Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3121006 C 2023/10/31

(11)(21) 3 121 006

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2020/01/03
(87) Date publication PCT/PCT Publication Date: 2020/07/09
(45) Date de délivrance/Issue Date: 2023/10/31
(85) Entrée phase nationale/National Entry: 2021/05/25
(86) N° demande PCT/PCT Application No.: US 2020/012273
(87) N° publication PCT/PCT Publication No.: 2020/142751
(30) Priorité/Priority: 2019/01/04 (US62/788,726)

(51) Cl.Int./Int.Cl. *G06Q 10/087* (2023.01),
G06Q 30/06 (2023.01)

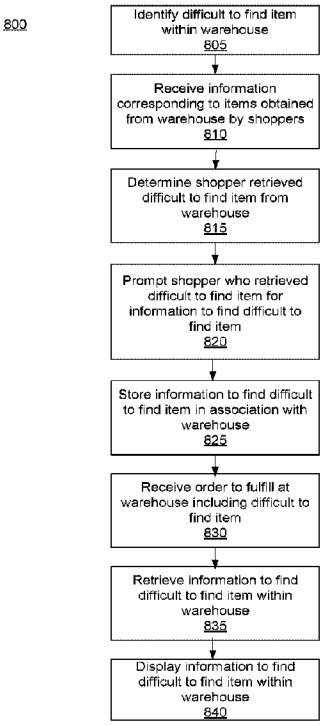
(72) Inventeurs/Inventors:
ZHUANG, MINGZHE, US;
VAN HORNE, CAMILLE, US;
RUDNICK, CHRISTOPHER, US;
KNIGHT, BEN, US;
JENKINS, CHRIS, US;
ANDONOVA, VIKTORIYA, US;
GLUHOVIC, DJORDJE, US;
...

(73) Propriétaire/Owner:
MAPLEBEAR INC. (DBA INSTACART), US

(74) Agent: GOWLING WLG (CANADA) LLP

(54) Titre : FOURNITURE D'INFORMATIONS POUR LOCALISER UN ARTICLE DANS UN ENTREPOT D'UN CLIENT A D'AUTRES CLIENTS RECUPERANT L'ARTICLE DANS L'ENTREPOT

(54) Title: PROVIDING INFORMATION FOR LOCATING AN ITEM WITHIN A WAREHOUSE FROM A SHOPPER TO OTHER SHOPPERS RETRIEVING THE ITEM FROM THE WAREHOUSE



(57) Abrégé/Abstract:
Based on orders fulfilled by shoppers of an online concierge system, the online concierge system identifies items in an order that are difficult to find in a warehouse in which the order is fulfilled. When a shopper obtains a difficult to find item from the warehouse, the online concierge system prompts the shopper to provide information for finding the difficult to find item in the warehouse. The online concierge system stores the information for finding the difficult to find item from the shopper in association with the difficult to find item and with the warehouse. Subsequently, when a different shopper is fulfilling an order from the warehouse including the difficult to find item, the online concierge system displays the information for finding the difficult to find item in the warehouse to the different shopper.

CA 3121006 C 2023/10/31
(11)(21) 3 121 006
(13) C

(72) Inventeurs(suite)/Inventors(continued): SEJPAL, RIDDHIMA, US; GOLIVKIN, MAKSIM, US; RAO, SHARATH, US

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
09 July 2020 (09.07.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/142751 A1

(51) International Patent Classification:
G06Q 10/08 (2012.01) *G06Q 30/00* (2012.01)
G06Q 20/20 (2012.01) *G06Q 30/06* (2012.01)

(21) International Application Number:
PCT/US2020/012273

(22) International Filing Date:
03 January 2020 (03.01.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/788,726 04 January 2019 (04.01.2019) US

(71) Applicant: **MAPLEBEAR INC. (DBA INSTACART)** [US/US]; 50 Beale Street, Suite 600, San Francisco, CA 94105 (US).

(72) Inventors: **ZHUANG, Mingzhe**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **VAN HORNE, Camille**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **RUDNICK, Christopher**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **KNIGHT, Ben**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **JENKINS, Chris**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **ANDONOVA, Vicky**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **GLUHOVIC, Djordje**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **SEJPAL, Riddhima**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **GOLIVKIN, Maksim**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US). **RAO, Sharath**; C/o Maplebear Inc. (dba Instacart), 50 Beale Street, Suite 600, San Francisco, CA 94105 (US).

(74) Agent: **BRANNON, Brian, G.** et al.; Fenwick & West LLP, Silicon Valley Center, 801 California Street, Mountain View, CA 94041 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,

(54) Title: PROVIDING INFORMATION FOR LOCATING AN ITEM WITHIN A WAREHOUSE FROM A SHOPPER TO OTHER SHOPPERS RETRIEVING THE ITEM FROM THE WAREHOUSE

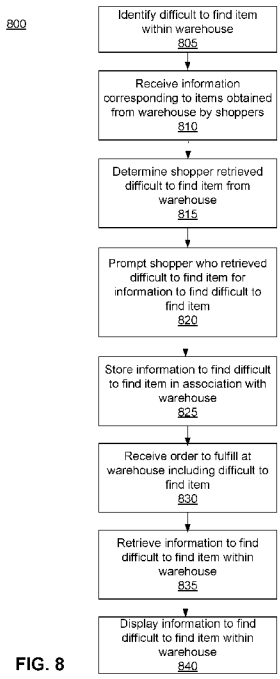


FIG. 8

(57) Abstract: Based on orders fulfilled by shoppers of an online concierge system, the online concierge system identifies items in an order that are difficult to find in a warehouse in which the order is fulfilled. When a shopper obtains a difficult to find item from the warehouse, the online concierge system prompts the shopper to provide information for finding the difficult to find item in the warehouse. The online concierge system stores the information for finding the difficult to find item from the shopper in association with the difficult to find item and with the warehouse. Subsequently, when a different shopper is fulfilling an order from the warehouse including the difficult to find item, the online concierge system displays the information for finding the difficult to find item in the warehouse to the different shopper.

WO 2020/142751 A1

[Continued on next page]

WO 2020/142751 A1

MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

PROVIDING INFORMATION FOR LOCATING AN ITEM WITHIN A WAREHOUSE FROM A SHOPPER TO OTHER SHOPPERS RETRIEVING THE ITEM FROM THE WAREHOUSE

[0001]

BACKGROUND

[0002] This disclosure relates generally to a process for a shopper retrieving an item from a warehouse, and more specifically to providing information locating certain items within the warehouse from a shopper to other shoppers.

[0003] In current online concierge systems, shoppers (or "pickers") fulfill orders at a physical warehouse, such as a retailer, on behalf of customers as part of an online shopping concierge service. In current online concierge systems, the shoppers may be sent to various warehouses with instructions to fulfill orders for items, and the pickers then find the items included in the customer order in a warehouse. But in conventional online concierge systems it is difficult to know before a shopper arrives at the warehouse if the item in the customer's order is in stock at the warehouse. Item inventory may fluctuate throughout a day or week, such that even if a shopper previously found an item at a warehouse, the shopper may be unable to find the item at the same warehouse for a subsequent delivery order.

[0004] Further, certain items may be available at a warehouse but difficult for a shopper to locate within the warehouse. For example, an item may be located in a location within a warehouse that is difficult for a shopper to see, or a shopper's view of the item within the warehouse may be obscured by other items or other physical obstructions within the warehouse. When a shopper fulfills an order including one or more items that are difficult to find within the warehouse, the shopper may spend unnecessary time looking for a difficult to locate item within the warehouse, increasing an amount of time for the shopper to fulfill the order and provide the items in the order to the customer. Additionally, a shopper's inability to find a difficult to locate item within a warehouse may cause the shopper to request the customer select an alternative item in place of the difficult to locate item, increasing customer frustration by having the user select an alternative item when the originally requested item is available from the warehouse, but difficult to locate within the warehouse.

SUMMARY

[0005] An online concierge system can generate and use a machine-learned model to

Date Reçue/Date Received 2022-11-25

predict item availability of items included in a delivery order and selected by a customer. The machine-learned model is trained using information about items, such as whether the items were found at a warehouse in previous orders. The previous delivery orders make up large scale training datasets that are used to statistically map item characteristics, order information, and other factors to item availability within the machine-learned model. Item information from new orders is then input into the machine-learned model to generate item availability probabilities. Based on the availability predictions from the machine-learned model, instructions are generated to a shopper who fulfills a delivery order. The instructions may reduce the amount of time that a shopper spends looking for an item at a warehouse by telling the shopper that an item is likely to be available or unavailable, and instructing the shopper to continue or stop looking for an item based on the predicted availability.

[0006] While the machine-learned model predicts availability of an item at a warehouse, an item that is available at the warehouse but difficult to be located within the warehouse by a shopper. For example, an item may be obscured from view within a warehouse by a physical obstruction or by other items within the warehouse. As another example, an item may be located in a section of the warehouse with unrelated objects or may be located in an area of the warehouse that is distant from other similar items. This may prevent various shoppers from finding and retrieving an item in the warehouse, even though the item is actually available at the warehouse.

[0007] To allow shoppers to better identify certain items within a warehouse that are difficult to locate within the warehouse, when the online concierge system receives an order from a customer including one or more items to be fulfilled at a warehouse, the online concierge system identifies a difficult to find item within the order. In various embodiments, an item is "difficult to find" if the trained model predicts that the item has at least a threshold availability at the warehouse and that a shopper other than the shopper fulfilling the order was unable to retrieve from the warehouse within a threshold amount of time from when the online concierge system received the order. For example, a difficult to find item is an item an order to be fulfilled at a warehouse that at least one shopper other than the shopper fulfilling the order did not find within the warehouse within 24 hours of a time from a time when the online concierge system received the order.

[0008] In response to receiving an indication that the shopper fulfilling the order including the difficult to find item at the warehouse retrieving the difficult to find item from the warehouse, the online concierge system prompts the shopper to provide information for finding the difficult to find item within the warehouse. For example, the online concierge

system receives an indication from a shopper mobile application executing on a client device of the shopper identifying the difficult to find product, the warehouse, the shopper, and an indication that the shopper has retrieved the difficult to find product from the warehouse location. In the preceding example, the online concierge system transmits a prompt to the shopper mobile application that prompts the shopper to specify information for finding the difficult to find item within the warehouse. The prompt may include a message congratulating the shopper for locating the difficult to find item within the warehouse. In various embodiments, the information for finding the difficult to find item is a picture of a location of the difficult to find item within the warehouse, a text description of a location of the difficult to find item within the warehouse, directions for locating the difficult to find item within the warehouse, or any combination thereof. The online concierge system stores the information for finding the difficult to find item within the warehouse in association with an identifier of the warehouse and in association with an identifier of the difficult to find item. In some embodiments, the online concierge system also stores an identifier of the shopper who retrieved the difficult to find item in association with the information for finding the difficult to find item within the warehouse.

