment to determine whether the structure conforms to standard industry practice. For instance, the machine learning algorithm may evaluate whether the developer **510** adhered to an entity component pattern that was called for in the assignment. The machine learning algorithm may further evaluate output based on various input for the completed assignment. For instance, if the assignment was to develop a component that accepts one or more user logins and sorts them into a database, the machine learning algorithm may test the completed component with one or more user logins to determine whether the completed assignment works properly.

[0103] The test assessment component **555** may generate a score that may be used by an expert classification component **560** to determine a classification or rank of the developer **510**. The expert classification component **560** may use any combination of quiz scores and assignment scores to determine a classification for the developer **510**. In various embodiments, the expert classification component **560** may weight one or more quizzes or assignments based on various criteria. For instance, the expert classification component **560** may weight a quiz that is related to a developers **510** expertise more than other quizzes or assignments. In another example, the expert classification component **560** may weight one or more quizzes or one or more assignments based on jobs that are available from the machine-readable specification **515**. For instance, the expert classification component **560** may weight quizzes or assignments related to databases if there are pending jobs that require database work. A pending job may be a job that is yet to be completed. The term "pending machine readable specification", as used herein, is a machine readable specification that includes one or more pending jobs.

[0104] The job evaluation system **544** transmits jobs to the developer **510** and assesses completed jobs that are received from the developer **510**. In an exemplary embodiment, the job evaluation system **544** may include a job assignment component **565** and a job evaluation component **570**. The job assignment component **565** may accept one or more jobs based on a machine-readable specification **515**. In an exemplary embodiment, the machine-readable specification **515** may include one or more building block components **525**, one or more adapters **530** that are designed to link the building block components **525**, and one or more designs **535** for a device application. Additionally, the machine-readable specification **515** may include a device application architecture **520** that defines a structure for the building block components **525**, the adapters **530**, and designs **535**.

[0105] One or more jobs may be resolved from the machine-readable specification **515**. The jobs may be then passed by the job assessment component **565** to a developer **510** to be completed. Once completed, the developer **510** may transmit the completed job back to the job evaluation system **544**. The job evaluation component **570** may assess the quality of the completed job. In an exemplary embodiment, the job evaluation component **570** comprises a machine learning algorithm that is configured to evaluate completed jobs. In various embodiments, different machine learning algorithms or models may be configured based on a type of job. For example, a machine learning algorithm may be configured to evaluate completed user interface components for device applications. For instance, a job to develop a building block component **525** that allows a user to select one or more items for purchase on a device application may be assigned to a developer **510**. Once the job is completed, the job evaluation component **570** may evaluate the completed job using a machine learned algorithm that is trained to evaluate components related to user input.

[0106] Referring to FIG. **5**B, FIG. **5**B is a schematic of an embodiment of the expert evaluation system **575**. The expert evaluation system **575** may be used to score or classify developers that work on various aspects of a device application. In an exemplary embodiment that is shown in FIG. **5**B, the expert evaluation system **575** includes a test evaluation system **542**, an expert ranking system **567**, and a job evaluation system **544**. The test evaluation system **542** generates tests for developers **510** and grades tests once they are completed by developers **510**. In an example embodiment, the test evaluation system **542** includes a test generation component **507** and a test assessment component **527**.

[0107] The test generation component **507** generates quizzes, assignments, and/or videos for the developer **510**. In an exemplary embodiment, the test generation component **507** may include a video generator **522** that generates videos for the developer **510** to view. The videos may be educational or part of the test. For example, the video generator **522** may generate one or more videos based on a content of quizzes or assignments that will be transmitted to the developer **510**. For example, a video generator **522** may generate a video that includes a code structure tutorial for the developer **510** to view before working on an assignment. Accordingly, the developer **510** could be tasked to adhere to a structure based on the video as the developer **510** works on the assignment.

[0108] The quiz generator **512** may generate quizzes for developers **510**. In an exemplary embodiment, quiz questions are selected based on the experience level of the developer **510**. For example, if the developer's resume shows expert level experience in using cloud platforms, the quiz generator **512** may test the developer's **510** experience with questions related to cloud providers such as AWS and Azure. In another example, the quiz generator **512** may generate quiz questions based on pending jobs. For example, the quiz generator **512** may generate a ratio of quiz questions based on the ratio of job types that are pending. An example ratio of job types may comprise 30% of jobs related to SQL databases. Accordingly, the quiz generator **512** may generate questions related to SQL databases for approximately 30% of the questions on the quiz.

