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(54) METHOD AND SYSTEM FOR EFFICIENTLY CREATING AND ASSESSING WORK AND DATA FLOWS

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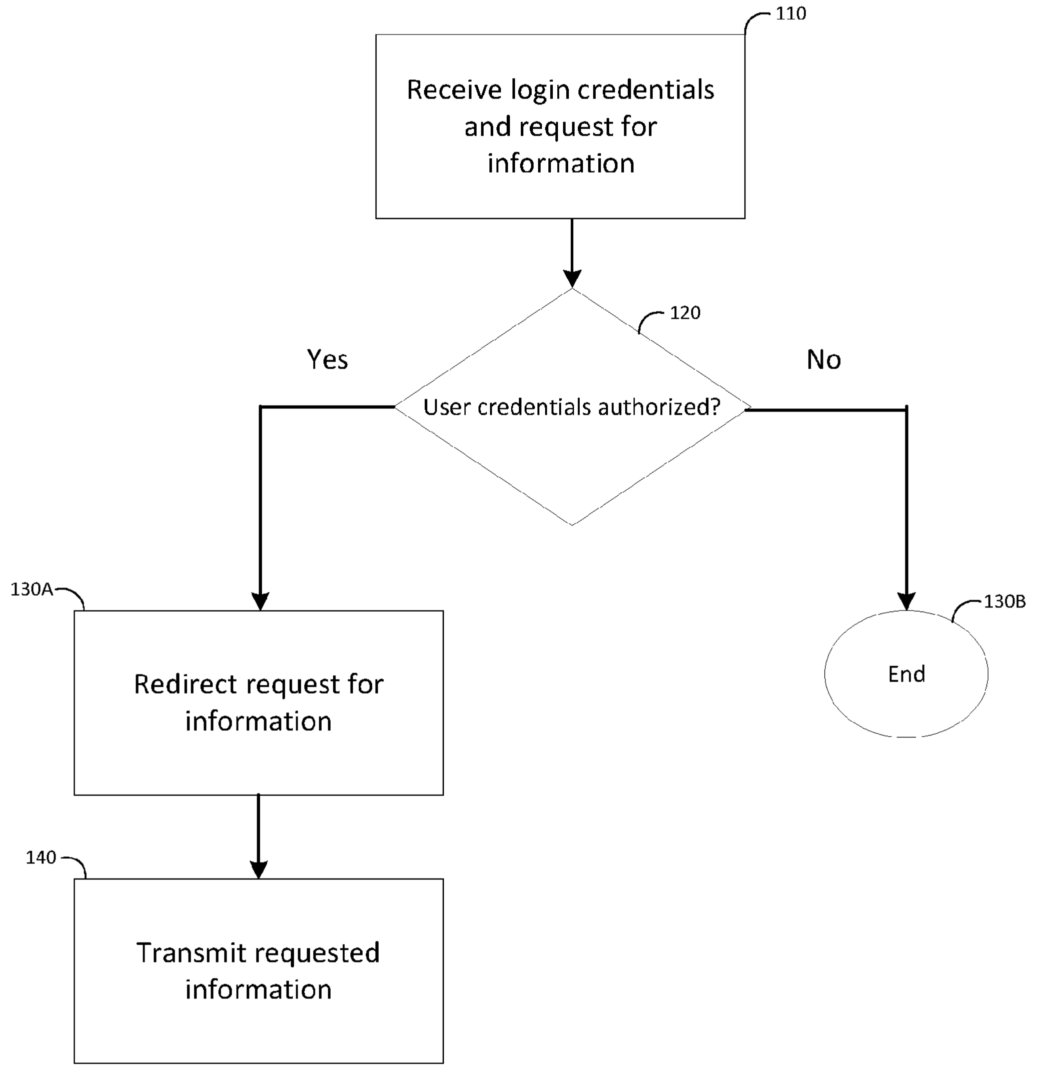
(57) **ABSTRACT**

Systems and methods for dynamically modeling a workflow and identifying parameters in a computing environment are disclosed. In some non-limiting embodiments, the dynamic modeling workflow system may include circuitry, such as a processor, that generates the workflow information to be displayed on a display for a user. The workflow information may contain information representing a first actor configured to perform a first operation and having a first output for outputting first data and a second actor configured to perform a second operation and having a first input for inputting the first data from the first output. In addition the workflow information may be configured to provide a visual representation of the order in which the first actor and the second actor perform the first operation and second operation, respectively, and information about the first data. Additionally, the workflow information may include first and second stages representing a first and second steps in the workflow and comprising the first and second actors, respectively. A method performed by the workflow system is also provided.


110
Receive login credentials and request for information
120
User credentials authorized?
Yes
No
130A
Redirect request for information
130B
End
140
Transmit requested information

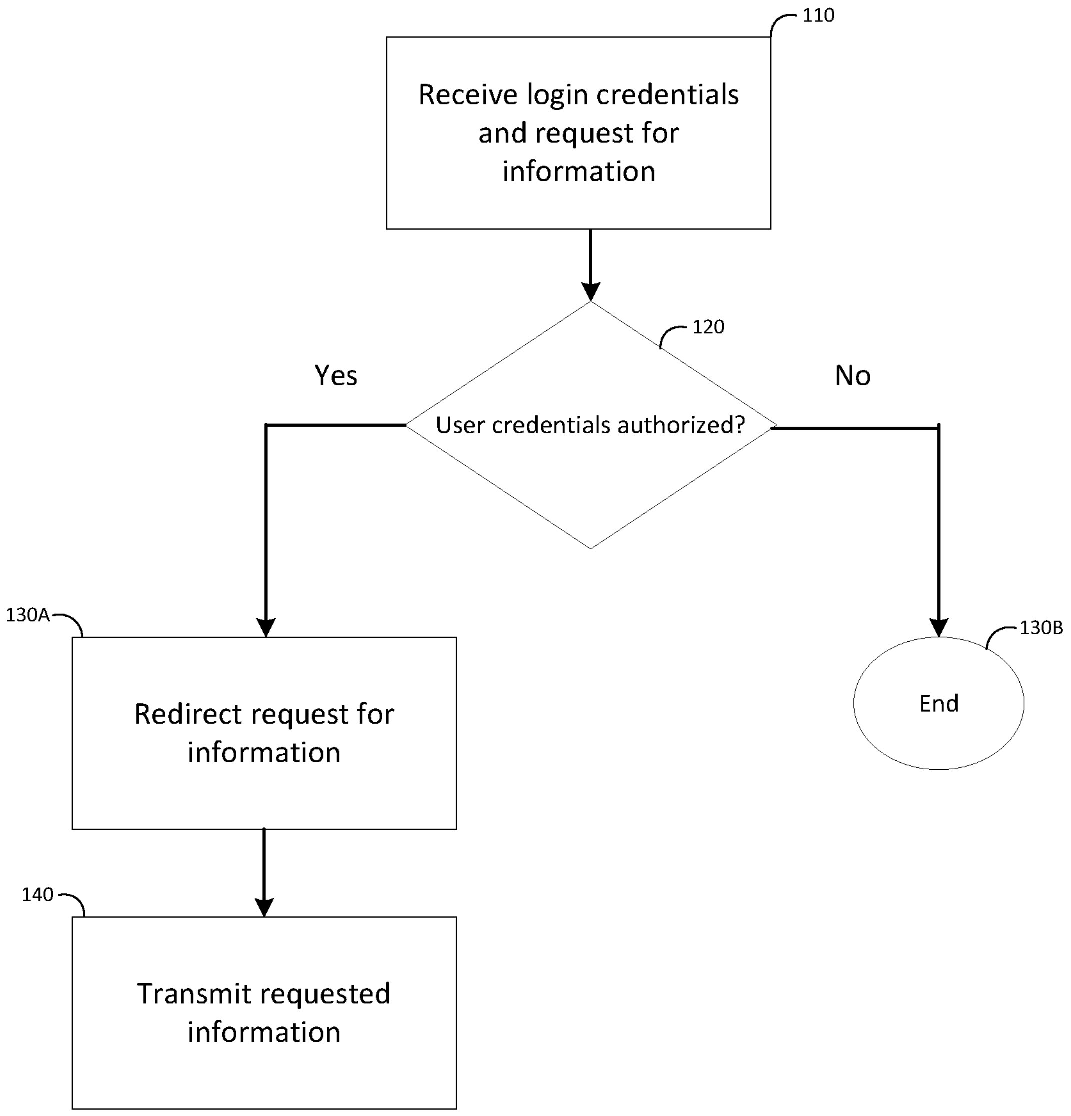

110
Receive login credentials and request for information
120
User credentials authorized?
Yes
No
130A
Redirect request for information
130B
End
140
Transmit requested information