[0009] Subsequently, when another shopper is fulfilling an order at the warehouse that includes the item that had been designated "difficult to find," the online concierge system retrieves the information for finding the difficult to find item within the warehouse stored in association with the identifier of the warehouse and the identifier of the difficult to find item. Via the shopper mobile application, the online concierge system displays the information for finding the difficult to find item within the warehouse to the other shopper fulfilling the order at the warehouse. For example, the online concierge system displays an indication that a location hint is available proximate to information identifying the difficult to find item in an interface. In response to receiving a selection of the indication from the shopper mobile application, the online concierge system displays the information for finding the difficult to find item within the warehouse, allowing the other shopper to leverage the stored information to more efficiently locate and retrieve the difficult to find item from the warehouse.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 illustrates an environment of an online shopping concierge service, according to one embodiment.

[0011] FIG. 2 is a diagram of an online shopping concierge system, according to one embodiment.

[0012] FIG. 3A is a diagram of a customer mobile application (CMA), according to one

embodiment.

[0013] FIG. 3B is a diagram of a shopper mobile application (SMA), according to one embodiment.

[0014] FIG. 4 is a flowchart of a process for predicting inventory availability, according to one embodiment.

[0015] FIG. 5 is a flowchart of a process for updating training datasets for a machine-learned model, according to one embodiment.

[0016] FIG. 6 is a flowchart of a process for determining instructions to a shopper if a probability indicates that an item is available at a warehouse, according to one embodiment.

[0017] FIG. 7 is a flowchart of a process for determining feedback to a customer based on a probability that an item is available at a warehouse, according to one embodiment.

[0018] FIG. 8 is a flowchart of a process for obtaining information for finding certain items within a warehouse for display to one or more shoppers, according to one embodiment.

[0019] FIG. 9 shows an example interface displayed by the shopper mobile application displaying a prompt to a shopper to provide information for finding a difficult to find item within the warehouse, according to one embodiment.

[0020] FIG. 10 shows an example interface displaying an order being fulfilled by a shopper, according to one embodiment.

[0021] FIG. 11 shows an example interface displayed by the shopper mobile application including information for finding a difficult to find item in a warehouse, according to one embodiment.

[0022] The figures depict embodiments of the present disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles, or benefits touted, of the disclosure described herein.

DETAILED DESCRIPTION

System Overview

[0023] FIG. 1 illustrates an environment 100 of an online platform, according to one embodiment. The figures use like reference numerals to identify like elements. A letter after a reference numeral, such as "110a," indicates that the text refers specifically to the element having that particular reference numeral. A reference numeral in the text without a following letter, such as "110," refers to any or all of the elements in the figures bearing that reference numeral. For example, "110" in the text refers to reference numerals "110a" and/or "110b"

in the figures.

[0024] The environment 100 includes an online concierge system 102. The system 102 is configured to receive orders from one or more customers 104 (only one is shown for the sake of simplicity). An order specifies a list of goods (items or products) to be delivered to the customer 104. The order also specifies the location to which the goods are to be delivered, and a time window during which the goods should be delivered. In some embodiments, the order specifies one or more retailers from which the selected items should be purchased. The customer may use a customer mobile application (CMA) 106 to place the order; the CMA 106 is configured to communicate with the online concierge system 102.

[0025] The online concierge system 102 is configured to transmit orders received from customers 104 to one or more shoppers 108. A shopper 108 may be a contractor, employee, or other person (or entity) who is enabled to fulfill orders received by the online concierge system 102. The shopper 108 travels between a warehouse and a delivery location (e.g., the customer's home or office). A shopper 108 may travel by car, truck, bicycle, scooter, foot, or other mode of transportation. In some embodiments, the delivery may be partially or fully automated, e.g., using a self-driving car. The environment 100 also includes three warehouses 110a, 110b, and 110c (only three are shown for the sake of simplicity; the environment could include hundreds of warehouses). The warehouses 110 may be physical retailers, such as grocery stores, discount stores, department stores, etc., or non-public warehouses storing items that can be collected and delivered to customers. Each shopper 108 fulfills an order received from the online concierge system 102 at one or more warehouses 110, delivers the order to the customer 104, or performs both fulfillment and delivery. In one embodiment, shoppers 108 make use of a shopper mobile application 112 which is configured to interact with the online concierge system 102.

[0026] FIG. 2 is a diagram of an online concierge system 102, according to one embodiment. The online concierge system 102 includes an inventory management engine 202, which interacts with inventory systems associated with each warehouse 110. In one embodiment, the inventory management engine 202 requests and receives inventory information maintained by the warehouse 110. The inventory of each warehouse 110 is unique and may change over time. The inventory management engine 202 monitors changes in inventory for each participating warehouse 110. The inventory management engine 202 is also configured to store inventory records in an inventory database 204. The inventory database 204 may store information in separate records – one for each participating warehouse 110 – or may consolidate or combine inventory information into a unified record.

Inventory information includes both qualitative and qualitative information about items, including size, color, weight, SKU, serial number, and so on. In one embodiment, the inventory database 204 also stores purchasing rules associated with each item, if they exist. For example, age-restricted items such as alcohol and tobacco are flagged accordingly in the inventory database 204. Additional inventory information useful for predicting the availability of items may also be stored in the inventory database 204. For example, for each item-warehouse combination (a particular item at a particular warehouse), the inventory database 204 may store a time that the item was last found, a time that the item was last not found (a shopper looked for the item but could not find it), the rate at which the item is found, and the popularity of the item.

[0027] Inventory information provided by the inventory management engine 202 may supplement the training datasets 220. Inventory information provided by the inventory management engine 202 may not necessarily include information about the outcome of picking a delivery order associated with the item, whereas the data within the training datasets 220 is structured to include an outcome of picking a delivery order (e.g., if the item in an order was picked or not picked).

[0028] The online concierge system 102 also includes an order fulfillment engine 206 which is configured to synthesize and display an ordering interface to each customer 104 (for example, via the customer mobile application 106). The order fulfillment engine 206 is also configured to access the inventory database 204 in order to determine which products are available at which warehouse 110. The order fulfillment engine 206 may supplement the product availability information from the inventory database 204 with an item availability predicted by the machine-learned item availability model 216. The order fulfillment engine 206 determines a sale price for each item ordered by a customer 104. Prices set by the order fulfillment engine 206 may or may not be identical to in-store prices determined by retailers (which is the price that customers 104 and shoppers 108 would pay at the retail warehouses). The order fulfillment engine 206 also facilitates transactions associated with each order. In one embodiment, the order fulfillment engine 206 charges a payment instrument associated with a customer 104 when he/she places an order. The order fulfillment engine 206 may transmit payment information to an external payment gateway or payment processor. The order fulfillment engine 206 stores payment and transactional information associated with each order in a transaction records database 208.

[0029] In some embodiments, the order fulfillment engine 206 also shares order details with warehouses 110. For example, after successful fulfillment of an order, the order

fulfillment engine 206 may transmit a summary of the order to the appropriate warehouses 110. The summary may indicate the items purchased, the total value of the items, and in some cases, an identity of the shopper 108 and customer 104 associated with the transaction. In one embodiment, the order fulfillment engine 206 pushes transaction and/or order details asynchronously to retailer systems. This may be accomplished via use of webhooks, which enable programmatic or system-driven transmission of information between web applications. In another embodiment, retailer systems may be configured to periodically poll the order fulfillment engine 206, which provides detail of all orders which have been processed since the last request.

[0030] The order fulfillment engine 206 may interact with a shopper management engine 210, which manages communication with and utilization of shoppers 108. In one embodiment, the shopper management engine 210 receives a new order from the order fulfillment engine 206. The shopper management engine 210 identifies the appropriate warehouse to fulfill the order based on one or more parameters, such as a probability of item availability determined by a machine-learned item availability model 216, the contents of the order, the inventory of the warehouses, and the proximity to the delivery location. The shopper management engine 210 then identifies one or more appropriate shoppers 108 to fulfill the order based on one or more parameters, such as the shoppers' proximity to the appropriate warehouse 110 (and/or to the customer 104), his/her familiarity level with that particular warehouse 110, and so on. Additionally, the shopper management engine 210 accesses a shopper database 212 which stores information describing each shopper 108, such as his/her name, gender, rating, previous shopping history, and so on. Methods that can be used to identify a warehouse 110 at which a shopper 108 can likely find most or all items in an order are described with respect to FIGS. 4-7.

[0031] As part of fulfilling an order, the order fulfillment engine 206 and/or shopper management engine 210 may access a customer database 214 which stores information describing each customer. This information could include each customer's name, address, gender, shopping preferences, favorite items, stored payment instruments, and so on.

Machine Learning Model

[0032] The online concierge system 102 further includes a machine-learned item availability model 216, a modeling engine 218, and training datasets 220. The modeling engine 218 uses the training datasets 220 to generate the machine-learned item availability model 216. The machine-learned item availability model 216 can learn from the training datasets 220, rather than follow only explicitly programmed instructions. The inventory

management engine 202, order fulfillment engine 206, and/or shopper management engine 210 can use the machine-learned item availability model 216 to determine a probability that an item is available at a warehouse 110. The machine-learned item availability model 216 may be used to predict item availability for items being displayed to or selected by a customer, or included in received delivery orders. A single machine-learned item availability model 216 is used to predict the availability of any number of items.

[0033] The machine-learned item availability model 216 can be configured to receive as inputs information about an item, the warehouse for picking the item, and the time for picking the item. The machine-learned item availability model 216 may be adapted to receive any information that the modeling engine 218 identifies as indicators of item availability. At minimum, the machine-learned item availability model 216 receives information about an item-warehouse pair, such as an item in a delivery order and a warehouse at which the order could be fulfilled. Items stored in the inventory database 204 may be identified by item identifiers. As described above, various characteristics, some of which are specific to the warehouse (e.g., a time that the item was last found in the warehouse, a time that the item was last not found in the warehouse, the rate at which the item is found, the popularity of the item) may be stored for each item in the inventory database 204. Similarly, each warehouse may be identified by a warehouse identifier and stored in a warehouse database along with information about the warehouse. A particular item at a particular warehouse may be identified using an item identifier and a warehouse identifier. In other embodiments, the item identifier refers to a particular item at a particular warehouse, so that the same item at two different warehouses is associated with two different identifiers. For convenience, both of these options to identify an item at a warehouse are referred to herein as an "item-warehouse pair." Based on the identifier(s), the online concierge system 102 can extract information about the item and/or warehouse from the inventory database 204 and/or warehouse database, and provide this extracted information as inputs to the item availability model 216.