[0109] The assignment generator **517** may generate assignments for the developer **510** that can be graded by the test assessment component **527**. The assignment generator

517 may be configured to generate assignments that are capable of being graded or scored. For instance, the assignment generator **517** may generate assignments directing a developer to produce a component that performs a specific function based on specific input. For example, the assignment generator, **517** may direct a developer **510** to produce a component that interacts with a bank API to perform a transaction. Accordingly, the test scoring module **514** of the test assessment component **527** may be capable of verifying a correct output of the component based on the bank API of the assignment. In various embodiments, the assignment generator **517** may be configured to assign a developer **510** assignments that are related to the developer's experience.

[0110] The test assessment component **527** may grade completed quizzes and completed assignments with the test scoring module **514** to determine a score for the developer **510**. In various embodiments, the test scoring module **514** comprises a machine learning algorithm that is trained to grade quizzes and/or assignments. Various machine learning algorithms may be used for the test scoring model **514**. In an exemplary embodiment, the machine learning algorithm is a neural network that uses natural language processing to analyze completed assignments and determine a quality of the completed assignment. Thus, completed quizzes and assignments may be assigned a score that is passed on to the expert ranking system **567**. The expert ranking system **567** may pass scores through the expert classification component **562** to determine a rank or classification of the developer **510** based on scores determined by the test assessment component **527**. In an exemplary embodiment, the expert classification component **562** classifies a developer **510** as one of either beginner, intermediate, or expert. In various embodiments, the expert classification component **562** determines a classification for each developer in multiple areas. For instance, a developer **510** may be classified as intermediate in relational databases and classified as a beginner in NoSQL databases.

[0111] The job evaluation system **544** assigns jobs to developers and evaluates completed jobs from developers **510**. The job evaluation system **544** may include a job assignment component **547** and a job evaluation component **544**. The job assignment component **547** may determine one or more jobs from a machine-readable specification to be assigned to a developer **510**. The job evaluation component **547** may assess completed jobs to determine a score that is passed to the expert ranking system **567**.

[0112] The job assessment component **547** may include a machine readable specification interpreter **552** and a job resolver **557**. The machine-readable specification interpreter may be configured to extract all related information from machine-readable specifications. For instance, the machine-readable specification interpreter **552** may extract information related to one or more components, designs, and adapters. The job resolver **557** may determine one or more jobs based on the components, designs, and adapters specified in the machine-readable specification. In an exemplary embodiment, the job resolver **557** may resolve jobs based on links between components as defined by the machine-readable specification. In various embodiments, the machine-readable specification may define links between various features and components in the device application. The job resolver may select one or more components based on the links. In one example, the job resolver may resolve a job to develop two components that communicate with one another. An example of components that communicate with one another comprises a first component that generates a message that is transmitted through the run engine and received by a second component.

[0113] In various embodiments, the job resolver **557** may determine a difficulty of the job. For example, the job resolver **557** may comprise a machine learning algorithm that is configured to determine a difficulty of a job. The machine learning algorithm may be trained, for example, on difficulties of previous jobs. In one example, the difficulty may be determined based on an amount of work to be performed for a job. An amount of work may be correlated to a number of linkages between components for a job to complete a building block component. For example, a building block component that is linked to two or more other building block components may be classified as expert level difficulty. A building block component that is linked to one other building block component may be classified as an intermediate difficulty. And a building block component that has no links to other building block components may be classified as a beginner level difficulty.

[0114] Once a developer **510** completes a job, the completed job is passed to the job evaluation component **538**. The job scoring module **536** may assign a score to the completed job based on a quality of the completed job. In an exemplary embodiment, the job scoring module may use a machine learning algorithm to analyze the completed job to determine the quality of the job. For example, the job scoring module may use a neural network that makes use of natural language processing to assess code that is submitted by the developer to develop a building block component for a device application. In another example, the job scoring module **536** may use a neural network to analyze a design for a user interface. For instance, the neural network may be trained to determine a score for various types of designs such as hero images, navigation menus, car layouts, and modal window designs. In one example, the neural network may be configured to evaluate a hero image based on an L-shaped pattern whereby interactive portions of the image are limited to two adjacent sides of the screen. The job scoring module **536** may output a score that may be evaluated by the expert ranking system **567** to determine a rank or update the rank/classification for the developer **510**.

[0115] Referring to FIGS. **6**A-**6**B, FIGS. **6**A-**6**B together show portions of a single flow diagram of an embodiment of the disclosed system for allocating resources to develop a device application. FIG. **6**A shows a first flow diagram **600** of a system for allocating resources. The system for allocating resources may select one or more developer resources to work on a job to contribute to generation of a device application. Various jobs may include, but are not limited to developing a building block component, designing an interface, and testing a quality of the device application. In various embodiments, the system for allocating resources may receive one or more jobs from the job resolver **557** and determine the optimal developer(s) to complete each job. The system for allocating resources may further automatically contact the developer and manage the timing at which jobs are completed.