FIG. 1

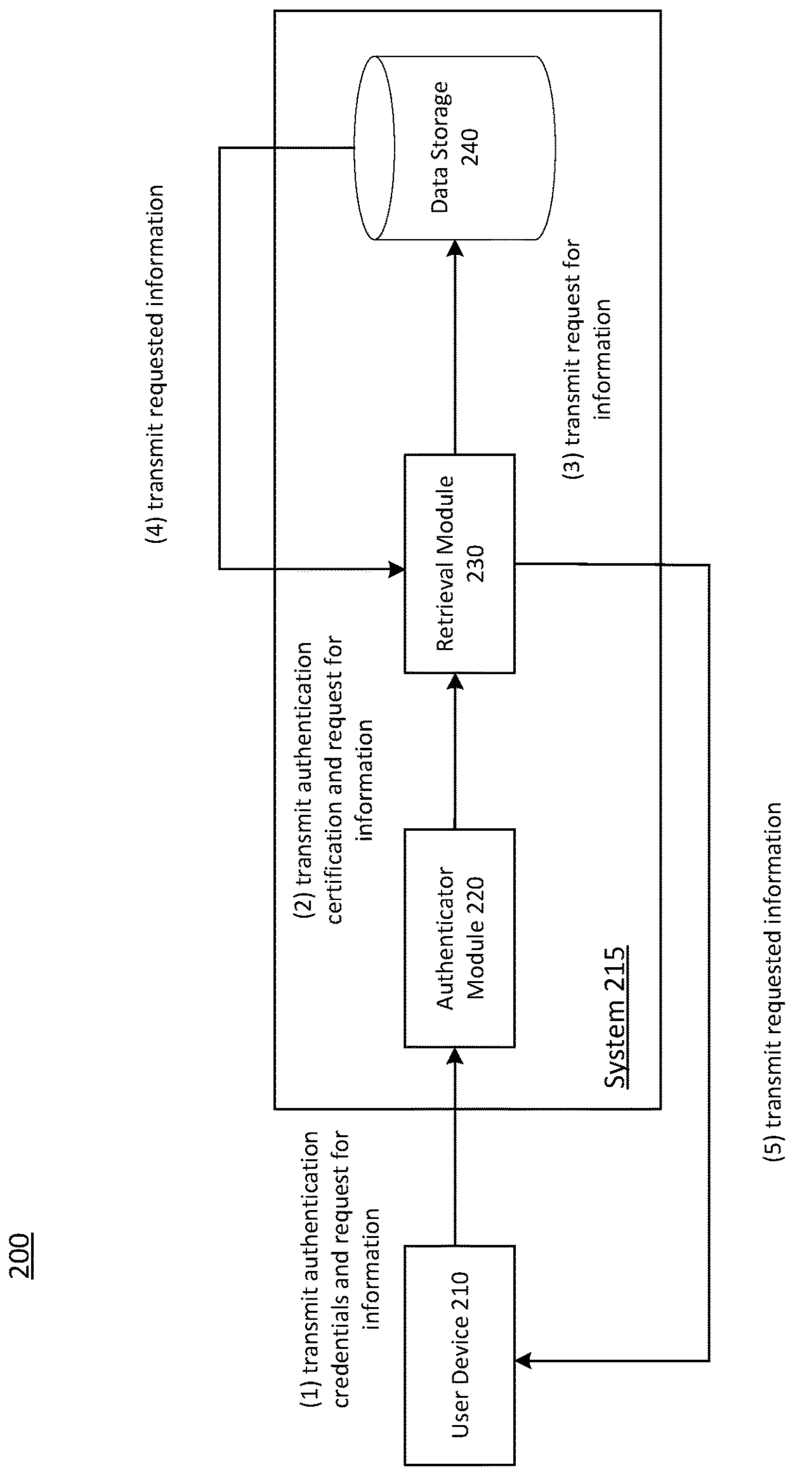

200
User Device 210
(1) transmit authentication credentials and request for information
Authenticator Module 220
(2) transmit authentication certification and request for information
Retrieval Module 230
(3) transmit request for information
Data Storage 240
(4) transmit requested information
(5) transmit requested information
System 215

FIG. 2

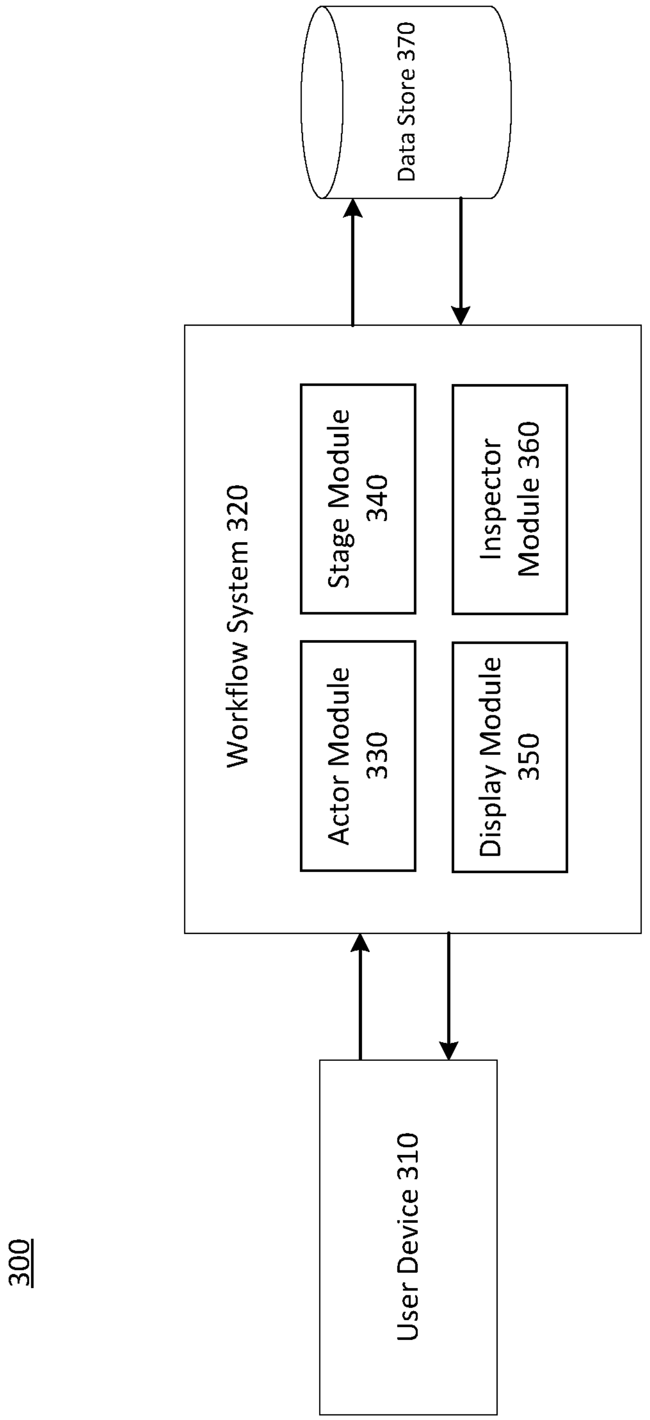

300
User Device 310
Workflow System 320
Actor Module 330
Stage Module 340
Display Module 350
Inspector Module 360
Data Store 370

FIG. 3

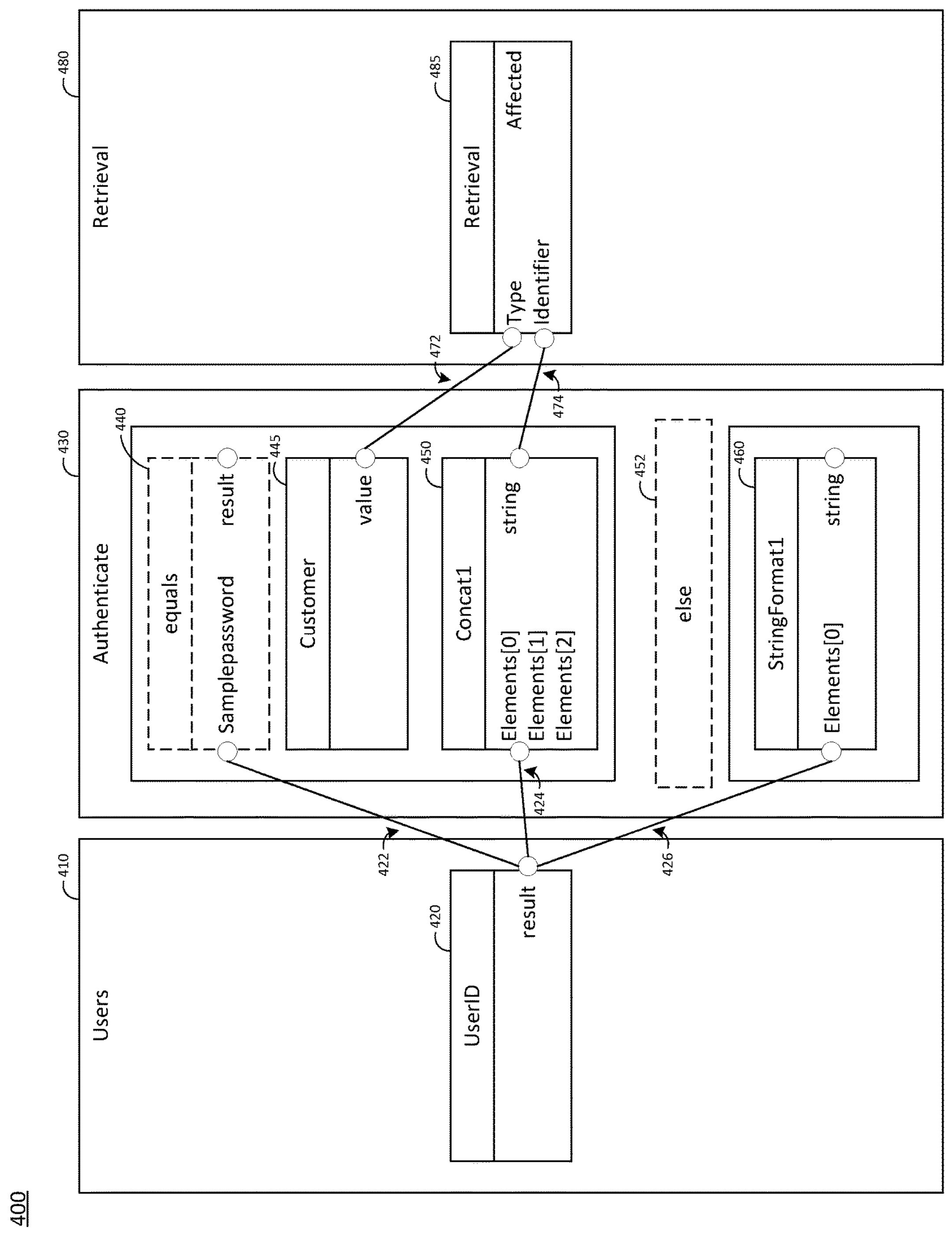

400
Users
410
UserID
420
result
422
424
426
Authenticate
430
440
equals
Samplepassword
result
445
Customer
value
450
Concat1
Elements[0]
Elements[1]
Elements[2]
string
452
else
460
StringFormat1
Elements[0]
string
472
474
Retrieval
480
485
Retrieval
Type
Identifier
Affected