[0034] The machine-learned item availability model 216 contains a set of functions generated by the modeling engine 218 from the training datasets 220 that relate the item, warehouse, and timing information, and/or any other relevant inputs, to the probability that the item is available at a warehouse. Thus, for a given item-warehouse pair, the machine-learned item availability model 216 outputs a probability that the item is available at the warehouse. The machine-learned item availability model 216 constructs the relationship between the input item-warehouse pair, timing, and/or any other inputs and the availability

probability (also referred to as "availability") that is generic enough to apply to any number of different item-warehouse pairs. In some embodiments, the probability output by the machine-learned item availability model 216 includes a confidence score. The confidence score may be the error or uncertainty score of the output availability probability, and may be calculated using any standard statistical error measurement. In some examples, the confidence score is based in part on whether the item-warehouse pair availability prediction was accurate for previous delivery orders (e.g., if the item was predicted to be available at the warehouse and not found by the shopper, or predicted to be unavailable but found by the shopper). In some examples, the confidence score is based in part on the age of the data for the item, e.g., if availability information has been received within the past hour, or the past day. The set of functions of the item availability model 216 may be updated and adapted following retraining with new training datasets 220. The machine-learned item availability model 216 may be any machine learning model, such as a neural network, boosted tree, gradient boosted tree or random forest model. In some examples, the machine-learned item availability model 216 is generated from XGBoost algorithm.

[0035] The item probability generated by the machine-learned item availability model 216 may be used to determine instructions delivered to the customer 104 and/or shopper 108, as described in further detail below.

[0036] The training datasets 220 relate a variety of different factors to known item availabilities from the outcomes of previous delivery orders (e.g. if an item was previously found or previously unavailable). The training datasets 220 include the items included in previous delivery orders, whether the items in the previous delivery orders were picked, warehouses associated with the previous delivery orders, and a variety of characteristics associated with each of the items (which may be obtained from the inventory database 204). Each piece of data in the training datasets 220 includes the outcome of a previous delivery order (e.g., if the item was picked or not). The item characteristics may be determined by the machine-learned item availability model 216 to be statistically significant factors predictive of the item's availability. For different items, the item characteristics that are predictors of availability may be different. For example, an item type factor might be the best predictor of availability for dairy items, whereas a time of day may be the best predictive factor of availability for vegetables. For each item, the machine-learned item availability model 216 may weight these factors differently, where the weights are a result of a "learning" or training process on the training datasets 220. The training datasets 220 are very large datasets taken across a wide cross section of warehouses, shoppers, items, warehouses, delivery orders,

times and item characteristics. The training datasets 220 are large enough to provide a mapping from an item in an order to a probability that the item is available at a warehouse. In addition to previous delivery orders, the training datasets 220 may be supplemented by inventory information provided by the inventory management engine 202. In some examples, the training datasets 220 are historic delivery order information used to train the machine-learned item availability model 216, whereas the inventory information stored in the inventory database 204 include factors input into the machine-learned item availability model 216 to determine an item availability for an item in a newly received delivery order. In some examples, the modeling engine 218 may evaluate the training datasets 220 to compare a single item's availability across multiple warehouses to determine if an item is chronically unavailable. This may indicate that an item is no longer manufactured. The modeling engine 218 may query a warehouse 110 through the inventory management engine 202 for updated item information on these identified items.

Machine Learning Factors

[0037] The training datasets 220 include a time associated with previous delivery orders. In some embodiments, the training datasets 220 include a time of day at which each previous delivery order was placed. Time of day may impact item availability, since during high-volume shopping times, items may become unavailable that are otherwise regularly stocked by warehouses. In addition, availability may be affected by restocking schedules, e.g., if a warehouse mainly restocks at night, item availability at the warehouse will tend to decrease over the course of the day. Additionally, or alternatively, the training datasets 220 include a day of the week previous delivery orders were placed. The day of the week may impact item availability, since popular shopping days may have reduced inventory of items, or restocking shipments may be received on particular days. In some embodiments, training datasets 220 include a time interval since an item was previously picked in a previously delivery order. If an item has recently been picked at a warehouse, this may increase the probability that it is still available. If there has been a long time interval since an item has been picked, this may indicate that the probability that it is available for subsequent orders is low or uncertain. In some embodiments, training datasets 220 include a time interval since an item was not found in a previous delivery order. If there has been a short time interval since an item was not found, this may indicate that there is a low probability that the item is available in subsequent delivery orders. And conversely, if there is has been a long time interval since an item was not found, this may indicate that the item may have been restocked, and is available for subsequent delivery orders. In some examples, training

datasets 220 may also include a rate at which an item is typically found by a shopper at a warehouse, a number of days since inventory information about the item was last received from the inventory management engine 202, a number of times an item was not found in a previous week, or any number of additional rate or time information. The relationships between this time information and item availability are determined by the modeling engine 218 training a machine learning model with the training datasets 220, producing the machine-learned item availability model 216.

[0038] The training datasets 220 include item characteristics. In some examples, the item characteristics include a department associated with the item. For example, if the item is yogurt, it is associated with the dairy department. The department may be the bakery, beverage, nonfood and pharmacy, produce and floral, deli, prepared foods, meat, seafood, dairy, the meat department, or dairy department, or any other categorization of items used by the warehouse. The department associated with an item may affect item availability, since different departments have different item turnover rates and inventory levels. In some examples, the item characteristics include an aisle of the warehouse associated with the item. The aisle of the warehouse may affect item availability, since different aisles of a warehouse may be more frequently re-stocked than others. Additionally, or alternatively, the item characteristics include an item popularity score. The item popularity score for an item may be proportional to the number of delivery orders received that include the item. An alternative or additional item popularity score may be provided by a retailer through the inventory management engine 202. In some examples, the item characteristics include a product type associated with the item. For example, if the item is a particular brand of a product, then the product type will be a generic description of the product type, such as "milk" or "eggs." The product type may affect the item availability, since certain product types may have a higher turnover and re-stocking rate than others, or may have larger inventories in the warehouses. In some examples, the item characteristics may include a number of times a shopper was instructed to keep looking for the item after he or she was initially unable to find the item, a total number of delivery orders received for the item, whether or not the product is organic, vegan, gluten free, or any other characteristics associated with an item. The relationships between item characteristics and item availability are determined by the modeling engine 218 training a machine learning model with the training datasets 220, producing the machine-learned item availability model 216.

[0039] The training datasets 220 may include additional item characteristics that affect the item availability, and can therefore be used to build the machine-learned item availability

model 216 relating the delivery order for an item to its predicted availability. The training datasets 220 may be periodically updated with recent previous delivery orders. The training datasets 220 may be updated with item availability information provided directly from shoppers 108, as described in further detail with reference to FIG. 5. Following updating of the training datasets 220, a modeling engine 218 may retrain a model with the updated training datasets 220, and produce a new machine-learned item availability model 216.

Customer Mobile Application

[0040] FIG. 3A is a diagram of the customer mobile application (CMA) 106, according to one embodiment. The CMA 106 includes an ordering interface 302, which provides an interactive interface with which the customer 104 can browse through and select products and place an order. The CMA 106 also includes a system communication interface 304 which, among other functions, receives inventory information from the online shopping concierge system 102 and transmits order information to the system 102. The CMA 106 also includes a preferences management interface 306 which allows the customer 104 to manage basic information associated with his/her account, such as his/her home address and payment instruments. The preferences management interface 306 may also allow the user to manage other details such as his/her favorite or preferred warehouses 110, preferred delivery times, special instructions for delivery, and so on.

Shopper Mobile Application

[0041] FIG. 3B is a diagram of the shopper mobile application (SMA) 112, according to one embodiment. The SMA 112 includes a barcode scanning module 320 which allows a shopper 108 to scan an item at a warehouse 110 (such as a can of soup on the shelf at a grocery store). The barcode scanning module 320 may also include an interface which allows the shopper 108 to manually enter information describing an item (such as its serial number, SKU, quantity and/or weight) if a barcode is not available to be scanned. SMA 112 also includes a basket manager 322 which maintains a running record of items collected by the shopper 108 for purchase at a warehouse 110. This running record of items is commonly known as a "basket". In one embodiment, the barcode scanning module 320 transmits information describing each item (such as its cost, quantity, weight, etc.) to the basket manager 322, which updates its basket accordingly. The SMA 112 also includes a system communication interface 324 which interacts with the online shopping concierge system 102. For example, the system communication interface 324 receives an order from the system 102 and transmits the contents of a basket of items to the system 102. The SMA 112 also includes an image encoder 326 which encodes the contents of a basket into an image. For

example, the image encoder 326 may encode a basket of goods (with an identification of each item) into a QR code which can then be scanned by an employee of the warehouse 110 at check-out.

Predicting Inventory Availability

[0042] As described with reference to FIG. 2, the machine-learned item availability model 216 of the online concierge system 102 can determine an availability of an item requested by the customer 104. FIG. 4 is a flowchart illustrating a process 400 for predicting inventory availability, according to one embodiment. The online concierge system 102 receives 402 a delivery order that includes a set of items and a delivery location. The delivery location may be any location associated with a customer, such as a customer's home or office. The delivery location may be stored with the customer location in the customer database 214. Based on the delivery order, the online concierge system 102 identifies a warehouse 404 for picking the set of items in the delivery order based on the set of items and the delivery location. In some cases, the customer specifies a particular warehouse or set of warehouses (e.g., a particular grocery store or chain of grocery stores) in the order. In other cases, the online concierge system 102 selects the warehouse based on the items and the delivery location. In some examples, there are a number of different possible warehouses that the set of items may be picked from. The warehouses may be identified by the order fulfillment engine 206 based on warehouses stored by the inventory management engine 202, and warehouses are identified with a suitable inventory and within a threshold distance of the delivery address. In some embodiments, a single delivery order can be split into multiple orders and picked at multiple warehouses, e.g., if the items cannot be fulfilled at a single warehouse. In this example, each possible warehouse is input into the machine-learned item availability model 216.

[0043] After the warehouses are identified, the online concierge system 102 retrieves 406 the machine-learned item availability model 216 that predicts a probability that an item is available at the warehouse. The items in the delivery order and the identified warehouses are input into the machine-learned item availability model 216. For example, the online concierge system 102 may input the item, warehouse, and timing characteristics for each item-warehouse pair into the machine-learned item availability model 216 to assess the availability of each item in the delivery order at each potential warehouse at a particular day and/or time. The machine-learned item availability model 216 predicts 408 the probability that one of the set of items in the delivery order is available at the warehouse. If a number of different warehouses are identified 404, then the machine-learned item availability model 216

predicts the item availability for each one. In some examples, the probability that an item is available includes a probability confidence score generated by the machine-learned item availability model 216.