[0116] At step **602**, an expert submits an assignment to the system. In various embodiments, the assignment is received by the test evaluation system **542**. At step **604**, the test assessment component **527** may evaluate the assignment to determine a score for the assignment.

[0117] In the exemplary embodiment shown in FIG. **6**A, the test assessment component **527** may perform a variety of checks on the assignment. The type of check may depend on the type of work that was performed for the job. For example, a job to develop a new component may be checked according to the steps shown in the first flow diagram **600**. At step **606**, the test assessment component **527** may check a quality of a development code. An exemplary embodiment the quality may be checked by analyzing SonarQube metrics and linting the code. Both the SonarQube metrics and linting are ways to check code for various errors and conforming to various standards. Further, at step **608**, the test assessment component **527** may do a plagiarism check on the submitted code. And at step **610**, the test assessment component **527** may validate the functional requirements of the code. The functional requirements may be verified by a machine learned algorithm that analyzes the completed assignment. At step **614**, the test assessment component **527** may determine a final score for the assignment. If the score doesn't meet a minimum threshold, the assignment will be rejected at step **616**. At step **618**, the system may create a report providing a breakdown of the score. And at step **619**, the system may determine whether the developer completed all courses and including tests and assignments. In various embodiments, a developer may be required to complete a minimum number of courses or assignments including quizzes, tests, or the like before being verified to work on a job. In an exemplary embodiment, developers that complete around of courses will be placed on probation whereby they are further evaluated based on completed job assignments.

[0118] At step **620**, the system for allocating resources may receive an allocation request to complete one or more tasks related to generating a device application. At step **622**, the big resource allocation tool may determine whether the allocation request is related to a noncritical project. A noncritical project may be any project that has a low priority. In an exemplary embodiment only projects that are noncritical are low priority. If the job is determined to be noncritical, a developer or expert that is on probation may be considered for the job. If the job is considered to be critical however, only non-probation developers are considered.

[0119] At step **634**, the system for allocating resources may allocate a job based on the allocation request to a non-probation developer. The job may be determined by the job resolver **557** by interpreting a machine-readable specification. Once the developer completes the job, the job may be evaluated by the job evaluation component **547** at step **636**. At step **638**, the score determined by the job evaluation component **547** is updated.

[0120] At step **624**, where it the system determined that an allocation request was noncritical, probationary and non-probationary developers may be considered. The classification or score of the developers may be considered to assign their job. In various embodiments developers that are on probation are assigned jobs that are one rank lower than their classification. For example, a developer that is on probation may be assigned jobs that have a difficulty that is below their level of classification. At step **628**, a probationary period is tracked for the developer that if the developer is in a probationary period. An exemplary embodiment, the probationary period may be for an amount of time, a number of projects, or combination thereof. In the embodiment shown in the first flow diagram **600**, developers that are within their probationary period are continually evaluated at step **632** until they reach 80% of their probation period.

[0121] Referring to FIG. **6**B, FIG. **6**B shows a second flow diagram **650** of a system for allocating resources. In the exemplary embodiment where the probationary developer has reached 80% of their probationary period and step **632**, the system for allocating resources may check if their score meets a minimum threshold at step **652**. The minimum threshold may be set to any arbitrary number that represents a minimum level of expertise required for the developer. If the developer does not meet the minimum threshold, the probation period may be extended for an amount of time. In the exemplary embodiment shown in the second flow diagram **650**, the probationary period may be extended by 50% at step **658** based on a request at step **656**.

[0122] At step **660**, the system for allocating resources may determine whether the developer's score meets a minimum threshold. If the score does meet the minimum threshold, the developer's probation will end at step **662** and the developer's rating will be updated at step **638**. If the developer does not meet the minimum threshold, the developer may be the deallocated and not considered for further jobs at step **664**.

[0123] Referring to FIG. **7**, FIG. **7** is a flow diagram **700** of an embodiment of the disclosed subject matter. The disclosed subject matter may be used to allocate human development resources to one or more jobs on a device application. In an exemplary embodiment, the job may be to work on an undeveloped software application. At step **702**, the system to allocate resources may receive one or more features for an undeveloped software application. In various embodiments, the features may be supplied by a user or client. The system may be tasked by the user or client to incorporate the features into a device application. The features may be incorporated into a machine-readable specification whereby the job resolver **557** may resolve one or more jobs from the machine-readable specification.

[0124] At step **704**, the system to allocate resources may determine one or more resource parameters for development of the undeveloped software application. Various parameters may include a development expertise needed for one or more jobs, an area of expertise, and a time needed for development of the undeveloped software application. As used herein, the term development expertise may refer to a total level of experience of a developer. The total level of experience may be in a specific area of expertise, a total experience, or combination thereof. For example, a developer may be classified as a level II developer for front-end systems and classified as a level I for backend systems. The developer may also be classified as a level II developer overall.