FIG. 4

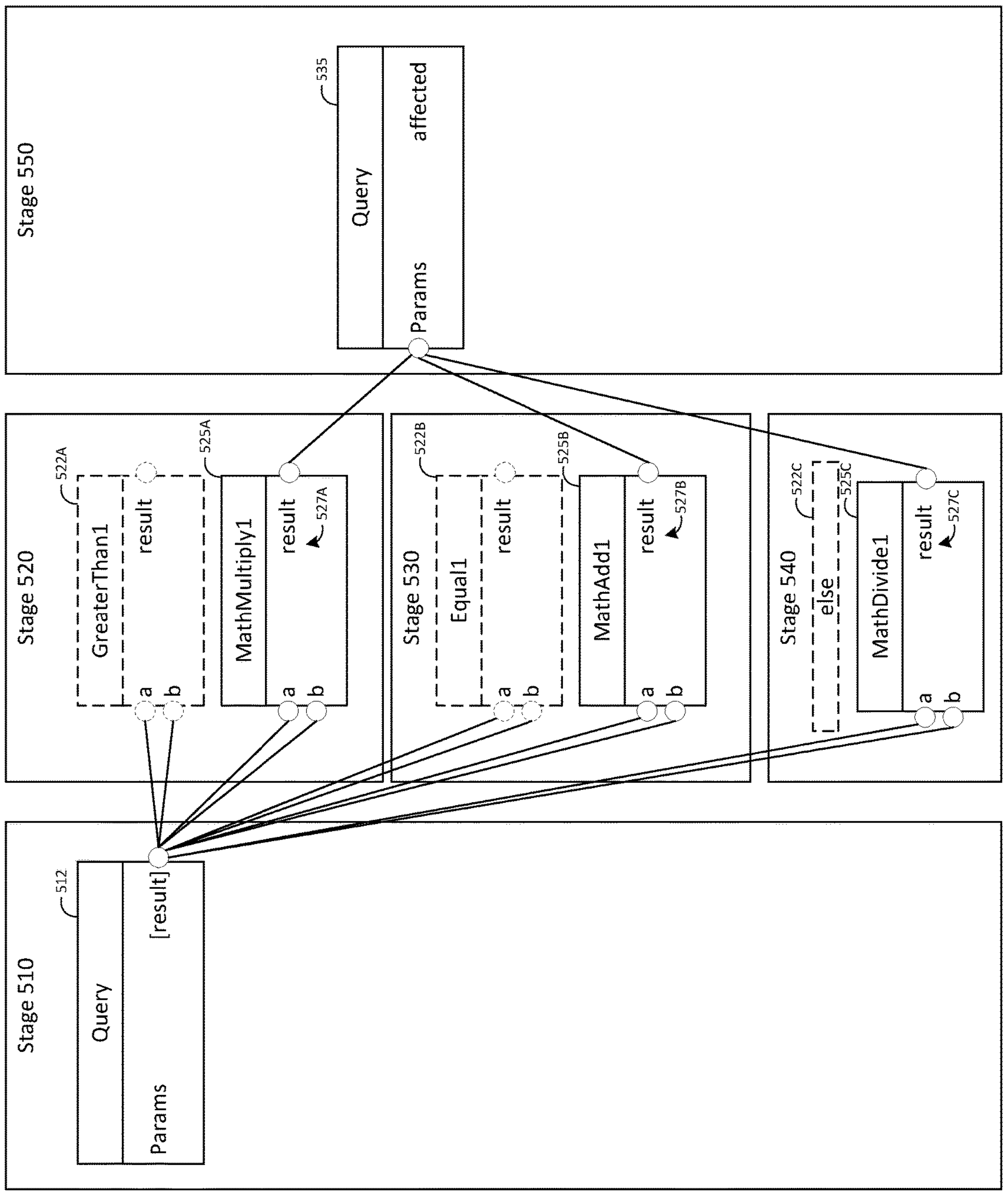

Stage 510
512
Query
Params
[result]
Stage 520
522A
GreaterThan1
result
a
b
525A
MathMultiply1
result
527A
a
b
Stage 530
522B
Equal1
result
a
b
525B
MathAdd1
result
527B
a
b
Stage 540
522C
else
525C
MathDivide1
result
527C
a
b
Stage 550
535
Query
Params
affected

FIG. 5

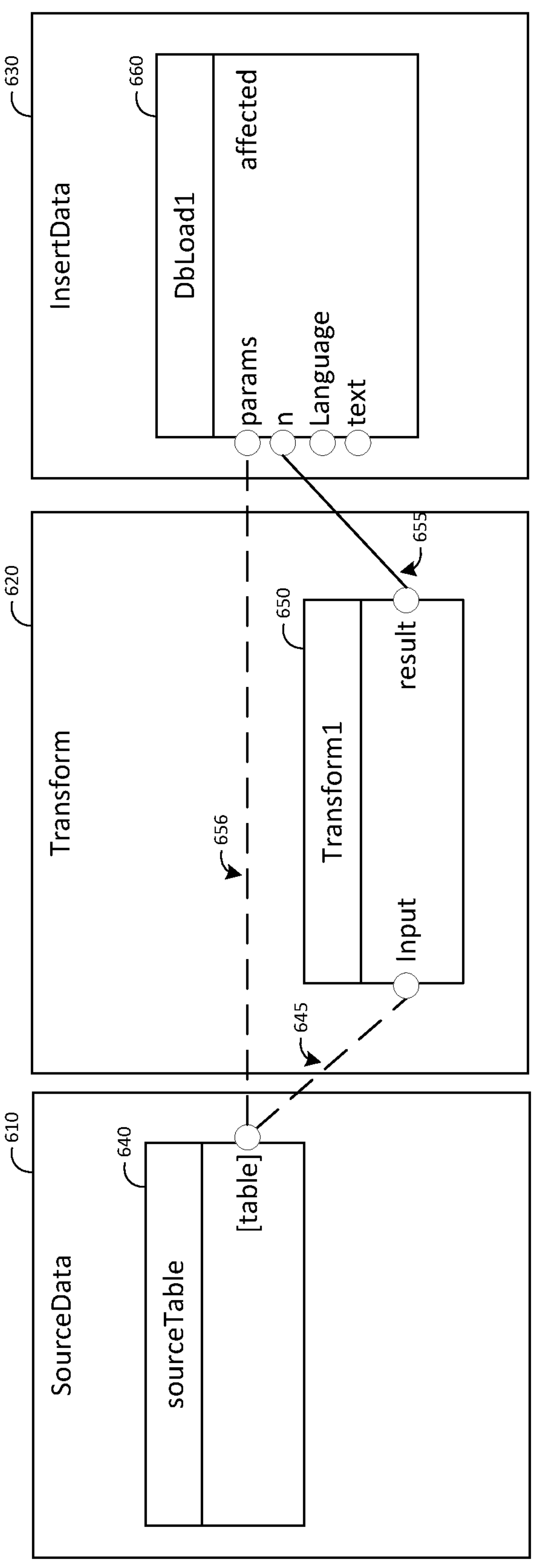

630
InsertData
660
DbLoad1
affected
params
n
Language
text
620
Transform
650
Transform1
result
655
Input
656
645
610
SourceData
640
sourceTable
[table]