[0044] The order fulfillment engine 206 uses the probability to generate 410 an instruction to a shopper. The order fulfillment engine 206 transmits the instruction to the shopper through the SMA 112 via the shopper management engine 210. The instruction is based on the predicted probability. In some examples, the shopper management engine 210 instructs the shopper to pick an item in the delivery order at a warehouse with the highest item availability score. For example, if a warehouse is more likely to have more items in the delivery order available than another warehouse, then the shopper management engine 210 instructs the shopper to pick the item at the warehouse with better availability. Other examples of the shopper management engine 210 instruction to the shopper are described in further detail with reference to FIGS. 5 and 6. In some other examples, the order fulfillment engine 206 sends a message and/or instruction to a customer based on the probability predicted by the machine-learned item availability model 216. This is described in further detail with reference to FIG. 7.

Updating the Training Datasets

[0045] FIG. 5 is a flowchart illustrating a process 500 for updating training datasets for a machine-learned model, according to one embodiment. The training datasets may be the training datasets 220 as shown in FIG. 2. While the training datasets 220 include large datasets of information collected from previous delivery orders (e.g., information identifying items and whether the items were available at a warehouse), certain items or warehouses might have less information associated with them in the training datasets 220 than other items or warehouses. For example, if an item is not frequently ordered, or has not been ordered for a long period of time, then it may be more difficult to build an accurate availability prediction in the machine-learned item availability model 216. One way to improve the ability of the machine-learned item availability model 216 to accurately predict item availability is to increase the information about the item in the training datasets 220, and add new information. With larger and/or more recent datasets on the item, the modeling engine 218 can build more statistically meaningful connections between the machine-learning factors described with reference to FIG. 2 and the predicted item availability.

[0046] Process 500 thus improves the machine-learned item availability model 216 by increasing the datasets for particular items in the training datasets 220 with low confidence scores. Process 500 may be carried out by the online concierge system 102, e.g., by the

inventory management engine 202 in conjunction with the shopper management engine 210, the item availability model 216, and the modeling engine 218. In some examples, process 500 is carried out by the online concierge system 102 following retrieving 406 a machine-learned model that predicts a probability that an item is available at a warehouse, as described in FIG. 4.

[0047] The online concierge system 102 (e.g., the inventory management engine 202 using the item availability model 216) identifies 502 an item-warehouse pair. For example, the item and warehouse in the item-warehouse pair may be an item in a received order and warehouse or potential warehouse for picking the items from the received order, e.g., to evaluate the suitability of the warehouse or likelihood of successfully picking the order before the order is picked.

[0048] As another example, the item-warehouse pair may be identified from items for which the availability predicted by the machine-learned item availability model 216 was incorrect (e.g., the item was predicted to be available and was determined by the shopper to be out of stock, or the item was predicted to be unavailable and the shopper was able to find it in the warehouse). For items for which the availability prediction was incorrect, the online concierge system 102 may determine if the items have sufficient associated information within the training datasets 220. If the online concierge system 102 determines that the incorrect probability was a result of insufficient or stale information in the training datasets 220, it may identify item-warehouse pairs and carry out process 500 to update the training datasets 220.

[0049] Additionally, or alternatively, item-warehouse pairs are identified from new items offered by the online concierge system 102. For new items, there may not be previous delivery order information relating the item availability to item characteristics, delivery order information, or time information in the training datasets 220. The lack of previous delivery orders may lead to a low confidence score for new items. The inventory management engine 202 may initiate the process 500 for new items until sufficient information about the items are collected in the training datasets 220 to improve the item availability confidence score associated with the items.

[0050] The online concierge system 102 (e.g., the inventory management engine 202 using the machine-learned item availability model 216) inputs the item, warehouse, and timing characteristics for the identified item-warehouse pair into the machine-learned item availability model 216 and determines 504 a confidence score associated with a probability that an item is available at the warehouse. The online concierge system 102 may determine

probabilities and/or confidence scores for all or selected items in an inventory, e.g., items that are expected to be picked based on already-received orders, sales, promotions, holidays, weather, historical trends, or other factors. The confidence score is generated along with the item availability probability (also referred to as "availability") by the machine-learned item availability model 216. The confidence score may be an error associated with the availability probability. The confidence score indicates items that may not have enough training data in the training datasets 220 to generate a statistically significant link between the item's availability and information from the delivery order and/or item characteristics. In some alternate embodiments, the online concierge system 102 may identify, using the item availability model 216, item-warehouse pairs with a low confidence score, e.g., all item-warehouse pairs with a confidence score below a particular threshold. This list of item-warehouse pairs may be filtered, e.g., based on item popularity, predicted items to be ordered, warehouse, or one or more other factors.

[0051] In response to the determined confidence level of an item-warehouse pair being below a threshold, the online concierge system 102 (e.g., the shopper management engine 210) instructs 506 the shopper to collect new information about items with a confidence score below a threshold. A confidence score threshold may be an item availability probability between 0 and 1. A threshold confidence score may be 0.3, such that in response to a confidence score below 0.3, the shopper is instructed to collect new information about an item. In some embodiments, the online concierge system 102 also considers the availability probability for the item-warehouse pair. For example, if an item-warehouse pair has a confidence level slightly below the threshold, but a very low or very high availability probability, the online concierge system 102 may determine not to collect new information about the item-warehouse pair. In some embodiments, the threshold used for the confidence score may depend on the availability probability, or vice versa.

[0052] In response to the instruction, the shopper 108 determines whether the item is available at the warehouse. The shopper may be instructed to try to find the item at the warehouse, and indicate, through the SMA 112, whether the item is available. This information is transmitted to the online concierge system 102 via the shopper management engine 210, and used to update 508 the training datasets 220. In some embodiments, a shopper may be given a list of items with low confidence scores to seek within the warehouse. The online concierge system 102 updates 508 the training dataset 220 with new information about the item, which includes whether or not the item is available in the warehouse, and any additional item characteristics, warehouse information, or time

information as described with respect to FIG. 2. The online concierge system 102 also updates the inventory database 204 based on the received information; e.g., if the inventory database 204 stores the time at which the item was most recently found or not found, this time will be updated based on the input from the shopper 108. In response to the new information collected by the shopper, the modeling engine 218 may update or retrain the machine learning item availability model 216 with the updated training datasets 220. Process 500 may be carried out by the online concierge system 102 until a confidence score associated with a probability that an item is available is above a threshold.

Use Case Examples

[0053] An example of process 500 used in conjunction with process 400 is described below. The online concierge system 102 receives 402 a delivery order from a customer 104 through the CMA 106. The customer 104 schedules a delivery at their home of three items to be delivered the following day. As an example, the customer 104 may order grated mozzarella, pizza dough, and tomato sauce, each of which is included in the delivery order. The online concierge system 102 sends the delivery order to the order fulfillment engine 206. The order fulfillment engine 206 uses the inventory management engine 202 and customer database 214 to identify 404 a warehouse for picking the requested items based on the items and the delivery location (i.e., the customer's home). A number of possible warehouses may be identified. For each possible warehouse, the order fulfillment engine 206 identifies 502 an item-warehouse pair with one of the items in the delivery order. Thus, a set of item-warehouse pairs is identified for each of the grated mozzarella, pizza dough and tomato sauce. The online concierge system 102 retrieves 406 the machine-learned item availability model 216 that predicts a probability that an item is available at the warehouse. The online concierge system 102 inputs the item, warehouse, and timing characteristics for each of the identified item-warehouse pairs into the machine-learned item availability model 216. The machine-learned item availability model 216 predicts 408 the probability that each of the grated mozzarella, pizza dough and tomato sauce are available at the identified warehouses. For each of the availability probabilities, the online concierge system 102 also determines 504 a confidence score associated with the probability from the machine-learned item availability model 216.

[0054] It is possible that the confidence score for pizza dough confidence score at one or more of the warehouses is below a threshold, given that people frequently make their own pizza dough and it may not be frequently ordered. Thus, pizza dough may have a relatively small and/or old associated dataset in the training dataset 220, leading to a low confidence

score on the pizza dough availability probability within the machine-learned item availability model 216. The online concierge system 102, using the shopper management engine 210, instructs 506 a shopper to collect new information about pizza dough at one or more of the warehouses. The shopper management engine 210 may identify an off-duty shopper, or a shopper already at one of the warehouses identified 502 in an item-warehouse pair to collect information about whether or not pizza dough is available at the warehouse. The shopper management engine 210 transmits this instruction through the SMA 112. The shopper 108 may find that pizza dough is in fact available, and transmit the availability to the online concierge system 102 through the SMA 112. This new information is used to update 508 the training dataset 220 and the inventory database 204. The shopper management engine 210 may transmit the same instruction to multiple shoppers 108 at different warehouses, or at different times, such that there is a larger set of data about pizza dough availability added to the training dataset 220, and more recent data in the inventory database 204.

[0055] In this example, the modeling engine 218 uses the updated training datasets 220 to retrain the machine-learned item availability model 216. The online concierge system 102 then re-inputs the pizza dough-warehouse pairs into the updated machine-learned item availability model 216 and determines 504 a confidence score associated with the probability that pizza dough is available at a number of possible warehouses. It is possible that the confidence scores are now above a threshold, because the increased data about pizza dough added to the training datasets 220 has improved the machine-learned item availability model 216, and/or the newer data in the inventory database 204 has improved the confidence score. The online concierge system 102 then generates 410 an instruction to a shopper 108 based on the availability probabilities for pizza dough. The instruction may be to pick the pizza dough at the warehouse with the highest availability probability. In other examples, the instruction may be to pick the pizza dough, grated mozzarella and tomato sauce at a warehouse with the highest availability probability for all of these items in the customer's delivery order. The online concierge system 102 transmits the instruction to a mobile device of the shopper 108.

[0056] Additionally, or alternatively, the online concierge system 102 may use the machine-learned item availability model 216 to predict an anticipated demand for an item at a warehouse. The online concierge system 102 may compare the number of times an item is included in a set of delivery orders to the item availability predictions generated by the machine-learned item availability model 216, and identify items that are frequently ordered but have low corresponding availability probabilities. For example, around the holidays, there may be an increase in delivery orders including Brussels sprouts, whereas Brussels

sprouts may have a low availability prediction since they are not typically stocked in large quantities. The online concierge system may identify the discrepancy between a large volume of item orders and the low availability probability and convey this information to a warehouse 110. Additionally, or alternatively, the online concierge system 102 may transmit information about items that have availability predictions below a threshold.