[0125] At step **706**, the system to allocate resources may optimize human development resources based on the one or more resource parameters. For example the system may determine a best developer to develop the undeveloped software application based on the one or more resource parameters. In various embodiments, more than one developer may be determined to develop the undeveloped software application at step **706**. In an exemplary embodiment, and optimization algorithm may be used to determine the one or more developers based on the one or more resource parameters.

[0126] At step **708**, the system to allocate resources may allocate human development resources based on the opti-

mization. For example, the system to allocate resources may contact the one or more developers that were selected at step **706**. In various embodiments, the system may further assign the one or more developers specific jobs to develop though undeveloped software application based on jobs that were determined by the job resolver **557**.

[0127] Referring to FIG. **8**, FIG. **8** is a flow diagram **800** of another embodiment of the disclosed subject matter. At step **802**, the system to allocate resources may determine one or more subprojects, where each of the one or more subprojects includes a development of one or more components that are applicable to a device application. For example one or more components may include a login component for a device application. In another example, the one or more components may include a database that stores user logins for a device application. In various embodiments the one or more subprojects may include checking the quality of a device application. In various embodiments the one or more subprojects may include designing a user interface for the device application. In various embodiments, the one or more subprojects may include checking the quality, designing the user interface, and developing various components such as a database for a device application.

[0128] At step **804**, the system to allocate resources may determine a timing to develop the one or more subprojects. For example, the system to allocate resources may determine that the component that logs user logins for a database is dependent on a design for the user interface. Accordingly, the system may determine that the user interface should be completed in eight within a first time and that the database be completed within a second time. Further, the system may determine various times development of the various subprojects should begin.

[0129] At step **806**, the system to allocate resources may determine an expertise to develop the one or more subprojects. For example, the expertise may be an area of expertise or a total development expertise or combination thereof. In various embodiments, the system may determine more than one expertise for a subproject. In one example, the system may determine that it requires a rank **2** developer in front-end development as well as a rank **2** developer in cross-platform development.

[0130] At step **808**, the system to allocate resources may assign one or more developers to develop a subproject for each of the one or more subprojects. The one or more developers may be selected based on the expertise determined at step **806** and the timing determined at step **804**. The system may further optimize selection of the developer based on the expertise and timing. For example, the system may allocate a developer with a high classification to perform a difficult subproject and allocate a lower ranked developer for a less difficult subproject.

[0131] At step **810**, the system to allocate resources may contact each of the one or more developers to develop the subproject based on the timing for each of the one or more subprojects. In an exemplary embodiment, the one or more developers may be contacted via an automated communication that is initiated by a computing system. For example, the one or more developers may be emailed by a computing system where the email specifies the timing that is determined in step **804**. In various embodiments, the computing system may communicate with the one or more developers by various other means. For example, the computing system may call the one or more developers using a bot that communicates with the one or more developers. The system to allocate resources may further refine the time to develop the one or more subprojects based on a response from the one or more developers. For example, the one or more developers may communicate a time conflict that will cause the system to allocate resources to update the timing.

[0132] Referring to FIG. **9**, FIG. **9** is a flow diagram **900** of yet another embodiment of the disclosed subject matter. At step **902**, the system to allocate resources may receive a set of features of a 1^{st} device application. In various embodiments, the 1^{st} set of features may be supplied by a client user, a computer system, or developer. In an exemplary embodiment, a user may describe a device application in ordinary language. The described computing system may convert the users ordinary language into a set of features that are received in step **902**.

[0133] At step **904**, the system to allocate resources may determine one or more subsets of the set of features where each subset is capable of operating independently of the other subsets in the 1^{st} device application. In an exemplary embodiment, the system determines features that are dependent on one another and separates them into groups. For example, a backend for a login user interface feature may be dependent on a front-end for the login user interface feature. Accordingly, the front-end and backend of the login user interface may be grouped together in a subset of the set of features. However, a geo-mapping feature may operate independently of the login user interface and may be grouped into a separate subset from the login user interface feature.

[0134] At step **906**, the system to allocate resources may determine a production time for each subset. In various embodiments, the production time may comprise a total time to complete the subset. In an exemplary embodiment, the production time further comprises a time to begin the subset. For example, the system to allocate resources may determine a beginning time for each subset such that each of the subsets are completed before a deadline.

[0135] At step **908**, the system to allocate resources may task a developer to complete the subset at a time based on the production time for each subset. In an exemplary embodiment, the system may automatically contact a developer to complete the subset. The system to allocate resources may determine an optimal developer based on the feature or features in the subset. The optimal developer may be selected based on various criteria such as the area of expertise of the developer the total experience of the developer, the difficulty of the subset, and the time zone of the developer.