FIG. 6

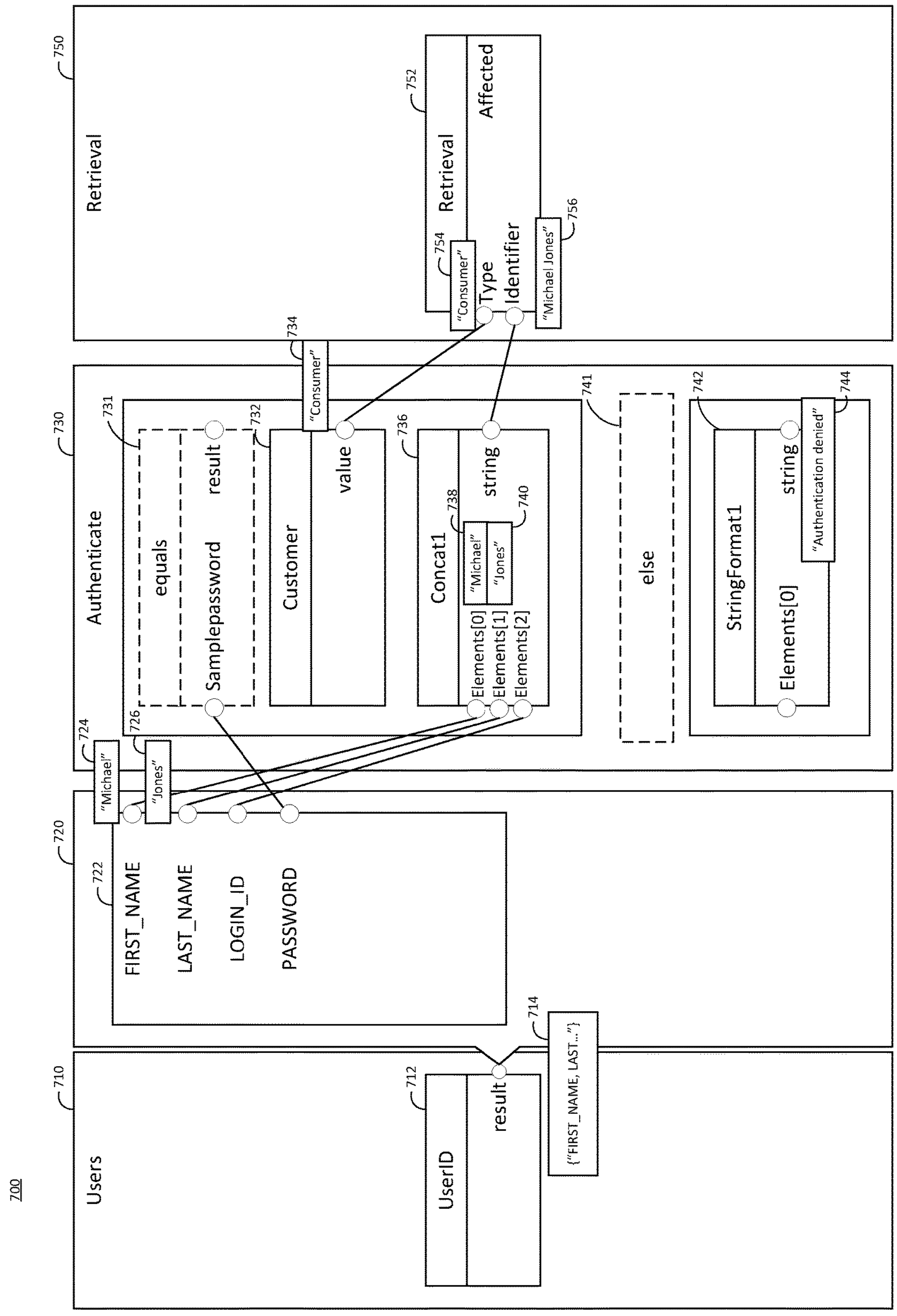
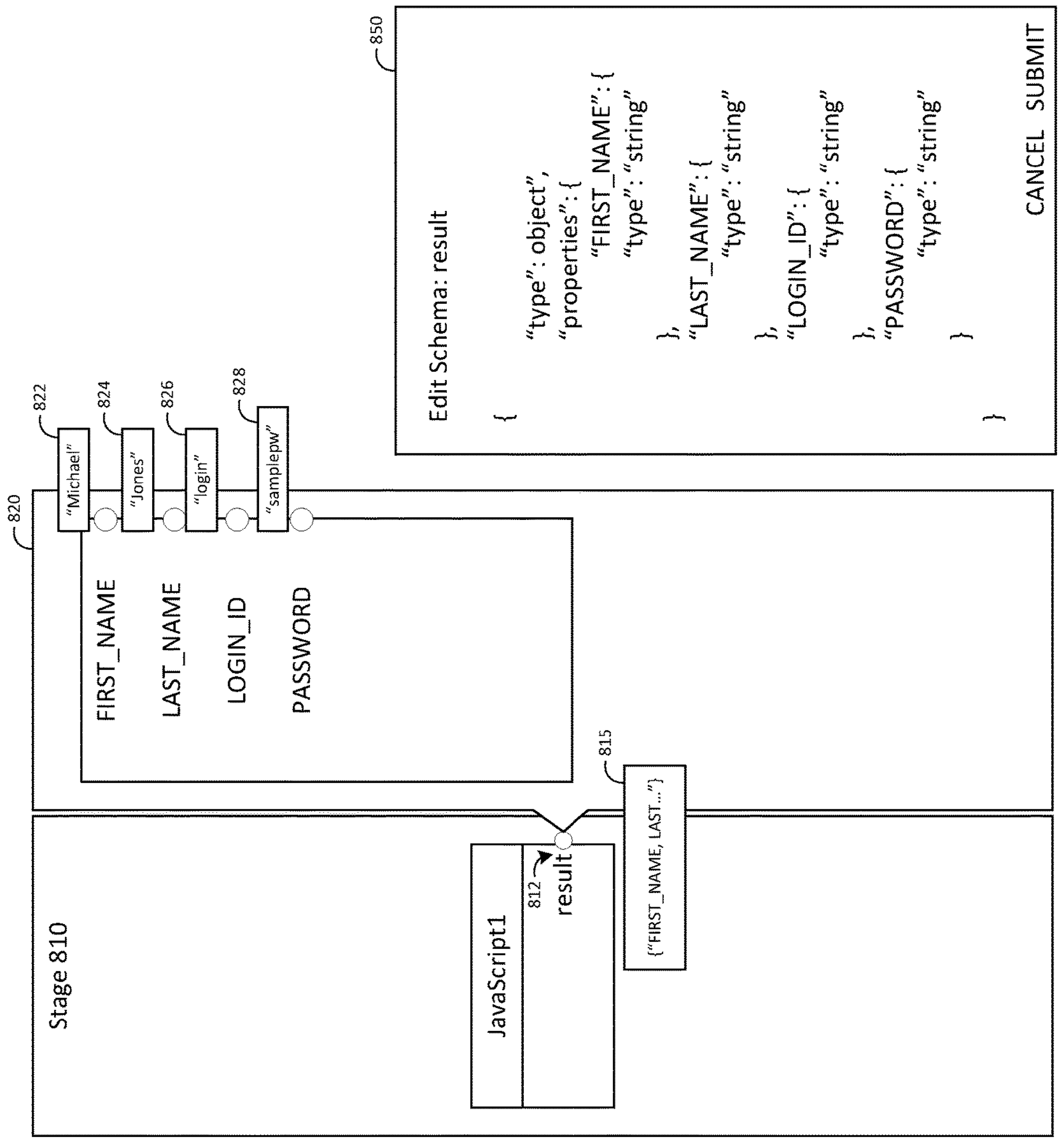

700
710
Users
712
UserID
result
714
{"FIRST_NAME, LAST..."}
720
722
FIRST_NAME
LAST_NAME
LOGIN_ID
PASSWORD
724
"Michael"
726
"Jones"
730
Authenticate
731
equals
Samplepassword
result
732
Customer
value
734
"Consumer"
736
Concat1
string
738
"Michael"
740
"Jones"
Elements[0]
Elements[1]
Elements[2]
741
else
742
StringFormat1
string
Elements[0]
744
"Authentication denied"
750
Retrieval
752
Retrieval
Affected
754
"Consumer"
Type
Identifier
756
"Michael Jones"

FIG. 7



```
{
    "type": object",
    "properties": {
        "FIRST_NAME": {
            "type": "string"
    },
    "LAST_NAME": {
            "type": "string"
    },
    "LOGIN_ID": {
            "type": "string"
    },
    "PASSWORD": {
            "type": "string"
    }
}
```

FIG. 8

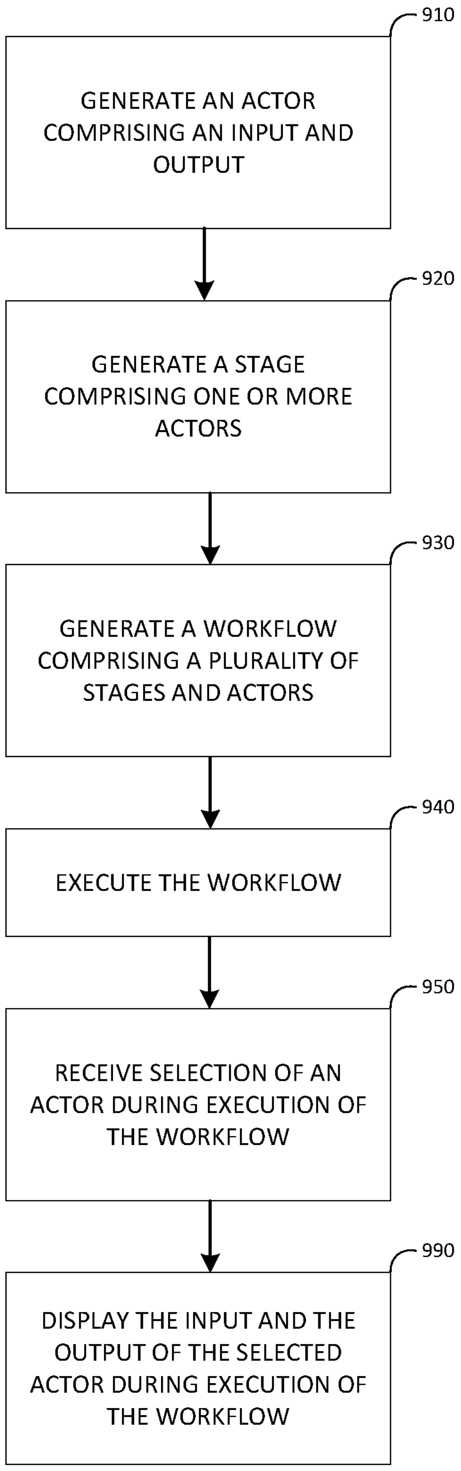

910
GENERATE AN ACTOR COMPRISING AN INPUT AND OUTPUT
920
GENERATE A STAGE COMPRISING ONE OR MORE ACTORS
930
GENERATE A WORKFLOW COMPRISING A PLURALITY OF STAGES AND ACTORS
940
EXECUTE THE WORKFLOW
950
RECEIVE SELECTION OF AN ACTOR DURING EXECUTION OF THE WORKFLOW
990
DISPLAY THE INPUT AND THE OUTPUT OF THE SELECTED ACTOR DURING EXECUTION OF THE WORKFLOW

FIG. 9

METHOD AND SYSTEM FOR EFFICIENTLY CREATING AND ASSESSING WORK AND DATA FLOWS

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 63/114,365, filed Nov. 16, 2020, the disclosure of which is hereby incorporated in its entirety.

[0002] FIELD OF THE DISCLOSURE

[0003] The present disclosure relates to generating a workflow that simultaneously displays the transfer of data and the order of workflow operations. It also relates to a workflow that dynamically identifies parameters in real time to enhance the visibility of data flows and to diagnose and correct errors in real time.

BACKGROUND OF THE DISCLOSURE

[0004] Flow diagrams are used in a variety of settings to visually represent an ordered step of events. For example, a business may use a process diagram to model the steps its employees should take to handle routine customer questions. A business may also use a data flow to model how information, data, or supplies are exchanged among its many individual departments or teams.

[0005] A workflow may include an execution flow or a data flow. Execution flows represent ordered lists of discrete tasks executed in a specific sequence. However, a traditional execution flow may not accurately reflect complicated relationships between tasks or entities performing the tasks. Furthermore, typical execution flows do not allow a user to easily introduce changes to simulate scenarios with different data or parameters. A data flow may track how data is transmitted within a system, but it does not help a user visualize how an execution flow executes the tasks or generates the data. Therefore, there is a need for systems and methods that can receive a set of data, effectively generate a workflow and data flow, and more easily modify the generated work and data flows.