Instructions to Shopper

[0057] FIG. 6 is a flowchart illustrating a process 600 for determining instructions to a shopper if a probability indicates that an item is available at a warehouse, according to one embodiment. Process 600 may be used to assist a shopper looking for an item in a delivery order at a warehouse, and may therefore reduce the time a shopper spends looking for items that are not actually available at a warehouse. Process 600 may be carried out by the online concierge system 102.

[0058] The online concierge system 102 (e.g., the shopper management engine 210) receives an indication 602 from a shopper that he or she cannot find an item at the warehouse. The shopper may transmit this information to the online concierge system 102 through the SMA 112, which communicates it to the shopper management engine 210. The shopper may input the item information into the SMA 112. In some examples, the shopper may also provide additional information about where they have already looked for the item within the warehouse, such as aisles in which the item was not found, departments in which the item was not found, the amount of time he or she spent looking for the item, etc. In response, the online concierge system 102 inputs the item, warehouse, and timing characteristics for the item received from the shopper and the warehouse in which the shopper is unable to find the item into the machine-learned item availability model 216. In some embodiments, the online concierge system 102 may incorporate the information provided by the shopper through the SMA 112 into the training datasets 220, which may be later used by the modeling engine 218 to update the machine-learned item availability model 216. The online concierge system 102 determines 604 a probability that the item is available at the warehouse from the probability output by the machine-learned item availability model 216. The online concierge system 102 then compares the output probability against a threshold and determines 606 if the item availability probability is above the threshold. In some examples, this threshold value may be an item availability probability of 0.3, or 30%. Additionally, or alternatively, the online concierge system 102 may compare a confidence score associated with the item availability probability to a threshold value.

[0059] If an availability probability is above the threshold, this indicates that the item is

predicted to be available at the warehouse. The shopper management engine 210 then instructs 608 a shopper to continue looking for the item. The instruction may be transmitted to the shopper through the SMA 112. In some examples, the instruction may be accompanied by information as to a location within the warehouse that the item is most likely to be available, such as an aisle of the warehouse and/or a department.

[0060] If the probability that the item is available is below a threshold value, then the shopper management engine 210 instructs 610 the shopper to stop looking for the item. The shopper management engine 210 may transmit the instruction through the SMA 112. The shopper management engine 210 may add the item-warehouse pair and any associated time or item information to the training dataset 220 indicating that the item was not found at the warehouse. The shopper management engine 210 may then instruct the shopper to look for the next item in a delivery order, or for a replacement item that has a high availability probability.

[0061] In some examples, the online concierge system 102 may determine 604 a probability that an item is available at a warehouse and compare 606 the availability probability to a threshold before receiving an indication 602 from a shopper that he or she cannot find an item. For example, the inventory management engine 202 may determine item availability probabilities for all items within a delivery order transmitted to a shopper. If the probability indicates that an item should be available, the online concierge system 102 may provide this information to the shopper through the SMA 112. If the probability indicates that an item might be unavailable, the online concierge system 102 may transmit a warning or other indication to the shopper that the item might be unavailable. In some examples, if the item probability indicates that an item is unavailable, the SMA 112 may instruct the shopper to limit the amount of time the shopper looks for the item in the warehouse, and/or to pick a replacement item. In some examples, the item availability probabilities provided to the shopper may include location information, such as where in a warehouse the item is most likely to be located, such as an aisle or department.

[0062] In some embodiments, when transmitting a delivery order to a shopper, the online concierge system 102 visually distinguishes items in the delivery order having less than a threshold availability probability from items having greater than the delivery order. For example, the online concierge system 102 transmits a delivery order to a client device (e.g., a mobile device) of a shopper along with instructions to display a set of items in the delivery order having less than the threshold availability probability identified in the instructions in a banner displayed above a list of items in the delivery order. In some

embodiments, the online concierge system 102 ranks items having availability probabilities less than the threshold availability probability so items with lower availability probabilities have higher positions in the ranking. The online concierge system 102 transmits instructions to the client device of the shopper that display the items with less than the threshold availability probability in the banner in an order based on the ranking; hence, items with lower availability probabilities are initially displayed in the banner. In some embodiments, a single item is displayed in the banner, and when the shopper selects the banner, a shopper mobile application 112 executing on the client device navigates to a position of the item displayed in the banner in a list. In some embodiments, the item with less than the threshold availability probability is visually distinguished from other items in the list (e.g., displayed in a different color, displayed with a highlight, displayed with a prominent border from other items, etc.). The shopper mobile application 112 also updates the banner to display a different item having less than the threshold availability probability, allowing the banner to display a single item having less than the threshold availability probability at once and to display different items having less than the threshold availability probability in response to the shopper selecting the banner.

Feedback to Customer

[0063] FIG. 7 is a flowchart illustrating a process 700 for determining feedback to a customer based on a probability that an item is available at a warehouse, according to one embodiment. Process 700 may be carried out by the online concierge system 102 (e.g., the order fulfillment engine 206) communicating with a customer via the CMA 106. The order fulfillment engine 206 provides a customer interface 702. The customer interface includes an ordering interface through which a customer may make item selections, and add items to a delivery order. The customer interface may be an interface of the CMA 106, such as the ordering interface 302 as described in FIG. 3A. The customer interface receives 704 an item to be included in a delivery order. This item may be any item selected for purchase by the customer through the customer interface. The customer may also provide a delivery time associated with the order, which the online concierge system 102 can use to determine or approximate a picking time for the order. In response to the customer inputs, the online concierge system 102 (e.g., the order fulfillment engine 206) determines 706 a probability that the item received at 704 is available at a warehouse, e.g., a warehouse selected by the customer, or a warehouse selected by the online concierge system 102 for fulfilling an order from the customer. The probability is determined by inputting the item, warehouse, and timing characteristics for the item received and the warehouse into a machine-learned item

availability model 216. The machine-learned item availability model 216 then outputs a probability that the item is available at the warehouse.

[0064] The order fulfillment engine 206 then determines 708 if the probability an item is available at the warehouse is below a threshold. In some examples, this threshold is a probability between 0.1 and 0.3. In some examples, the probability may also include a confidence score as provided by the machine-learned item availability model 216, and order fulfillment engine 206 may also determine if the confidence score associated with the probability 706 is above a threshold. If the probability that an item is available is not below a threshold, then the order fulfillment engine 206 allows 710 a customer to add the item to the delivery order. This delivery order may then be transmitted to a shopper through the SMA 112 to be picked at a warehouse.

[0065] If the probability that an item is available is below a threshold, then the order fulfillment engine 206 notifies the customer 712 through an ordering interface of the customer interface provided. The notification may be a warning or other message transmitted to the customer through the ordering interface. For example, the notification may be a message saying "item frequently not found" provided through the ordering interface. The ordering interface provides alternative options 714 to the item to the user. The alternative options may be items determined by the machine-learned item availability model 216 to be available. The alternative options 714 may be items of the same item type selected by the user that have high availability probabilities. For example, if process 700 receives an order for a specific brand of eggs 704, and the probability that the eggs are available at the warehouse is below a threshold 708, then the alternative options 714 may be other brands of the same kind of egg previously selected by the user (e.g., organic, brown, extra large, etc.) with high availability probabilities as determined by the machine-learned item availability model 216. The alternative options 714 may be ranked according to their availability probabilities. To encourage customers to select from the alternative options, a message may be included with the alternative options indicated that the item is likely available or was recently found at the warehouse.

[0066] In some examples, while the customer is notified 712 and provided with alternative options 714, the ordering interface may still allow the customer to add the item to the delivery order. The customer may instruct the shopper to substitute the item received with the alternative options provided if the shopper cannot find the item. In other examples, the ordering interface does not allow the customer to add the item received 704, and the customer chooses one of the alternative options 714 (or no item) to be added to the delivery

order.

[0067] In some examples, if the online concierge system 102 frequently receives customer requests to add an item to a delivery order that is then determined to have an availability probability below a threshold, the online concierge system 102 may temporarily remove the item from the item options provided to a customer through the customer interface.

Displaying Information for Finding One or More Items in a Warehouse from a Shopper

[0068] FIG. 8 is a flowchart of one embodiment of a process 800 for obtaining information for finding certain items within a warehouse for display to one or more shoppers. The process 800 may be carried out by the online concierge system 102 (e.g., the order fulfillment engine 206) communicating with a customer via the SMA 108. In various embodiments, the process 800 performs the steps described in conjunction with FIG. 8 in a different order than the order shown in FIG. 8. Further, in some embodiments, the process 800 includes different or additional steps than those described in conjunction with FIG. 8.

[0069] While the online concierge system 102 predicts availability of an item at a warehouse, as further described above in conjunction with FIGS. 4-7, an item may be available at the warehouse (i.e., have at least a threshold availability determined by the online concierge system 102) but be difficult to locate within the warehouse by a shopper. For example, an item may be obscured from view within a warehouse by a physical obstruction or by other items within the warehouse. As another example, an item may be located in a section of the warehouse with unrelated objects or may be located in an area of the warehouse that is distant from other similar items. This may prevent various shoppers from finding and retrieving an item in the warehouse, even though the item is available at the warehouse.

[0070] To allow shoppers to better identify certain items within a warehouse that are difficult to locate within the warehouse, the online concierge system 102 identifies 805 a difficult to find item (also referred to as a "specific item") within a warehouse from stored order information. In some embodiments, the online concierge system 102 identifies 805 a difficult to find item as an item having at least a threshold availability at the warehouse and that a shopper was unable to retrieve from the warehouse within a specific time interval. In some embodiments, the online concierge system 102 identifies 805 a difficult to find item when the online concierge system 102 receives an order from a user to be fulfilled at the warehouse. For example, the online concierge system 102 identifies 805 a difficult to find item within the warehouse as an item in the received order having at least a threshold availability at the warehouse and that a shopper different than the shopper fulfilling the received order was unable to find in the warehouse within a specific time interval (e.g., 24

hours) of a time when the online concierge system 102 received the order. As another example, the online concierge system 102 retrieves information describing previously completed orders from the warehouse and identifies 805 a difficult to find item as an item with at least a threshold availability at the warehouse that was not found by at least a threshold number of shoppers at the warehouse within a specific time interval (e.g., 24 hours) of a time when the online concierge system 102 retrieved the information describing the previously completed orders. In the preceding examples, the online concierge system 102 determines the availability of the difficult to find item at the warehouse by inputting the difficult to find item, the warehouse, and timing characteristics from the order into a machine-learned item availability model, as further described above in conjunction with FIGS. 2–7. The machine-learned item availability model predicts the probability that the difficult to find item is available at the warehouse, as further described above in conjunction with FIGS. 2–6. The online concierge system 102 stores information identifying the difficult to find item in association with information identifying the warehouse; this allows the online concierge system 102 to maintain a record of one or more difficult to find items corresponding to the warehouse. As different warehouses may have different difficult to find items, maintaining an association between a difficult to find item and a warehouse allows the online concierge system 102 to identify difficult to find items in different warehouses.