[0136] Referring to FIG. **10**, FIG. **10** is a flow diagram **1000** of an embodiment of a system for allocating developers to a job. The system to allocate developers to a job may include a big resource allocation tool **1020** which is also referred herein as BRAT **122**. The big resource allocation tool **1020** may accept an allocation request **1022** to perform work that can be applied to one or more device applications. To allocate one or more developers to the work, the big resource allocation tool **1020** may accept various developer data.

[0137] As shown in FIG. **10**, an exemplary embodiment of the developer data may include expert classification **1002** data, automated code analysis data such as Codejudge **1006** or SonarQube data, database **1012** data, and knowledge graph data. Developer data for designer developers and

quality analysis developers may vary from the developer data shown in FIG. **10**. The expert classification **1002** data may include expert quiz scores, expertise of developers, partner scores for developers, and time zones in which the developer resides, which are together referred to as classification data **1004**. The automated code analysis data may include various bugs **1008**, code smell, and vulnerability of code for developers that write code. In an exemplary embodiment the database data **1010** may include a feature interface type, a client time zone, a developer's experience, the expected speed of the project, and a user interface engine. Examples of feature interface types included navigation interfaces, and input interface, a settings interface, and immediate interface. Examples of user interface engines include, but are not limited to React Native, Flutter, Xamarin, and Ionic.

[0138] The developer data may be used by the big resource allocation tool **1020** to determine an expert score **1024**. In an exemplary embodiment, a calculated expert score **1034** is determined based on an allocation state **1026** of the developer, a qualitative score **1028** of the developer, a quantitative score **1030** of a developer, and a quiz score **1032** of a developer. The allocation state **1026** of the developer may comprise the current status of the developer. For example, if a developer is working on a job and is unavailable, the developer would be in a state of "allocated." The qualitative score **1028** of the developer may be a score based on a quality of the developers work. For example, a developer's Codejudge **1006** analysis may be factored into the qualitative score **1028**. The quantitative score **1030** may comprise the developer's experience, the total number projects that the developer worked on, the amount of time that the developer has worked with a client, the amount of time that the developer has worked on a development area, or a combination thereof. The quiz score **1032** may be a score as determined by the test evaluation system **542**.

[0139] The developer prioritization component **1040** may determine the amount of time that should be taken to develop the various features of the allocation request **1022**. The developer prioritization component **1040** may further determine a time to start the development of each feature. The developer prioritization component **1040** may prioritize various subprojects in the allocation request using linear interpolation **1042** followed by Fibonacci prioritization **1044**. The linear interpolation **1042** may prioritize various tasks in the allocation request by determining their relative importance and value.

[0140] The Fibonacci prioritization **1044** may further prioritize tasks by differentiating tasks that have similar values in the linear interpolation. Criteria used in the Fibonacci request prioritization include expertise of the developer, allocation status of the developer, client time zone, developer time zone probation status of the developer, and project and bundle affinity of the developer. Project and bundle affinity of the developer refers to a quality of developers work for a specific client or for a specific project. Data from the developer prioritization component **1040** may be fed into a mixed integer linear programming (MILP) solver **1050** determine an optimal allocation **1052**. The MILP solver **1052** may use the prioritization data for each subproject and determine a time frame for completion of each subproject. Groups of features may be separated into the various swim lanes or subprojects based on their interdependence.

[0141] Referring to FIG. **11**, FIG. **11** is a flow diagram **1100** of an embodiment for allocating developers based on a machine readable specification. As shown in the flow diagram **1100**, the system for allocating resources may include a swim lanes API **1104** that resolves one or more swim lanes from a machine readable specification **1102**. The term swim lane, as used herein, may refer to one or more subprojects within a project to develop a device application. Each of the subprojects or swim lanes is assumed to operate independently of the other swim lanes. The swim lanes API **1104** resolves features of the machine readable specification **1102** to determine which features operate independently of one another. The swim lanes API **1104** may further distribute work among swim lanes such that developers allocated to the various swim lanes finish at an optimized time, which may be determined by a variety of parameters.

[0142] As stated above, the swim lanes API **1104** resolves work from a machine-readable specification into multiple swim lanes **1106**. In various embodiments, the swim lanes API **1104** may resolve jobs from multiple machine readable specifications **1102**. As shown in the flow diagram, swim lanes may comprise a 1^{st} swim lane **1108**, a 2^{nd} swim lane **1110**, and an Nth swim lane **1112**. Further, the swim lanes API **1104** may resolve a design swim lane **1114**, which includes design work that was resolved from the machine readable specification **1102**. The swim lanes of **1106** may also include, but are not shown in FIG. **11**, one or more swim lanes comprising quality control jobs.