SUMMARY OF THE DISCLOSURE

[0006] An illustrative embodiment of a workflow modeling system is provided. In some implementations, the system comprising: at least one interface configured to output workflow information; and circuitry configured to generate the workflow information. The workflow information may comprise information representing a first actor and a second actor. The first actor may be configured to perform a first operation and have a first output for outputting first data, and the second actor may be configured to perform a second operation and have a first input for inputting the first data from the first output. The workflow information may also be configured to provide a visual representation of the order in which the first actor and the second actor perform the first operation and second operation, respectively, and information about the first data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Various objectives, features, and advantages of the disclosed subject matter can be more fully appreciated with reference to the following detailed description of the enclosed subject matter when considered in connection with the following drawings, in which like reference numerals identify like elements. The following drawings should not be construed as limiting the present disclosure and are intended to be illustrative only.

[0008] FIG. **1** illustrates an example of a workflow.

[0009] FIG. **2** illustrates an example of a data flow.

[0010] FIG. **3** is a diagram illustrating an example of a dynamic workflow modeling system, according to an embodiment of the present disclosure.

[0011] FIG. **4** is a diagram illustrating an example of a dynamic workflow model, according to an embodiment of the present disclosure.

[0012] FIG. **5** is a diagram illustrating an example of a dynamic workflow model with conditional stages, according to an embodiment of the present disclosure.

[0013] FIG. **6** is a diagram illustrating an example of a dynamic workflow model performing an iterative operation, according to an embodiment of the present disclosure.

[0014] FIG. **7** is a diagram illustrating an example of a dynamic workflow model data inspector, according to an embodiment of the present disclosure.

[0015] FIG. **8** is a diagram illustrating an example of a dynamic workflow model schema editor, according to an embodiment of the present disclosure.

[0016] FIG. **9** is a diagram illustrating an example of a dynamic workflow process, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] FIG. **1** illustrates an example of a workflow for handling a user's request for information. In block **110**, a module, such as an authenticator module, or login portal, may receive login credentials along with a request for protected or confidential information. For example, a consumer who shops at an online retailer may wish to access historical information associated with the consumer's account (e.g., purchase history, financial records, profile information, etc.) by accessing the retailer's system over the Internet via an end user computer. However, due to the personal nature of the information requested, the online retailer's system may only provide such information upon receiving valid login credentials (such as a user name and password) from the consumer via the end user computer. In block **120**, the retailer's system analyzes the received login credentials and determines if the received credentials are correct. For example, the online retailer's system may use a lookup table to compare the received login credentials to a list of valid retail consumer credentials stored in a database. If the received login credentials are not associated with a valid consumer record, then the process may simply terminate in block **130**B. Alternatively, the system may send a message back to the consumer's end user computer indicating that the credentials were invalid and prompting the consumer to input the credentials again. On the other hand, if the received login credentials match a valid consumer record, then the process may proceed to block **130**A. In block **130**A, the authenticator module of the retailer's system may pass along the request for information to another module in the retailer's system that can process the request. For example, the authenticator module can redirect or transmit the request for information to a remote server hosting a database storing customer information. In block **140**, the system may transmit the requested information back to the consumer's end user computer. For example, upon receiving a request for a specific customer's purchase history, the retailer's system may extract the information from a consumer records database and transmit the information back to the end user computer in the form of a webpage, spreadsheet, table, file, or other format.

[0018] FIG. **2** illustrates an example of a data flow associated with the workflow described above in FIG. **1**. The process is performed in a system **200**, which comprises a user device **210** (such as the consumer's end user computer) and the retailer's system **215**. System **215** comprises authenticator module **220**, retrieval module **230**, and data storage **240**. In some embodiments, user device **210** and system **215** may be connected via a communication pathway (e.g., a local wireless network, a wired connection, the Internet, etc.). User device **210** may transmit authentication credentials (such as login credentials) and a request for information to system **215** (per item (**1**) in FIG. **2**). Authenticator module **220** may then receive the credentials and confirm the validity of the credentials by, for example, matching the received credentials with a master list of confirmed user credentials. In some embodiments, authenticator module **220** may transmit an authentication certification and the request for information to retrieval module **230** (per item (**2**) in FIG. **2**). In some embodiments, retrieval module **230** may be configured to communicate with data storage **240** (such as a database) to extract information in response to the request for information. The retrieval module **230** transmits or passes along the request for information to data storage **240** (per item (**3**) in FIG. **2**). For example, retrieval module **230** may transmit an identifier associated with the user (e.g., a unique user pin number or user ID) which may then be used by data storage **240** to search for the stored data associated with the user. Data storage **240** may then transmit the requested information back to retrieval module **230** (per item (**4**) in FIG. **2**). Retrieval module **230** may then transmit the information received from data storage **240** to user device **210** over the communication pathway (per item (**5**) in FIG. **2**).

[0019] There are disadvantages associated with the workflow and dataflow illustrated in FIGS. **1** and **2**. For example, the workflow of FIG. **1** shows the high level steps involved in handling a user's request for information. However, while FIG. **1** displays steps in a sequential order, it does not provide any detailed information regarding how such steps are actually implemented in a system. For example, a basic business flow, such as one shown in FIG. **1**, does not show which modules, processors, or other system components are assigned to execute the tasks in the workflow. Furthermore, the basic workflow does not show how multiple components within the system communicate and transfer data within the system while performing the workflow to accomplish the tasks. Therefore, for example, if an error occurs while executing the business flow, a user will have difficulty diagnosing the exact cause and location of the error within the system.

[0020] The data flow illustrated in FIG. **2** also presents its own problems. For example, the data flow shows system modules and components as well as the flow of data within the system. Such a data flow may be easy to follow assuming the tasks executed to generate the data are simple. However, a user may be quickly overwhelmed in embodiments where many different components and modules must execute complex tasks to generate and transfer data. In some embodiments, multiple data flows may exist at any one time and may execute simultaneously, further frustrating a user's efforts to understand how each data flow factors into the overall workflow. It is therefore desirable, in some non-limiting embodiments, to provide a system that allows a user to examine the details of a complex data flow while also allowing the user to keep track of the broader workflow process at any step and point within the system.

[0021] FIG. **3** is a diagram illustrating an example of a dynamic workflow modeling environment, in accordance with a non-limiting embodiment, which shows how certain modules and devices may interact to generate a dynamic workflow. The dynamic workflow operates in an environment **300** and comprises a user device **310**, workflow system **320**, and data store **370**. In some embodiments, user device **310**, workflow system **320**, and data store **370** may be configured to exchange information via one or more communication pathways, such as a variety of wired and/or wireless networks, including but not limited to local area networks, wide area networks, and/or the Internet. In some embodiments, user device **310** may be any device associated with a user, such as, for example, a desktop computer, a laptop computer, a mobile smartphone, tablet, wireless device, or other device.

[0022] As further shown in FIG. **3**, the workflow system **320** includes an actor module **330**, a stage module **340**, a display module **350**, and an inspector module **360**. The modules **330**, **340**, **350**, and **360** may be implemented by software, such as software executed by a processor, components, packages, classes, objects, or a collection of interactive objects. Alternatively, the modules **330**, **340**, **350**, and **360** may be implemented by dedicated hardware, such as an ASIC, individual processing units, storage devices, I/O devices, or communication devices. Yet still, the modules **330**, **340**, **350**, and **360** may be implemented with a combination of hardware and software. The display module **350** may include a display, such as LCD, LED, or OLED monitor. The display module **350** may alternatively or additionally include software, hardware, or combination of software and hardware that creates data to ultimately be displayed on a display.

[0023] Actor module **330** may be configured to receive an input, execute a specific set of actions, and generate an output as part of the dynamic workflow modeling process. For example, actor module **330** may be configured to accept an input (e.g., a numeric value), execute a set of operations based on the input (e.g., multiply the numeric input by 2), and produce an output (e.g., a modified numeric value). In some embodiments, actor module **330** may include one or more "actors," with each actor being configured to perform a different or redundant set of instructions or operations. These "actors" may be predefined and/or may be customized and created by a user. Furthermore, the "actors" may be stored in a database. As noted below, in one implementation, the actors constitute smaller "building blocks" that perform particular operations and can be easily and efficiently combined to perform a wide variety of robust functions and operations.

[0024] In one embodiment, an "actor" may be a reusable piece of logic, with inputs and outputs, that can be assembled with other actors to create more complex logic. For example, a first actor may be a data structure configured to receive an array of numbers as an input, multiply each number in the array by 10, and output a new array comprising the multiplied numbers. The first actor may be used together with a second actor, which may receive the new array as an input and produce another output. In one implementation, an actor may be an object-type data structure configured to execute a set of instructions on data stored in the data structure.

[0025] As an additional example, while one actor may be configured to multiply an input numeric value by 2 and output the result, a different actor may be configured to accept a different type of input (e.g., a floating point integer) and generate a different output (e.g., a string). In some embodiments, actor module **330** may be configured to receive edits or changes from a user. For example, a user may access workflow system **320** via an appropriate user interface (such as a keyboard, mouse, and monitor) to add additional actors to actor module **330**. These additional actors may by predetermined actors and/or may be predetermined actors that have been modified by the user. In some embodiments, a user may instead create one or more actors "from scratch" according to the user's own specifications. As will be described in connection with FIG. **4**, actors may be linked together such that a first actor may generate an output that may be used as an input for a second actor. In some embodiments, actors may have an "inheritance" hierarchy that allows an actor to use logic or arguments used in another actor. For example, a "calculator" actor, which is configured to perform a variety of mathematical operations on input numbers, may inherit logic used to add numbers together from an "addition" actor and may also inherit logic used to multiply numbers together from a "multiplication" actor. In other embodiments, actors may reuse a constant value across multiple flows or reuse actor logic such as JavaScript or SQL. In yet other embodiments, actors that are linked together may themselves be collectively saved as a single actor. Once the linked actors are saved as a new, single actor, this new actor may be reused in the same dynamic workflow or another flow. It will be appreciated that the actors may be configured in alternative ways depending on the implementation.