[0071] As shoppers fulfill orders, the online concierge system 102 receives 810 information from shopper mobile applications 112 corresponding to items the shoppers obtain from different warehouses to fulfill orders. The information the online concierge system 102 receives 810 from a shopper mobile application 112 identifies the shopper, identifies a warehouse, and identifies one or more items the shopper obtained from the warehouse. For example, the online concierge system 102 receives a shopper identifier, a warehouse identifier, and one or more item identifiers from the shopper mobile application 112 that the shopper obtained from the warehouse corresponding to a shopper.

[0072] The online concierge system 102 compares information identifying items a shopper obtained from the warehouse to one or more identifiers of difficult to find items associated with the warehouse. In response to determining 815 a shopper obtained a difficult to find item associated with the warehouse from the warehouse, the online concierge system 102 prompts 820 the shopper who obtained the difficult to find item from the warehouse to provide information for finding the difficult to find item within the warehouse. In some embodiments, the online concierge system 102 also compares an identifier of a shopper who obtained the difficult to find item from the warehouse to identifiers of shoppers who were

previously unable to obtain the difficult to find item from the warehouse, and prompts 820 the shopper who obtained the difficult to find item from the warehouse to provide information for finding the difficult to find item within the warehouse in response to the identifier of the shopper who obtained the difficult to find item from the warehouse differing from an identifier of a shopper who was previously unable to obtain the difficult to find item from the warehouse. This comparison of a shopper who was previously unable to obtain the difficult to find item from the warehouse to a shopper who obtained the difficult to find item from the warehouse allows the online concierge system 102 to prompt 820 different shoppers than shoppers who were unable to obtain the difficult to find item from the warehouse for information for finding the difficult to find item within the warehouse.

[0073] The online concierge system 102 may maintain one or more criteria to be satisfied for a shopper who obtained the difficult to find item from the warehouse to be prompted 820 for information for finding the difficult to find item within the warehouse. In some embodiments, the criteria specify that a shopper have fully completed an order via the online concierge system 102 within a specified time interval of finding the difficult to find item within the warehouse (e.g., within 30 days of finding the difficult to find item within the warehouse), specify that a shopper have completed a minimum number of orders (e.g., 20 orders, 15 orders) via the online concierge system 102, and that the shopper have at least a threshold amount of orders completed via the online concierge system 102 receive at least a threshold ranking form consumers for whom the orders were completed. In various embodiments, the online concierge system 102 prompts 820 shoppers who found the difficult to find item within the warehouse who satisfy at least a threshold amount of (or all of) the criteria for information for finding the difficult to find item within the warehouse, but does not prompt 820 shoppers who found the difficult to find item within the warehouse but who do not satisfy at least the threshold amount of the criteria for information for finding the difficult to find item within the warehouse. Enforcing the one or more criteria allows the online concierge system 102 to obtain information for finding the difficult to find item within the warehouse from shoppers who are likely to provide reliable or accurate information.

[0074] In various embodiments, the online concierge system 102 transmits a prompt to the shopper mobile application 112 corresponding to the shopper who obtained the difficult to find item from the warehouse, and the shopper mobile application 112 displays the prompt to the shopper who obtained the difficult to find item from the warehouse. The prompt may include a message congratulating the shopper for locating the difficult to find item within the warehouse and one or more fields for providing information for finding the difficult to find

item within the warehouse. In various embodiments, the information for finding the difficult to find item is a picture of a location of the difficult to find item within the warehouse, a text description of a location of the difficult to find item within the warehouse, directions for locating the difficult to find item within the warehouse, or any combination thereof.

[0075] FIG. 9 shows an example interface 900 displayed by the shopper mobile application 112 displaying a prompt to a shopper to provide information for finding the difficult to find item within the warehouse. In the example shown by FIG. 9, the interface 900 displays an image 905 of the difficult to find item. The interface 900 may also display a name of the difficult to find product or a description of the difficult to find item along with the image 905 of the difficult to find item in some embodiments. Additionally, the interface 900 displays a prompt 910 requesting the shopper provide information for finding the difficult to find item within the warehouse. The interface 900 also includes an interface element 915 that, when selected, allows the shopper to capture a photograph of a location within the warehouse where the difficult to find item was located via a client device (e.g., a mobile device) executing the shopper mobile application 112. In the example shown by FIG. 9, the interface 900 also includes fields 920A, 920B for receiving text input from the shopper. For example, the shopper enters text data describing the location in the interface where the difficult to find item was located in field 920A and enters an aisle number or other location within the warehouse in field 920B. Hence, interface 900 allows the shopper who found the difficult to find item within the warehouse to provide information to the online concierge system 102 allowing other shoppers to more readily locate the difficult to find item within the warehouse.

[0076] Referring back to FIG. 8, the online concierge system 102 stores 825 the information for finding the difficult to find item within the warehouse in association with an identifier of the warehouse and in association with an identifier of the difficult to find item. In some embodiments, the online concierge system also stores an identifier of the shopper who obtained the difficult to find item in association with the information for finding the difficult to find item within the warehouse. Hence, the online concierge system 102 maintains information for finding one or more difficult to find items within the warehouse, allowing the online concierge system 102 to subsequently retrieve information for finding a difficult to find item within the warehouse.

[0077] Subsequently, when the online concierge system 102 receives 830 an order to be fulfilled at the warehouse and that includes the difficult to find item within the warehouse, the online concierge system 102 retrieves 835 the information for finding the difficult to find

item within the warehouse stored in association with the identifier of the warehouse and with the identifier of the difficult to find item. The online concierge system 102 displays 840 the information for finding the difficult to find item within the warehouse to a shopper fulfilling the order at the warehouse via a shopper mobile application 112 corresponding to the shopper fulfilling the order. For example, the online concierge system 102 displays an indication that information for finding the difficult to find item is available proximate to information identifying the difficult to find item in an interface of the shopper mobile application 112. FIG. 10 shows an example interface 1000 displaying an order being fulfilled by a shopper. The interface 1000 displays different items 1005, 1015, 1020 included in the order, with an image and a name or a description of each item 1005, 1015, 1020 included in the order displayed in the interface 1000. In the example of FIG. 10, the difficult to find item described above in conjunction with FIG. 9 is included in the order, so image 905 of the difficult to find item is displayed in the interface 1000. To allow the shopper fulfilling the order to more quickly locate the difficult to find item, the interface 1000 displays an indication 1010 that the online concierge system 102 maintains information for locating the difficult to find item in the warehouse proximate to the image 905 of the difficult to find item, or proximate to other information identifying the difficult to find item.

[0078] Referring back to FIG. 8, in response to receiving a selection of the indication from the shopper mobile application, the online concierge system 120 displays 840 the information for finding the difficult to find item within the warehouse, allowing the shopper fulfilling the order to leverage the stored information to more efficiently locate and retrieve the difficult to find item from the warehouse. FIG. 11 shows an example interface 1100 displayed by the shopper mobile application 112 including information for finding a difficult to find item in a warehouse. In the example shown by FIG. 11, the interface 1100 is displayed to a shopper after the shopper selects the indication 1010 described above in conjunction with FIG. 10. The interface 1100 includes the image 905 of the difficult to find item, and may include a name of the difficult to find item or a description of the difficult to find item in some embodiments. In the example of FIG. 11, the interface 1100 displays an image 1105 of a location of the item in the warehouse in which the item is difficult to find and displays a text description 1110 of the location of the item in the warehouse in which the item is difficult to find. However, in other embodiments, the interface 1100 includes one of the image 1105 of the location of the item in the warehouse or the text description 1110 of the item in the warehouse; thus, the interface 1100 displays information received from a shopper who found the difficult to find item in the warehouse in based on how the shopper who found

the difficult to find item provided the information to the online concierge system 102. In some embodiments, the interface 1100 also displays a name of or other information identifying (e.g., a picture, a username, etc.) of a shopper from whom the information for finding the difficult to find item in the warehouse was received, allowing the shopper viewing the interface 1100 to determine what shopper provided the information for finding the difficult to find item in the warehouse.

[0079] In the example shown by FIG. 11, the interface 1100 also displays a positive feedback element 1115 and a negative feedback element 1120, allowing a shopper viewing the interface 1100 to provide the online concierge system 102 with feedback regarding usefulness of the information for finding the difficult to find item in the warehouse. The shopper viewing the interface 1110 selects the positive feedback element 1115 to send an indication to the online concierge system 102 that the information for finding the difficult to find item in the warehouse was helpful in finding the difficult to find item. The shopper viewing the interface 1110 selects the negative feedback element 1120 to send a negative indication to the online concierge system 102 that information for finding the difficult to find item in the warehouse was not helpful in finding the difficult to find item. In some embodiments, in response to receiving a threshold number of negative indications (or in response to receiving negative indications from at least a threshold number of distinct users), the online concierge system 102 stops displaying the information for finding the difficult to find item in the warehouse to users. Additionally, if a shopper sends a negative indication to the online concierge system 102 for information for finding the difficult to find item in the warehouse, the online concierge system 102 stores the negative indication in association with an identifier of the shopper and an identifier of the information for finding the difficult to find item in the warehouse (or in association with the identifier of the shopper and the information for finding the difficult to find item in the warehouse), so the online concierge system 102 does not subsequently display the information for finding the difficult to find item in the warehouse to shopper from whom the negative indication was received. In some embodiments, in response to receiving a negative indication from the shopper to whom the information for finding the difficult to find item in the warehouse was displayed, the online concierge system 102 transmits another interface or another prompt to the client device of the shopper from whom the negative indication was received that allows the user from whom the negative indication was received to modify (e.g., edit) the information for finding the difficult to find item in the warehouse. The online concierge system 102 may remove the information for finding the difficult to find item in the warehouse in response to receiving at least a

threshold number of negative indications for the information for finding the difficult to find item in the warehouse or in response to receiving negative indications for the information for finding the difficult to find item from at least a threshold number of different shoppers.

Additional Considerations

[0080] The foregoing description of the embodiments of the invention has been presented for the purpose of illustration; it is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Persons skilled in the relevant art can appreciate that many modifications and variations are possible in light of the above disclosure.

[0081] Some portions of this description describe the embodiments of the invention in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and representations are commonly used by those skilled in the data processing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logically, are understood to be implemented by computer programs or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations as modules, without loss of generality. The described operations and their associated modules may be embodied in software, firmware, hardware, or any combinations thereof.