[0143] Based on the swim lanes **1106**, the system to allocate resources may include a timing API **1116** that optimizes swim lanes based on a predicted time of completion for each swim lane. The timing API may determine a time of completion based on a difficulty of the job and experience of the developer. In various embodiments a machine learning algorithm may be used to predict a time for jobs the are resolved from the machine-readable specification. Training data to determine completion time for jobs resolved from the machine-readable specification may include historical data from previous jobs. As shown in the flow diagram **1100**, the timing API **1116** may determine a completion time for a 1^{st} swim lane **1118**, a 2^{nd} swim lane **1120**, and a design swim lane **1122**.

[0144] The system to allocate resources may further resolve swim lanes based on developer parameters. Accordingly, jobs within a swim lane may be optimally distributed to developers. In the example shown in the flow diagram **1100**, swim lanes are divided by a swim lane resolver **1124** based on an area of expertise. The 1^{st} swim lane is divided into front-end development **1126** and backend development **1128**. In an exemplary embodiment, front-end development may be coded in React Native and backend development may be coded in Ruby on Rails. Thus, jobs for swim lane **1** may be divided between developers that specialize in React Native and developers that specialize in Ruby on Rails. The system to allocate resources may determine optimal timing to allocate the jobs divided from a single swim lane as one may be dependent on the other. Accordingly, in the example shown in the flow diagram **1100**, and allocation system **1140** may schedule front-end development **1126** to be completed at an earlier time **1142** than the backend development **1128**.

[0145] In various embodiments, the allocation system **1140** may determine a number of developers that are needed to be allocated for each swim lane and/or each divided swim lane. In the example shown in the flow diagram **1100**, the

allocation system **1140** may consolidate a front-end version of the 2nd swim lane **1130** and a backend version of the 2nd swim lane **1132** into development by a single developer that can be allocated at a single time **1146**. The allocation system **1140** may further determine a time to allocate one or more developers to complete one or more designs **1148**. At step **1150**, the system to allocate resources may compute a total project time and cost based on developer allocations and the difficulty of the jobs resolved from the machine readable specification **1102**.

[0146] Referring to FIGS. **12**A-**12**B, FIGS. **12**A-**12**B are schematics of embodiments for assessing the effort required for a feature to be completed. FIG. **12**A is a schematic **1200** showing how a system for allocating resources may break down a feature into multiple jobs. The swim lane resolver **1124** and allocation system **1140** combined to break a feature, swim lane, or subproject, into subparts. In various embodiments, the allocation system determines the amount of effort required to complete every feature in a swim lane. The allocation system **1140** determines one or more dependencies for every feature. For instance, the allocation system may determine whether a front-end is required for any feature. The term front-end as used herein refers to a part of a device application that is configured to accept input from a user. For instance, any part of a device application that directly interacts with a user may be considered a front-end portion of the device application. On the other hand, portions of a device application that did not accept input or interact with a user may be considered a backend. Many, but not all, backend portions of a device application are dependent on input that is accepted from the front-end.

[0147] In various embodiments, the swim lane resolver **1124** may determine various interdependencies within a feature. In the example shown in the schematic **1200**, the system for allocating resources may determine whether a feature **1202** requires a front-end. If the feature **1202** does require a front-end, the effort required to complete the feature **1202** may be broken up into front-end effort **1204** and backend effort **1206**. If the feature **1202** does not require a front-end, work to complete the feature may be limited to backend effort **1210**. In various embodiments, jobs to produce a front-end or backend may require different expertise. For example, a developer may prefer that a front-end be coded in React Native and that a backend be coded in Ruby on Rails. Accordingly, different developers may specialize in either front-end, backend development, or both. The system for allocating resources may allocate developers based on the interdependencies for each feature and determine timing for when interdependent portions of a feature are developed. For example, the system for allocating resources may schedule a front-end to be developed for a backend.

[0148] Referring to FIG. **12**B, FIG. **12**B is a schematic **1250** showing how a feature may be further divided into subparts based on dependencies. As shown in the schematic **1250**, a feature may be divided into a backend effort **1252** and a front-end effort **1254**. If for example the machine-readable specification includes compatibility with android/iOS, the front-end may be further divided into a front-end that is encoded in React **1256** and a front-end that is coded in React Native **1258**.

[0149] Referring to FIG. **13**, FIG. **13** is a schematic **1300** of an exemplary embodiment for allocating resources to a job. As shown in FIG. **11**, resource allocation system may establish subprojects or swim lanes based at least partly on an amount of effort required to complete a swim lane. For example 2 features that are not dependent on one another may be arbitrarily placed in any swim lane relative to one another. When the resource allocation system determines an optimal allocation of developers to complete a job with multiple swim lanes, the allocation system may generate swim lanes based on various criteria.