[0026] Stage module **340** may be configured to represent one or more steps or stages in the dynamic workflow process. For example, in a dynamic workflow model representing the workflow associated with certifying a user's credentials, the stage module **340** may generate or utilize a first stage for receiving a user's credentials before transmitting requested information to a user, a second stage for authenticating the credentials, and a third stage for transmitting an authentication message and/or the requested information to the user. It will be appreciated that other dynamic workflows may use a different number of stages and configurations. Stages may be arranged and executed in a specific order. For example, the stage associated with receiving a user's credentials may be executed before the stage associated with authenticating the received credentials. A user may use stage module **340** to rearrange a plurality of stages in any order the user wishes. Furthermore, in some embodiments, a user may generate a stage and populate the stage with one or more actors of the user's choosing. In certain implementations, the actors in a particular stage may be executed simultaneously, and in other implementations, the actors may be executed sequentially or in another designated order. In some embodiments, each stage can be assigned an error handler. The error handler may be an actor that contains logic to execute an action if an error occurs during a stage. For example, a stage's error handler may be an actor that terminates the stage upon encountering an error. In one example, a stage that is responsible for performing transformations on entries in an array may include an error handler that automatically terminates the process if the referenced array is empty.

[0027] Display module **350** may be configured to generate a visual representation embodying the various stages and actors in a dynamic workflow model. Such a visual representation will enable a user to assess the operations of the dynamic workflow (including the data generated by the workflow) and modify them if needed. Examples of such a visual representation are discussed below with reference to FIGS. **4-8**.

[0028] Inspector module **360** may generate an overlay or window while workflow system **320** executes at least one stage in a dynamic workflow model. Alternatively or additionally, inspector model **360** may generate an overlay or window before, during, or after the workflow system **320** executes one or more or all stages in a dynamic workflow model. As explained via a non-limiting example in more detail below, the inspector overlay or window may be configured to display a variety of information during the execution of the dynamic workflow model. For example, inspector module **360** may generate an overlay displaying input and output parameters of all actors in the dynamic workflow. In some embodiments, inspector module **360** may only display additional information upon receiving a user input. For example, the inspector module **360** may display the input and output parameters of a specific actor only when a user selects the actor with a mouse click or touch gesture or when the user uses a mouse to hover a cursor/pointer over the actor. In some embodiments, inspector module **360** may be configured to display other information. For example, inspector module **360** may display a visual indication showing what stage is currently being executed in real time. By displaying information during execution in real time, inspector module **360** allows a user to test, understand, and debug a dynamic workflow in an efficient, easy, and transparent manner.

[0029] In some embodiments, data store **370** may be a database stored on a remote server or in local memory. Data store **370** may store information being processed by workflow system **320**. For example, if a stage in workflow system **320** generates or outputs a result (e.g., a string), that result may be stored in data store **370**. In some embodiments, data store **370** may additionally or alternatively store a plurality of predefined actors or stages. The workflow system **320** may then refer to data store **370** to reuse the actors or stages that are already stored in data store **370**. If a user creates a new actor or stage, data store **370** may be updated to include the new actor or stage.

[0030] FIG. **4** is a diagram illustrating an example dynamic workflow model **400**. In this example, model **400** is associated with an authentication and information retrieval workflow and can be executed through workflow system **320** and displayed via display module **350**. Model **400** comprises a user ID stage **410**, and authentication stage **430**, and an information retrieval stage **480**. Each of the stages **410**, **430**, and **480** represents a step in the authentication and information retrieval workflow.

[0031] Each of the stages **410**, **430**, and **480** may comprise at least one actor. For example, stage **410** comprises a user ID actor **420**. Stage **430** comprises an equals actor **440**, a customer actor **445**, a concat1 actor **450**, an else actor **452**, and a stringformat1 actor **460**. Stage **480** comprises a retrieval actor **485**. Actors within a stage may be further divided into groups. For example, Stage **430** includes actors **440**, **445**, and **450** in one group (as denoted by the solid-lined box surrounding the actors **440**, **445**, and **450**), while actor **460** is separated into its own group within the same stage (as shown by the box around actor **460**). In some embodiments, actors belonging to a single group may be implemented as sub-actors in one larger actor representing the entire group. Stages **410**, **430**, and **480** are displayed in order from left to right and may be executed sequentially in that order as well. It will be appreciated that some embodiments may utilize a different arrangement of stages and execution order. While the order of steps in a flow may be visually represented (e.g. via display module **350**) by the sequential order of the stages **410**, **430**, and **480** (e.g. from left to right), the flow of data associated with the process may be visually represented in the dynamic workflow model as well.

[0032] As shown in the example in FIG. **4**, display module **350** of workflow system **320** may display the flow of the work and data as a series of nodes and links connecting actors together via their inputs and outputs. For example, the output of actor **420** from stage **410** is provided to the input of actor **440** via link **422**, to the input of actor **450** via link **424**, and to the input of actor **460** via link **426**. Similarly, the output of actor **445** is provided to a first input of actor **485** via link **472**. The output of actor **450** is provided to a second input of actor **485** via links **474**.

[0033] In this embodiment, each of stages **410**, **430**, and **480** comprises one or more actors to execute specific instructions or operations to be performed during the stage. For example, the users stage **410** in the workflow system **320** may receive user credentials (e.g. user ID and an alphanumeric password such as "Samplepassword") from a user's end user computer for accessing data in the user's account. In this example, stage **410** comprises the single user ID actor **420**, which forwards the received user ID and password ("Samplepassword") from its output to the authentication stage **430** via links **422**, **424**, and **426**.

[0034] As shown in the example, authentication stage **430** uses multiple actors **440**, **445**, **450**, **452**, and **460** to authenticate the user ID and password. The equals actor **440** may receive the user's password ("Samplepassword") (and/or the user ID) from actor **420** via its input over link **422** and compare it to a list of authorized passwords (and/or user IDs). If the received password (and/or user ID) matches one of the passwords (and/or user IDs) on the list, the process may proceed to the customer actor **445**. In this case, actor **445** may transmit an integer value (e.g., 1), which indicates that the password (and/or user ID) has been authenticated, via its output to the first input of retrieval actor **485** via link **472**. In response to the actor **445** generating the integer value (e.g. 1), the concat1 actor **450** may also input the received alphanumerical password ("Samplepassword") from the actor **420** via link **424** store it as an string array "Elements [0]." If equals actor **440** determines that the received password ("Samplepassword") (and/or user ID) matches one of the passwords (and/or user IDs) on the list, customer actor **450** may provide a string (e.g., "Samplepassword accepted") to the second input of actor **485** via link **474**. It should be noted that, in some embodiments, actor **450** is not limited to inputting only one array element

[0035] "Elements[0]." In some embodiments, actor **450** may include Elements[1], Elements[2], or any other number of array entries to accept a variable number of inputs. In yet other, non-limiting embodiments, equals actor **440** may not output a "result" of is analysis of the password and/or user ID to customer actor **445** or concat1 actor **450** via an external link. For example, customer actor **445** and concat1 actor **450** may be integrated or otherwise closely associated with equals actor **440**, such that they "internally" receive the result of equals actor **440**. Such a relationship between the actors **440** and the actors **445** and **450** may be denoted by a dashed border notation of actor **440** and/or by the solid border box surrounding the three actors **440**, **445**, and **450**), as shown in FIG. **4**.

[0036] However, if equals actor **440** determines that that received password ("Samplepassword") (and/or user ID) does not match one of the authorized passwords (and/or user IDs), then customer actor **445** may output a different integer value (e.g., 0) via link **472** to the first input of actor **485** indicating that the password has not been authenticated. In this case, the authentication stage **430** may proceed to the else actor **452** and then, to the stringformat1 actor **460**. As shown in FIG. **4**, the stringformat1 actor **460** receives the alphanumerical password ("Samplepassword") from the actor **420** via link **426** and stores it as an string array "Elements[**0**]." The actor **460** may output a string (e.g., "Samplepassword denied") that can be displayed on the end user device. Moreover, the actor **460** may prevent the process from proceeding to the retrieval stage **480** and actor **485** so that confidential information is not retrieved during the stage **480**. In some embodiments, actor **460** may be integrated or otherwise closely associated with else actor **452** and may be executed without receiving an input from actor **452** via an external link. Such a relationship between the actors **452** and **460** may be denoted by a dashed border notation of actor **452**, as shown in FIG. **4**.

[0037] As indicated above, retrieval actor **485** is configured to receive an integer value from actor **445** via its first input and an alphanumeric string from actor **450** via its second input. The actor **485** stores the integer value as a "type" and stores the alphanumeric string as an "identifier." For example, actor **485** may receive an integer value (e.g. a 0 or 1) from actor **445**. When the actor **485** receives a value of "1," it knows that the password ("Samplepassword") (and/or user ID) has been successfully authenticated. One the other hand, when the actor **485** receives a value of "0," it knows that the password is not correct.

[0038] In some embodiments, actor **485** may be configured to perform a set of actions depending on the received inputs. For example, if actor **485** receives the integer value "1" from the actor **445** and the string "Samplepassword accepted" from the actor **450**, it may pass along the string to the user for display on the user's computer and grant the user access to protected information or supply requested information to the user's computer.

[0039] FIG. **5** is a diagram illustrating an example of a dynamic workflow model with conditional stages. Multiple stages and actors may be used in a dynamic workflow to represent a process involving conditional steps. As shown, the model includes five stages, **510**, **520**, **530**, **540**, and **550**. Stage **510** includes a query actor **512**. Stage **520** includes a greaterthan1 actor **522**A and a mathmultiply1 actor **525**A. Stage **530** includes an equal1 actor **522**B and a mathadd1 actor **525**B. Stage **540** includes an else actor **522**C and a mathdivide1 actor **525**C. Stage **550** includes a query actor **535**.

[0040] As shown in this example, the workflow system **320** executes one of stages **520**, **530**, or **540** depending on the output of query actor **512** in stage **510**. For example, the output of actor **512** may be an array of integers (e.g., labeled "[result]") containing integers (e.g., integers a and b), and the array of integers are provided to stages **520**, **530**, and **540**. For example, the output of actor **512** may be transmitted to actors **522**A, **525**A, **522**B, **525**B, and **522**C, as shown in FIG. **5**. In some embodiments, stages **520**, **530**, and **540** may be executed sequentially. For example, stage **520** may be executed before stages **530** and **540**, and stage **530** may be executed before stage **540**. In other embodiments, stages **520**, **530**, and **540** may be configured to be executed simultaneously. In yet other embodiments, stages **520**, **530**, and **540** may be configured to check for different conditions, as will be discussed below.