[0082] Any of the steps, operations, or processes described herein may be performed or implemented with one or more hardware or software modules, alone or in combination with other devices. In one embodiment, a software module is implemented with a computer program product comprising a computer-readable medium containing computer program code, which can be executed by a computer processor for performing any or all of the steps, operations, or processes described.

[0083] Embodiments of the invention may also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, and/or it may comprise a general-purpose computing device selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a tangible computer readable storage medium, which include any type of tangible media suitable for storing electronic instructions, and coupled to a computer system bus. Furthermore, any computing systems referred to in the specification may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

[0084] Embodiments of the invention may also relate to a computer data signal embodied in a carrier wave, where the computer data signal includes any embodiment of a computer program product or other data combination described herein. The computer data signal is a product that is presented in a tangible medium or carrier wave and modulated or otherwise encoded in the carrier wave, which is tangible, and transmitted according to any suitable transmission method.

[0085] Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based hereon. Accordingly, the disclosure of the embodiments of the invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

What is claimed is:

1. A computer implemented method comprising:

receiving, at an online concierge system, an order comprising a plurality of items and a delivery location, wherein the received order is completed at an ordering interface of the online concierge system, and the ordering interface displays items that have discrepancies in availabilities compared to actual availabilities of the items at a warehouse;

identifying, by the online concierge system, the warehouse for picking the plurality of items based on the items in the received order and the delivery location;

identifying a difficult-to-find item in the items in the received order, wherein the difficult-to-find item is associated with an averaged time interval for other shoppers to find the difficult-to-find item at the warehouse in previous orders, the averaged time interval for the difficult-to-find item is higher than a threshold;

using a machine-learned availability model to predict an availability score of the difficult-to-find item, the availability score corresponding to a probability that the difficult-to-find item is available at the warehouse, wherein the machine-learned availability model is iteratively trained using past item-warehouse pairs that are associated with timing and availability labels;

determining that the difficult-to-find item is likely available at the warehouse based on the availability score generated by the machine-learned availability model;

receiving, at the online concierge system, information from a client device of a shopper fulfilling the received order at the warehouse, the information identifying items in the received order that the shopper has obtained from the warehouse;

Date Reçue/Date Received 2022-11-25

transmitting, by the online concierge system, a notification to the shopper that the difficult-to-find item is likely available at the warehouse;

receiving, by the online concierge system from the shopper, an indication that the shopper has obtained the difficult-to-find item from the warehouse;

determining, by the online concierge system, that the shopper satisfies a threshold amount of criteria maintained by the online concierge system, wherein at least one of the criteria specifies that the shopper has completed an additional order within a specified time interval of obtaining the difficult-to-find item from the warehouse;

prompting the shopper to provide information for finding the difficult-to-find item in the warehouse through an interface displayed to the shopper via a shopper mobile application executing on the client device in response to determining (a) that the shopper obtained the difficult-to-find item from the warehouse and (b) that the shopper satisfies the threshold amount of the criteria; and

storing the information for finding the difficult-to-find item in the warehouse received from the shopper at the online concierge system in association with the difficult-to-find item and in association with the warehouse.

2. The method of claim 1, wherein the criteria maintained by the online concierge system are selected from a group consisting of: the shopper having completed a minimum number of orders, the shopper having at least a threshold amount of completed orders that received at least a threshold ranking from consumers for whom the orders were completed, and any combination thereof.

Date Reçue/Date Received 2022-11-25

3. The method of claim 1, wherein the availability score of the difficult-to-find item at the warehouse is determined by applying machine-learned availability model to a combination of the difficult-to-find item and the warehouse.

4. The method of claim 1, wherein the information for finding the difficult-to-find item in the warehouse comprises at least one selected from a group consisting of: a picture of a location in the warehouse of the difficult-to-find item, a text description of a location in the warehouse of the difficult-to-find item, and any combination thereof.

5. The method of claim 1, further comprising:

receiving an additional order including the difficult-to-find item and to be fulfilled at the warehouse by a different shopper after storing the information for finding the difficult-to-find item in the warehouse;

retrieving the information for finding the difficult-to-find item in the warehouse received from the shopper in association with the difficult-to-find item and in association with the warehouse; and

transmitting an interface to a client device of the different shopper, the interface displaying the information for finding the difficult-to-find item in the warehouse received from the shopper.

6. The method of claim 5, wherein transmitting the interface to the client device of the different shopper, the interface displaying the information for finding the difficult-to-find item in the warehouse received from the shopper comprises:

displaying an additional interface to the different shopper that displays each item included in the additional order, the additional interface displaying an indication proximate to information identifying the difficult-to-find item in the additional interface; and

Date Reçue/Date Received 2022-11-25

transmitting the interface to the client device of the different shopper in response to receiving a selection of the indication from the different shopper.

7. The method of claim 5, wherein the interface displays information identifying the shopper from whom the information for finding the difficult-to-find item in the warehouse was received.

8. The method of claim 5, further comprising:

receiving a negative indication for the information for finding the difficult-to-find item in the warehouse from the different shopper via the interface;

storing the negative indication in association with the different shopper and in association with the information for finding the difficult-to-find item in the warehouse; and

preventing subsequent presentation of the information for finding the difficult-to-find item in the warehouse to the different shopper.

9. The method of claim 1, further comprising:

receiving a threshold number of negative indications for the information for finding the difficult-to-find item in the warehouse from different shoppers to whom the information for finding the difficult-to-find item was displayed; and

removing the information for finding the difficult-to-find item in the warehouse in response to receiving the threshold number of negative indications.

10. A computer program product comprising a non-transitory computer-readable storage medium having instructions encoded thereon that, when executed by a processor, cause the processor to:

receive, at an online concierge system, an order comprising a plurality of items and a delivery location, wherein the received order is completed at an ordering

Date Reçue/Date Received 2022-11-25

interface of the online concierge system, and the ordering interface displays items that have discrepancies in availabilities compared to actual availabilities of the items at a warehouse;

identify, by the online concierge system, the warehouse for picking the plurality of items based on the items in the received order and the delivery location;

identify a difficult-to-find item in the items in the received order, wherein the difficult-to-find item is associated with an averaged time interval for other shoppers to find the difficult-to-find item at the warehouse in previous orders, the averaged time interval for the difficult-to-find item is higher than a threshold;

use a machine-learned availability model to predict an availability score of the difficult-to-find item, the availability score corresponding to a probability that the difficult-to-find item is available at the warehouse, wherein the machine-learned availability model is iteratively trained using past item-warehouse pairs that are associated with timing and availability labels;

determine that the difficult-to-find item is likely available at the warehouse based on the availability score generated by the machine-learned availability model;

receive, at the online concierge system, information from a client device of a shopper fulfilling the received order at the warehouse, the information identifying items in the received order that the shopper has obtained from the warehouse;

transmit, by the online concierge system, a notification to the shopper that the difficult-to-find item is likely available at the warehouse;

receiving, by the online concierge system from the shopper, an indication that the shopper has obtained the difficult-to-find item from the warehouse;

Date Reçue/Date Received 2022-11-25

determine, by the online concierge system, that the shopper satisfies a threshold amount of criteria maintained by the online concierge system, wherein at least one of the criteria specifies that the shopper has completed an additional order within a specified time interval of obtaining the difficult-to-find item from the warehouse;

prompt the shopper to provide information for finding the difficult-to-find item in the warehouse through an interface displayed to the shopper via a shopper mobile application executing on the client device in response to determining (a) that the shopper obtained the difficult-to-find item from the warehouse and (b) that the shopper satisfies the threshold amount of the criteria; and

store the information for finding the difficult-to-find item in the warehouse received from the shopper at the online concierge system in association with the difficult-to-find item and in association with the warehouse.

11. The computer program product of claim 10, wherein the criteria maintained by the online concierge system are selected from a group consisting of: the shopper having completed a minimum number of orders, the shopper having at least a threshold amount of completed orders that received at least a threshold ranking from consumers for whom the orders were completed, and any combination thereof.

12. The computer program product of claim 10, wherein the availability score of the difficult-to-find item at the warehouse is determined by applying machine-learned availability model to a combination of the difficult-to-find item and the warehouse.

13. The computer program product of claim 10, wherein the information for finding the difficult-to-find item in the warehouse comprises at least one selected from a group consisting of: a picture of a location in the warehouse of the difficult-to-find item, a

Date Reçue/Date Received 2022-11-25

text description of a location in the warehouse of the difficult-to-find item, and any combination thereof.

14. The computer program product of claim 10, wherein the non-transitory computer readable storage medium further has instructions encoded thereon that, when executed by the processor, cause the processor to:

receive an additional order including the difficult-to-find item and to be fulfilled at the warehouse by a different shopper after storing the information for finding the difficult-to-find item in the warehouse;

retrieve the information for finding the difficult-to-find item in the warehouse received from the shopper in association with the difficult-to-find item and in association with the warehouse; and

transmit an interface to a client device of the different shopper, the interface displaying the information for finding the difficult-to-find item in the warehouse received from the shopper.

15. The computer program product of claim 14, wherein transmit the interface to the client device of the different shopper, the interface displaying the information for finding the difficult-to-find item in the warehouse received from the shopper comprises:

display an additional interface to the different shopper that displays each item included in the additional order, the additional interface displaying an indication proximate to information identifying the difficult-to-find item in the additional interface; and

transmit the interface to the client device of the different shopper in response to receiving a selection of the indication from the different shopper.

Date Reçue/Date Received 2022-11-25

16. The computer program product of claim 14, wherein the interface displays information identifying the shopper from whom the information for finding the difficult-to-find item in the warehouse was received.

17. The computer program product of claim 14, wherein the non-transitory computer readable storage medium further has instructions encoded thereon that, when executed by the processor, cause the processor to:

receive a negative indication for the information for finding the difficult-to-find item in the warehouse from the different shopper via the interface;

store the negative indication in association with the different shopper and in association with the information for finding the difficult-to-find item in the warehouse; and

prevent subsequent presentation of the information for finding the difficult-to-find item in the warehouse to the different shopper.

18. The computer program product of claim 10, wherein the non-transitory computer readable storage medium further has instructions encoded thereon that, when executed by the processor, cause the processor to:

receive a threshold number of negative indications for the information for finding the difficult-to-find item in the warehouse from different shoppers to whom the information for finding the difficult-to-find item was displayed; and

remove the information for finding the difficult-to-find item in the warehouse in response to receiving the threshold number of negative indications.