[0150] For example, the system for allocating resources may generate swim lanes based on the amount of effort required to complete each swim lane. As shown in scenario **1** in the schematic **1300**, a 1st swim lane **1302** includes 50 features and a 2nd swim lane **1304** includes 10 features. The system may generate swim lane shown in scenario **1** when it determines that each of the swim lanes may require the same amount of effort. For example the effort required to complete all the features in the 2nd swim lane **1304** may be the same as the effort to complete the 50 features in the 1st swim lane **1302**. The system for allocating resources may factor difficulty of features, a timeline needed to complete the features, and the relative speed of the developers will be allocated complete the swim lane. For example, a relatively inexperienced developer may be expected to develop at a slow speed, which may be considered in generating the swim lanes.

[0151] In an exemplary embodiment, as shown in scenario **2** system for allocating resources may distribute features equally between swim lanes. Accordingly, the 1st swim lane **1306** and 2nd swim lane **1308** may be generated with an equal number of 30 features. Additional embodiments may consider additional criteria for adding features to swim lanes.

[0152] Referring to FIG. **14**, FIG. **14** is another schematic **1400** of an exemplary embodiment for allocating resources to a job. As shown in FIG. **11**, the system for allocating resources may convert a machine-readable specification into multiple swim lanes or subprojects that each include a predicted amount of time to complete. Accordingly, the machine-readable specification **1402** of the schematic **1400** is converted into multiple development swim lanes **1404**.

[0153] And as shown in FIG. **12**A, the system to allocate resources may further resolve features in each swim lane based on various criteria such as developer expertise. For instance, the development swim lanes **1406** may include swim lanes that are resolved into a front-end and a backend. The system to allocate resources may then allocate one or more developers from a developers pool **1426** to work on the resolved jobs from the development swim lanes **1406**. For instance, one or more designer developers from a designer pool **1428** may be allocated to a design swim lane **1420** or design subproject. If the front-end jobs in the development swim lanes **1406** comprise coding in React, one or more developers from a development pool of React developers **1430** may be allocated to complete a front-end project from one or more of the development swim lanes.

[0154] When there are more jobs than there are developers, the system to allocate resources may use various criteria to select which job gets completed first. For example as shown in the schematic **1400**, the front-end **1422** of swim lane **2**, which has the highest development effort as evidenced by the horizontal length of swim lane **2**, may be selected to be completed first. Other criteria may be used as well. For instance, if a backend system requires a front-end before it can be properly developed, the system to allocate resources may be forced to wait and tell a front-end is

developed until backend developers can be allocated to work on a backend job. However, if one or more front-ends are already developed based on other projects or other machine-readable specifications, their associated backends can begin development immediately. For example, if swim lane **4** has a front-end that is already developed, the system to allocate resources may allocate one or more backend developers **1432** who specialize in Ruby on Rails to begin development on a backend project **1424** for swim lane **4**.

[0155] Referring to FIG. **15**, FIG. **15** is a schematic illustrating a computing system **1500** that may be used to implement various features of embodiments described in the disclosed subject matter. The terms components, entities, modules, surface, and platform, when used herein, may refer to one of the many embodiments of a computing system **1500**. The computing system **1500** may be a single computer, a co-located computing system, a cloud-based computing system, or the like. The computing system **1500** may be used to carry out the functions of one or more of the features, entities, and/or components of a software project.

[0156] The exemplary embodiment of the computing system **1500** shown in FIG. **15** includes a bus **1505** that connects the various components of the computing system **1500**, one or more processors **1510** connected to a memory **1515**, and at least one storage **1520**. The processor **1510** is an electronic circuit that executes instructions that are passed to it from the memory **1515**. Executed instructions are passed back from the processor **1510** to the memory **1515**. The interaction between the processor **1510** and memory **1515** allow the computing system **1500** to perform computations, calculations, and various computing to run software applications.

[0157] Examples of the processor **1510** include central processing units (CPUs), graphics processing units (GPUs), field programmable gate arrays (FPGAs), complex programmable logic devices (CPLDs), and application specific integrated circuits (ASICs). The memory **1515** stores instructions that are to be passed to the processor **1510** and receives executed instructions from the processor **1510**. The memory **1515** also passes and receives instructions from all other components of the computing system **1500** through the bus **1505**. For example, a computer monitor may receive images from the memory **1515** for display. Examples of memory include random access memory (RAM) and read only memory (ROM). RAM has high speed memory retrieval and does not hold data after power is turned off. ROM is typically slower than RAM and does not lose data when power is turned off.

[0158] The storage **1520** is intended for long term data storage. Data in the software project such as computer readable specifications, code, designs, and the like may be saved in a storage **1520**. The storage **1520** may be stored at any location including in the cloud. Various types of storage include spinning magnetic drives and solid-state storage drives.