[0041] At stage **520**, actor **522**A receives the array of integers a and b from actor **512** and determines if both integers are greater than a predetermined value (e.g., 1). If so, actor **522**A may generate and/or output a Boolean value "true" as the result. When the value is "true," the stage **520** may execute actor **525**A, which multiples the integers a and b together to generate result **527**A (e.g., an integer value c=a*b). Then, actor **525**A may output result **527**A to actor **535** in stage **550**.

[0042] On the other hand, if actor **522**A determines that the integers a and b are not greater than 1, it generates and/or outputs a Boolean value "false," and the actor **525**A does not perform its operation on the integers a and b. If the stages are executed sequentially (as opposed to simultaneously), the value "false," may cause stage **530** to be executed. Alternatively, if stages **520**, **530**, and **540** execute simultaneously, stage **530** may execute regardless of the result of stage **520** (and actor **522**A within the stage **520**).

[0043] At stage **530**, actor **522**B determines if the integers a and b are both equal to the value 1. If integers a and b are both equal to the value 1, actor **522**B may generate and/or output the Boolean value "true." In this case, stage **530** then executes actor **525**B, which adds the input integers a and b together to generate result **527**B (e.g., an integer value c=a+b). Then, actor **525**B may output result **527**B to actor **535**.

[0044] On the other hand, if actor **522**B determines that integers a and b are both not equal to 1, actor **522**B generates and/or outputs a Boolean value "false," and the actor **525**B does not perform its operation on integers a and b. If the stages are executed sequentially (as opposed to simultaneously), the output value "false," may cause stage **540** to be executed.

[0045] At stage **540**, actor **525**C may perform a different mathematical operation on input integers a and b. For example, actor **525**C may divide integer a by integer b to generate result **527**C (e.g., a floating point value c=a/b) and output the result to actor **535**.

[0046] Each of stages **520**, **530**, and **540** represents a set of processes that may be sequentially executed after stage **510**, such that stages **520**, **530**, or **540** may be executed one at a time. In some embodiments, multiple stages may be executed simultaneously. Although FIG. **5** represents conditions as multiple stages, it will be appreciated that conditional flows may be represented in other ways in other embodiments. For example, a single stage may comprise multiple actors, wherein each actor in the stage is associated with a separate condition.

[0047] While actors **522**A and **522**B represent conditions that are mutually exclusive, it will be appreciated that multiple conditions may be satisfied at the same time in some embodiments. For example, a first actor (e.g. a "GreaterThan1" actor) may determine whether integers a and b are both greater than 1 (like actor **522**A), and a second actor (e.g. a "GreaterThan5" actor) may determine whether integers a and b are both greater than 5. In this case, both actors may return the Boolean value "true" if the integers a and b are both equal to 7. Similarly, multiple conditions may fail at the same time in some embodiments. For example, the GreaterThan1 actor and the GreaterThan5 actor may both return Boolean values "false" if input integers a and b are both numbers smaller than 1. Also, in some embodiments, actors **522**A, **522**B, and **522**C are stylized with dashed lines in this embodiment to indicate that they do not provide an output via external links to other actors and are closely associated with other actors, as explained above.

[0048] FIG. **6** illustrates an example of a dynamic workflow model performing an iterative operation. Stages and actors may be arranged in a dynamic workflow to represent any sort of task or process that a user wishes. The workflow system **320** may then execute the stages in order from left to right. However, certain processes may require iterative operations and may require certain actors or stages to execute more than once. For example, performing some sort of data transformation on multiple entries in a database or traversing through an array may require an actor to repeatedly perform the same operations on different information.

[0049] As shown, the model includes a sourcedata stage **610**, a transform stage **620**, and an insertdata stage **630**. The source data stage **610** has a sourcetable actor **640** that retrieves data from a first location in a table stored in a database, and outputs the first data via link **645** to the transform stage **620**. Stage **620** has a Transform1 actor **650** that inputs the first data and transforms it (e.g., by performing a mathematical operation) and outputs the transformed data via a link **655** to the InsertData stage **630**. Stage **630** has a DbLoad1 actor **660** that inputs the transformed data and stores it in a database. Then, as shown by link **656**, sourcedata stage **610** is executed again.

[0050] As such, in this example, stages **610**, **620**, and **630** are sequentially executed a number of times to similarly process data located in other locations of the table. Workflow system **320** may therefore represent the iterative operation using a combination of dashed links **645** and **656** and non-dashed link **655**. In some embodiments, a dashed link may signal to workflow system **320** that a specific action must be performed in successive iterations. For example, dashed link **656** signals that each entry of the original table in stage **610** is transmitted over to actor **660**, and dashed link **645** signals that Transform1 actor **650** must perform a data transformation for each entry referenced in sourceTable **640**. Transform1 actor **650** may perform an alteration or transformation operation on the received inputs. For example, if the input table from sourceTable **640** is a table of customer names and associated passwords, Transform1 actor **650** may adjust each password entry to reflect any user password changes but leave the customer names unchanged. By contrast, a non-dashed link may signal that an action does not need to be iteratively performed on multiple entries. For example, non-dashed link **655** signals that no traversal is needed because Transform 1 receives only one input at a time (via link **645**) and generates one corresponding output (on link **655**).

[0051] FIG. **7** is a diagram illustrating an example of a dynamic workflow model data inspector **700**, which may be implemented via inspector module **360**. As explained above, the inspector **700** (implemented in one example via the inspector model **360**) may generate an overlay before, during, or after the workflow system **320** executes at least one stage in a dynamic workflow model. This overlay may be configured to display a variety of information during the execution of the dynamic workflow model, such as input and output parameters of the actors in the dynamic workflow.

[0052] As such, in one example, the dynamic workflow model data inspector **700** shown in FIG. **7** displays information for a user to review during the execution of the dynamic workflow. By displaying information during execution, the inspector **700** may offer a transparent view of how data flows in the process. Accordingly, the inspector **700** may be helpful to check for errors in the process or to determine how modify the process to perform different, but similar tasks.

[0053] The inspector **700** may display a variety of information on the screen by default or in response to some user input. In the embodiment shown in FIG. **7**, the inspector **700** is used in conjunction with dynamic workflow model that is similar to the dynamic workflow model **400** shown in FIG. **4**. Thus, operations of the model shown in FIG. **7** that are similar to the operations of the model **400** shown in FIG. **7** are omitted for the sake of brevity.

[0054] In one embodiment, if the user moves a mouse via a user interface to hover a cursor above an input or an output of an actor, the inspector **700** may display a window showing at least some of the information that will be, has been, or is being, provided from the output. For example, if the user moves the cursor over the "result" output of the actor **712**, the inspector **700** may display a small window **714** containing some information, such as strings or parameters including the first name "FIRST NAME" and last name "LAST NAME" of a user requesting information from the system. Alternatively, the system may automatically display a small window, such as the window **714**, all the time, during a specific operational mode, or periodically, without having to hover a cursor above the input or output of an actor.

[0055] In a further implementation, if the user actually selects the input or output of an actor (e.g., via a mouse click), the inspector **700** may generate a larger window to display more detailed information. For instance, continuing with the example above, if the user clicks on the small window **714** or the "result" output with the mouse, the inspector **700** displays a larger window **720** to display more detailed information output from the actor **712**. Namely, as shown, the window **720** contains a list **722** indicating that the output of the actor **712** includes multiple strings or parameters, including the first name "FIRST NAME," last name "LAST NAME," user ID "LOGIN ID," and password "PASSWORD" of the user requesting information from the system.

[0056] Furthermore, the list of strings or parameters in a larger window may indicate which strings or parameters are input from or output to which actors. For example, the larger window **720** may indicate that the "FIRST NAME," "LAST NAME," and "LOGIN ID" parameters are output from actor **712** to actor **736** in stage **730** (as noted by the links between the parameters and the inputs to the actor **736**). Additionally, the window **720** may indicate that the "PASSWORD" parameter is output to the actor **731** in stage **730** (as noted by the link between the parameter and the actor **731**).

[0057] In yet another embodiment, the inspector **700** may offer more detailed information about the workflow model in case the user desires additional information. For example, as shown in FIG. **7**, additional windows **724**, **726**, **734**, **738**, **740**, **744**, **754**, and **756** are provided that display the actual contents or values of specific parameters generated by actors and/or exchanged between actors during or after they are input to or output from the actors. For example, the window **724** indicates that the "FIRST NAME" parameter output from actor **712** has a value "Michael," and the window **726** indicates that the "LAST NAME" parameter output from actor **712** has a value "Jones." Similarly, the windows **738** and **740** indicate that the actor **736** inputs the "FIRST NAME" parameter having the value "Michael" as Element [0] and the "LAST NAME" parameter having the value "Jones" as Element[1]. Also, windows **734** and **754** indicate that a string having a value "Consumer" is output from actor **732** and input to actor **752**, and window **756** indicates that a string having a value "Michael Jones" is input to actor **752**. These additional windows **724**, **726**, **734**, **738**, **740**, **744**, **754**, and **756** may be displayed at all times, individually selectively displayed upon the user's request, and/or displayed when the inspector **700** is operated in a certain mode. Moreover, in one implementation, the windows **724**, **726**, **734**, **738**, **740**, **744**, **754**, and **756** (as well as the windows **714** and **722**) may be updated in real time so that the user can see how the information propagating through the dynamic workflow changes during execution. As such, the inspector **700** provides increased transparency of how data flows in a dynamic workflow process. In some embodiments, inspector **700** may display an additional window displaying even more detailed information when the user performs a selection action (e.g., a mouse click) on a specific actor, input, or output.

[0058] Similar to the operation of the dynamic workflow model **400** shown in FIG. **4**, actor **731** in stage **730** may input the "PASSWORD" parameter having a certain value and may determine if it matches a password, such as "Samplepassword," on a list of valid passwords. If there is a match, actor **731** may return a Boolean value "true" indicating that the password has been validated. In some embodiments, and as described above in conjunction with FIG. **4**, this Boolean value "true" output from actor **731** may be used by actors **732** and **736**. For example, if the password is validated as "true," then actor **732** may output a string (e.g., "consumer," "administrator," or "seller" account) identifying the type of account associated with the validated password. In this example, the type of account is a consumer account, and the actor **732** outputs the string "Consumer" (as indicated by window **734**). Then, as indicated by window **756**, the string "Consumer" is received by actor **752** in stage **750**.

[0059] Additionally, as shown in FIG. **7**, after actor **736** receives the "FIRST NAME," "LAST NAME," and "LOGIN ID" parameters as inputs, it may transmit them as an output string to actor **752** in stage **750**. For example, as shown, the actor **736** receives the "FIRST NAME" parameter having a value "Michael" (as indicated by window **738**) and receives the "LAST NAME" parameter having a value

"Jones" (as indicated by window **740**). Then, the actor **736** outputs a string "Michael Jones" to actor **752** (as indicated by window **756**).

[0060] The windows **724**, **726**, **734**, **738**, **740**, **744**, **754**, and **756** may be useful to help a user determine whether the actors in the dynamic workflow model are operating properly. For example, the user may confirm via windows **734** and **754** that the "Consumer" string output from actor **734** is successfully received by actor **752**. Additionally, user can determine whether the "FIRST NAME" and "LAST NAME" parameters having values "Michael" and "Jones," respectively, are successfully output from actor **712** and received by actor **736** via windows **738** (as indicated by windows **724**, **726**, **738**, and **740**). Moreover, the user can determine whether the actor **736** successfully combines the input values "Michael" and "Jones" to output a string having the value "Michael Jones" to actor **752** (as indicated by windows **738**, **740**, and **756**). Additionally or alternatively, the inspector **700** may rely on the information in the windows (or the underlying data) to automatically determine whether the actors in the workflow model are operating properly. The inspector **700** may further provide a status and/or alarm to the user indicating that the actors are working properly or if there is an error. For example, if the user accidentally provides a misspelled or incorrect "FIRST NAME" or "LAST NAME," the user may see via inspector **700** that actors **741** and **742** are executed instead of actors **732** and **736**. In such an embodiment, inspector **700** may display window **744** to show the error message "Authentication denied" (in window **744**) to the user to notify the user of an error in the retrieval process.

[0061] FIG. **8** is a diagram illustrating an example of a dynamic workflow model schema editor, which allows a user to edit a "schema." A "schema" describes a data type and its associated properties and values. For example, a schema meant to represent data about a person may include an "object" data type along with the "FIRST NAME" and "LAST NAME" properties. As mentioned above in connection with FIG. **3**, a user may wish to create new actors or stages (or edit existing ones) to create (or modify) a workflow or as part of a debugging process. The schema editor is one mechanism for doing so.

[0062] In some embodiments, actors and stages may utilize schemas to define data used in the workflow or to design data flows that leverage known data structures. A schema may comprise instructions about how an actor should process input information or data to generate corresponding output information or data. In some embodiments, a schema can be updated or edited during runtime and when the workflow is not being run.

[0063] In one embodiment, when a workflow is displayed, a user may use a mouse to click or select an actor, a stage, input to the actor, output from the actor, node, etc. For example, as shown in FIG. **8**, a user may select a node **812** (i.e., the output of "JavaScript1" actor in stage **810**) to instruct the inspector **700** to display window **820** containing detailed information regarding the selected node **812**. When the scheme editor is invoked, the inspector **700** may also display a schema editor window **850**, which displays code associated with the selected node. For example, as shown window **850** may display a file, such as a JSON file, associated with the parameters "FIRST NAME," "LAST NAME," "LOGIN ID," and "PASSWORD" displayed in window **820**. Moreover, a user may examine the actual values of the parameters through windows **822**, **824**, **826**, and **828** during execution and then edit the schema using window **850**. For example, the user may change the "type" of the "FIRST NAME" parameter from "string" to "integer" to modify the operation or properties of the "JavaScript1" actor's output. In some embodiments, the user may directly edit the code found in window **850** by entering changes to the information displayed in the window **850** and submitting the edits. Upon submitting the edits, the process may automatically re-execute using the updated schema. Moreover, a user may add additional properties or parameters to the "JavaScript1" actor's output by entering the information via the window **850**. It will be appreciated that in some embodiments, a user may implement edits or changes to actors or stages differently.

[0064] FIG. **9** is a diagram illustrating an example dynamic workflow process. In block **910**, workflow system **320** may generate an actor comprising an input and output. In some embodiments, the actor may accept a variety of inputs and provide a variety of outputs. For example, an actor may accept strings, Booleans, arrays, constant values, or other types of data as inputs, and provide similar outputs. An actor may be configured to accept specific types of inputs and to automatically convert a received input into the specified type of information. In some embodiments, the actor's input may be the output from another actor. Therefore, multiple actors may be linked together to form a logic chain. In some embodiments, a logic chain formed by linking multiple actors together may itself be saved as a single actor. In some embodiments, the actor may be stored in a data store to be used at a later point.

[0065] In block **920**, the system may generate a stage comprising one or more actors. A stage may represent one or more steps in the dynamic workflow process. For example, a three-step process may be divided into a first stage, a second stage, and a third stage. Stages may be arranged and executed in a specific order. For example, a first stage may be executed before a second stage, and the second stage may in turn be executed before a third stage. A user may generate a stage and populate the stage with one or more actors of the user's choosing. In some embodiments, the actors in a particular stage may be executed simultaneously. Each stage may also be assigned an error handler. The error handler may be an actor that contains logic to execute an action if an error occurs during a stage. For example, a stage's error handler may be an actor that terminates the stage upon encountering an error.

[0066] In block **930**, the system generates a workflow comprising a plurality of stages and actors. It will be appreciated that any number of stages and actors may be used to represent a dynamic workflow. In block **940**, the system executes the generated workflow. The workflow system may execute the workflow by executing stages in a specific order by default. For example, if stages are arranged from left to right, then the workflow may be executed by first executing the left-most stage and proceeding sequentially to the right. Alternatively, the workflow may execute stages in a different order or may be configured to allow a user to selectively configure the workflow to execute the stages in a particular order.

[0067] In block **950**, the system receives a selection of an actor during execution of the workflow. For example, the system may receive a user input (e.g., a mouse click) that identifies a specific actor in the dynamic workflow. In block

960, the system displays the input and the output of the selected actor during the execution of the workflow. As mentioned above in connection with FIG. **7**, the input and output of a selected actor may be displayed using an inspector.

[0068] In some embodiments, the dynamic workflow process may include additional or fewer steps. For example, the dynamic workflow may also include receiving, during execution of a workflow, an edit to the workflow comprising at least an edit to an actor from the plurality of actors. The system may generate a modified actor based at least partly on the received edit and execute a modified workflow based at least partly on the modified actor.

[0069] Moreover, some or all of the structure and functionality of the embodiments described above may be implemented on a single processor or a single server. Alternatively, some or all of the structure and functionality of the embodiments described above may be implemented via a distributed network of processors and servers located in the same or different remote locations.

[0070] As will be apparent to one of ordinary skill in the art from a reading of this disclosure, the disclosed subject matter can be embodied in forms other than those specifically disclosed above. The particular embodiments described above are, therefore, to be considered as illustrative and not restrictive. Those skilled in the art will recognize, or be able to ascertain, using no more than routine experimentation, numerous equivalents to the specific embodiments described herein. The scope of the invention is as set forth in the appended claims and equivalents thereof, rather than being limited to the examples contained in the foregoing description.

1. A workflow modeling system, comprising:
at least one interface configured to output workflow information; and
circuitry configured to generate the workflow information, wherein the workflow information comprises information representing:
a first actor configured to perform a first operation and having a first output for outputting first data,
a second actor configured to perform a second operation and having a first input for inputting the first data from the first output,
wherein the workflow information is configured to provide a visual representation of:
the order in which the first actor and the second actor perform the first operation and second operation, respectively, and
information about the first data.

2. The workflow system as claimed in claim **1**, wherein the circuitry is further configured to receive a user input and provide the information about the first data in response to the user input.

3. The workflow system as claimed in claim **1**, wherein the information about the first data indicates a value of the first data.

4. The workflow system as claimed in claim **1**, wherein the information about the first data indicates a data type of the first data.

5. The workflow system as claimed in claim **1**, wherein the workflow information further comprises information representing:
a first stage representing a first step in the workflow and comprising the first actor, and
a second stage representing a second step in the workflow and comprising the second actor.

6. The workflow system as claimed in claim **5**, wherein the first stage comprises the first actor and a third actor configured to perform a third operation.

7. The workflow system as claimed in claim **5**, wherein the second stage comprises the second actor and a third actor configured to perform a third operation.

8. The workflow system as claimed in claim **1**, wherein the workflow information further comprises information representing a third actor for performing a third operation.

9. The workflow system as claimed in claim **8**, wherein the third actor has a second input for inputting the first data from the first output.

10. The workflow system as claimed in claim **8**, wherein the first actor has a second output for outputting second data,
wherein the third actor has a second input for inputting the second data from the second output.

11. The workflow system as claimed in claim **10**, wherein the workflow information is configured provide a visual representation of information about the second data.

12. The workflow system as claimed in claim **11**, wherein the information about the first data comprises at least one of a first value of the first data or a first data type of the first data, and
wherein the information about the second data comprises at least one of a second value of the second data or a second data type of the second data.

13. The workflow system as claimed in claim **12**, wherein the information about the first data comprises the first data type of the first data and the information about the second data comprises the second data type of the second data, and wherein the first data type is different than the second data type.

14. The workflow system as claimed in claim **12**, wherein the circuitry is further configured to receive a user input and provide the information about the first data or the second data in response to the user input.

15. The workflow system as claimed in claim **1**, wherein the circuitry comprises at least one processor configured to generate the workflow information.

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