[0159] The computing system **1500** may connect to other computing systems in the performance of a software project. For instance, the computing system **1500** may send and receive data from 3rd party services such as Office **365** and Adobe. Similarly, users may access the computing system **1500** via a cloud gateway **1530**. For instance, a user on a separate computing system may connect to the computing system **1500** to access data, interact with the run entities **108**, and even use 3rd party services **1525** via the cloud gateway.

[0160] Many variations may be made to the embodiments of the software project described herein. All variations, including combinations of variations, are intended to be included within the scope of this disclosure. The description of the embodiments herein can be practiced in many ways. Any terminology used herein should not be construed as restricting the features or aspects of the disclosed subject matter. The scope should instead be construed in accordance with the appended claims.

1. A method for developing device applications, the method comprising:
- receiving a set of features of a first device application;
- determining one or more subsets of the set of features, each subset is capable of operating independently of other subsets in the first device application;
- determining a production time for each subset; and
- for each subset, tasking a developer to complete the subset at a time based on the production time.

2. The method of claim **1**, further comprising determining internal dependencies for each subset; and
- wherein the production time is determined based on the internal dependencies.

3. The method of claim **1**, further comprising determining a difficulty of developing each feature of the set of features; and
- wherein tasking the developer comprises correlating an expertise of the developer to the difficulty.

4. The method of claim **3**, wherein the expertise of the developer is determined by an automated evaluation, the automated evaluation comprising:
- determining a score for the developer;
- assigning, to the developer, a job based on a machine readable specification, the machine readable specification comprising one or more jobs that are completable by the developer; and
- receiving a completed job based on one of the one or more jobs; and
- updating the score based on an assessment of the completed job.

5. The method of claim **4**, wherein the score is a classification that corresponds to a classification of the job.

6. The method of claim **5**, further comprising determining the classification of the job based on the machine readable specification.

7. The method of claim **1**, wherein tasking the developer comprises automatically contacting, by a computer system, the developer to communicate a job to complete the subset.

8. A computer system configured to develop a device application, the computer system comprising:
- a processor coupled to a memory, the processor configured to:
  - receive a set of features of a first device application;
  - determine one or more subsets of the set of features, each subset is capable of operating independently of other subsets in the first device application;
  - determine a production time for each subset; and
  - for each subset, task a developer to complete the subset at a time based on the production time.

9. The computer system of claim **8**, wherein the processor is further configured to determining internal dependencies for each subset; and
- wherein the production time is determined based on the internal dependencies.

10. The computer system of claim **8**, wherein the processor is further configured to determine a difficulty of developing each feature of the set of features; and

wherein task a developer comprises the processor configured to correlate an expertise of the developer to the difficulty.

11. The computer system of claim **10**, wherein the expertise of the developer is determined by an automated evaluation, the automated evaluation comprising the processor further configured to:

determine a score for the developer;

assign, to the developer, a job based on a machine readable specification, the machine readable specification comprising one or more jobs that are completable by the developer; and

receive a completed job based on one of the one or more jobs; and

update the score based on an assessment of the completed job.

12. The computer system of claim **11**, wherein the score is a classification that corresponds to a classification of the job.

13. The computer system of claim **12**, wherein the processor is further configured to determine the classification of the job based on the machine readable specification.

14. The computer system of claim **8**, wherein task the developer comprises the processor being configured to automatically contact the developer to communicate a job to complete the subset.

15. A computer readable storage medium having data stored therein representing software executable by a computer, the software comprising instructions that, when executed, cause the computer readable storage medium to perform:

receiving a set of features of a first device application;

determining one or more subsets of the set of features, each subset is capable of operating independently of other subsets in the first device application;

determining a production time for each subset; and

for each subset, tasking a developer to complete the subset at a time based on the production time.

16. The computer readable storage medium of claim **15**, wherein the instructions further cause of the computer readable storage medium to perform determining internal dependencies for each subset; and

wherein the production time is determined based on the internal dependencies.

17. The computer readable storage medium of claim **15**, wherein the instructions further cause of the computer readable storage medium to perform determining a difficulty of developing each feature of the set of features; and

wherein tasking the developer comprises correlating an expertise of the developer to the difficulty.

18. The computer readable storage medium of claim **17**, wherein the instructions further cause of the computer readable storage medium to perform determining a difficulty of developing each feature of the set of features; and

wherein tasking the developer comprises correlating an expertise of the developer to the difficulty.

19. The computer readable storage medium of claim **18**, wherein the instructions further cause of the computer readable storage medium to perform:

determining a score for the developer;

assigning, to the developer, a job based on a machine readable specification, the machine readable specification comprising one or more jobs that are completable by the developer; and

receiving a completed job based on one of the one or more jobs; and

updating the score based on an assessment of the completed job.

20. The computer readable storage medium of claim **19**, wherein the score is a classification that corresponds to a classification of the job.

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