19. A system comprising:

a processor;

Date Reçue/Date Received 2022-11-25

memory configured to store instructions, the instructions, when executed by the processor, cause the processor to:

receive, at an online concierge system, an order comprising a plurality of items and a delivery location, wherein the received order is completed at an ordering interface of the online concierge system, and the ordering interface displays items that have discrepancies in availabilities compared to actual availabilities of the items at a warehouse;

identify, by the online concierge system, the warehouse for picking the plurality of items based on the items in the received order and the delivery location;

identify a difficult-to-find item in the items in the received order, wherein the difficult-to-find item is associated with an averaged time interval for other shoppers to find the difficult-to-find item at the warehouse in previous orders, the averaged time interval for the difficult-to-find item is higher than a threshold;

use a machine-learned availability model to predict an availability score of the difficult-to-find item, the availability score corresponding to a probability that the difficult-to-find item is available at the warehouse, wherein the machine-learned availability model is iteratively trained using past item-warehouse pairs that are associated with timing and availability labels;

determine that the difficult-to-find item is likely available at the warehouse based on the availability score generated by the machine-learned availability model;

Date Reçue/Date Received 2022-11-25

receive, at the online concierge system, information from a client device of a shopper fulfilling the received order at the warehouse, the information identifying items in the received order that the shopper has obtained from the warehouse;

transmit, by the online concierge system, a notification to the shopper that the difficult-to-find item is likely available at the warehouse;

receiving, by the online concierge system from the shopper, an indication that the shopper has obtained the difficult-to-find item from the warehouse;

determine, by the online concierge system, that the shopper satisfies a threshold amount of criteria maintained by the online concierge system, wherein at least one of the criteria specifies that the shopper has completed an additional order within a specified time interval of obtaining the difficult-to-find item from the warehouse;

prompt the shopper to provide information for finding the difficult-to-find item in the warehouse through an interface displayed to the shopper via a shopper mobile application executing on the client device in response to determining (a) that the shopper obtained the difficult-to-find item from the warehouse and (b) that the shopper satisfies the threshold amount of the criteria; and

store the information for finding the difficult-to-find item in the warehouse received from the shopper at the online concierge system in association with the difficult-to-find item and in association with the warehouse.

20. The system of claim 19, wherein the criteria maintained by the online concierge system are selected from a group consisting of: the shopper having completed a

Date Reçue/Date Received 2022-11-25

minimum number of orders, the shopper having at least a threshold amount of completed orders that received at least a threshold ranking from consumers for whom the orders were completed, and any combination thereof.

Date Reçue/Date Received 2022-11-25

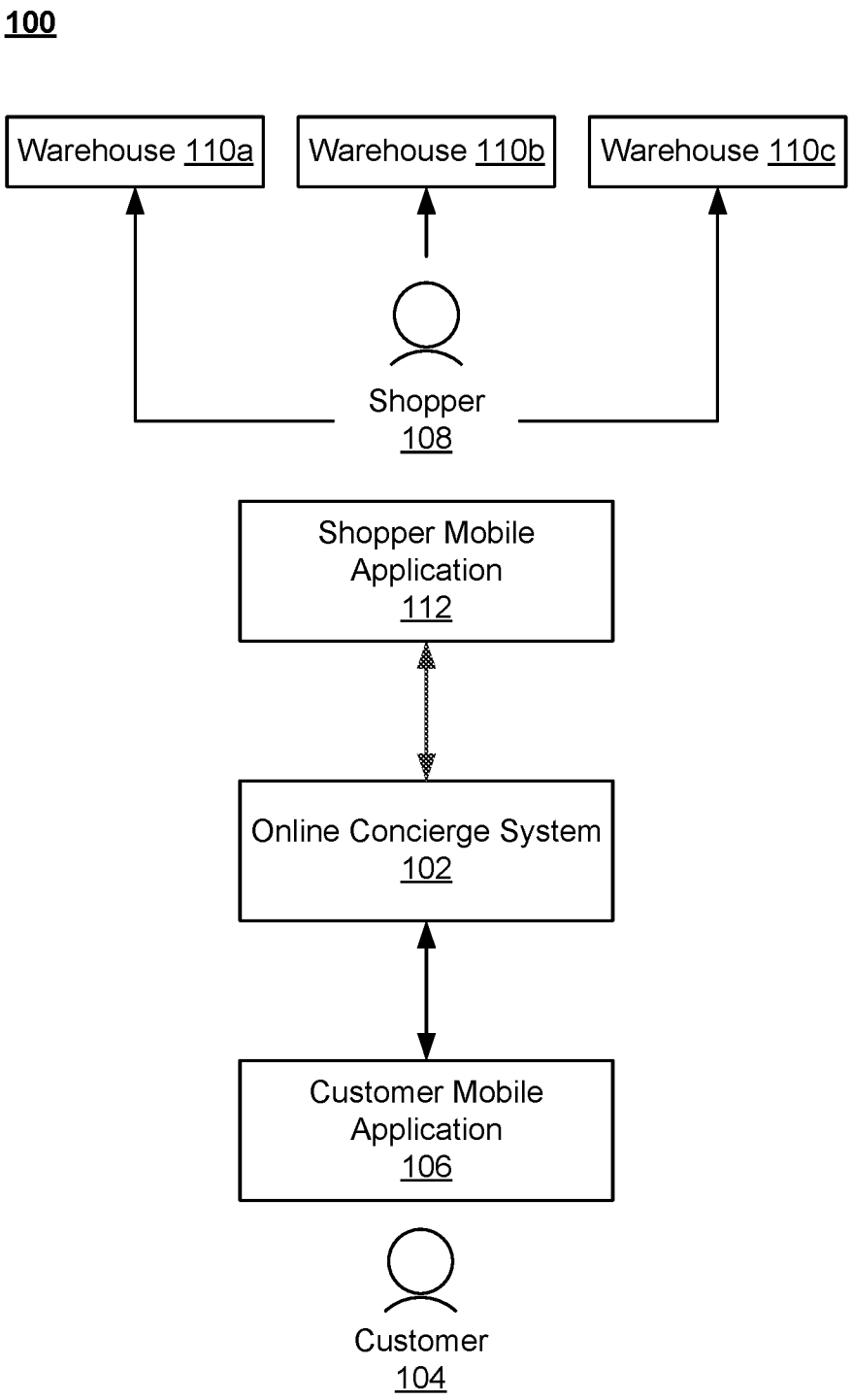

100
Warehouse 110a
Warehouse 110b
Warehouse 110c
Shopper
108
Shopper Mobile
Application
112
Online Concierge System
102
Customer Mobile
Application
106
Customer
104

FIG. 1

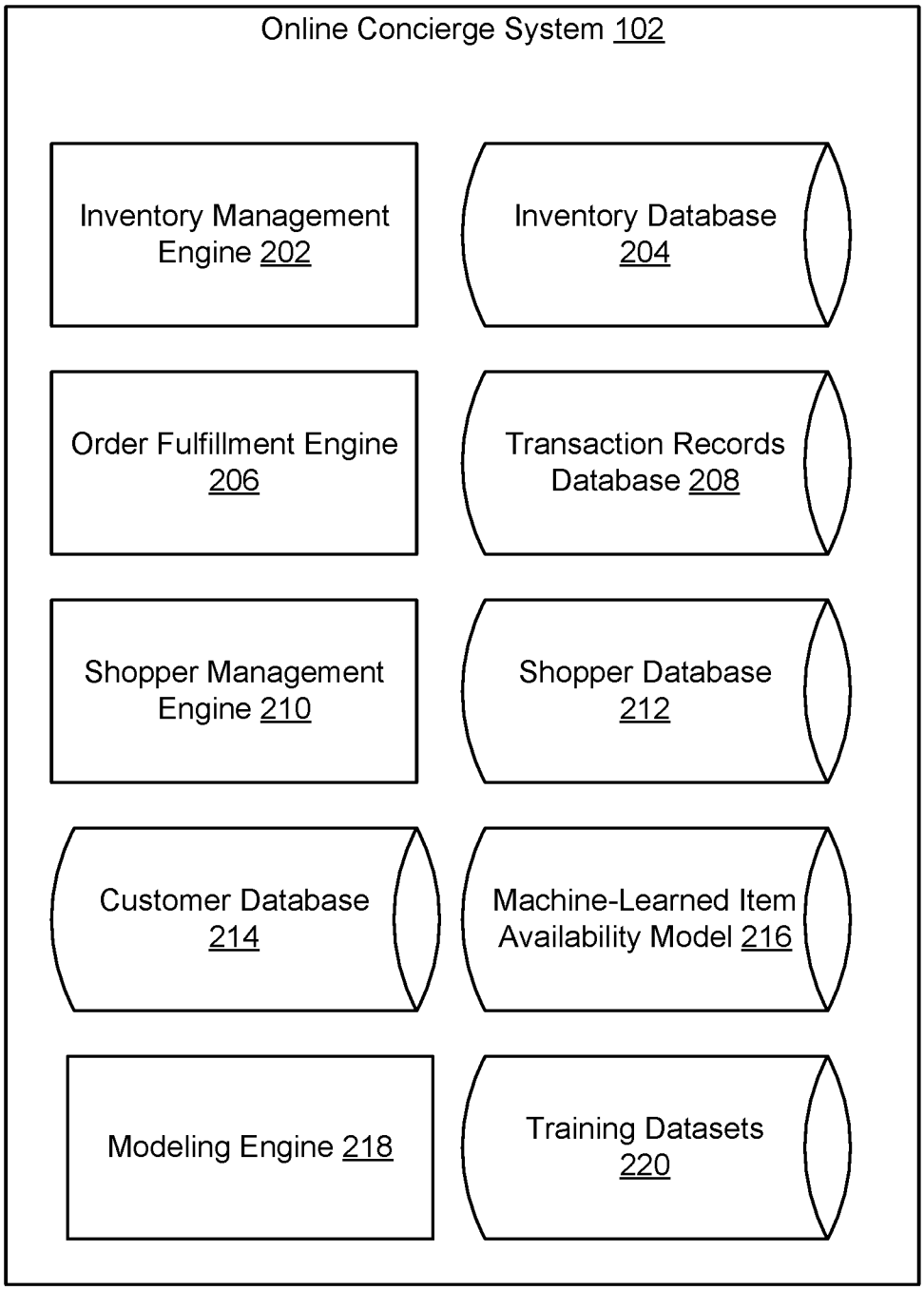

Online Concierge System 102
Inventory Management Engine 202
Inventory Database 204
Order Fulfillment Engine 206
Transaction Records Database 208
Shopper Management Engine 210
Shopper Database 212
Customer Database 214
Machine-Learned Item Availability Model 216
Modeling Engine 218
Training Datasets 220

FIG. 2

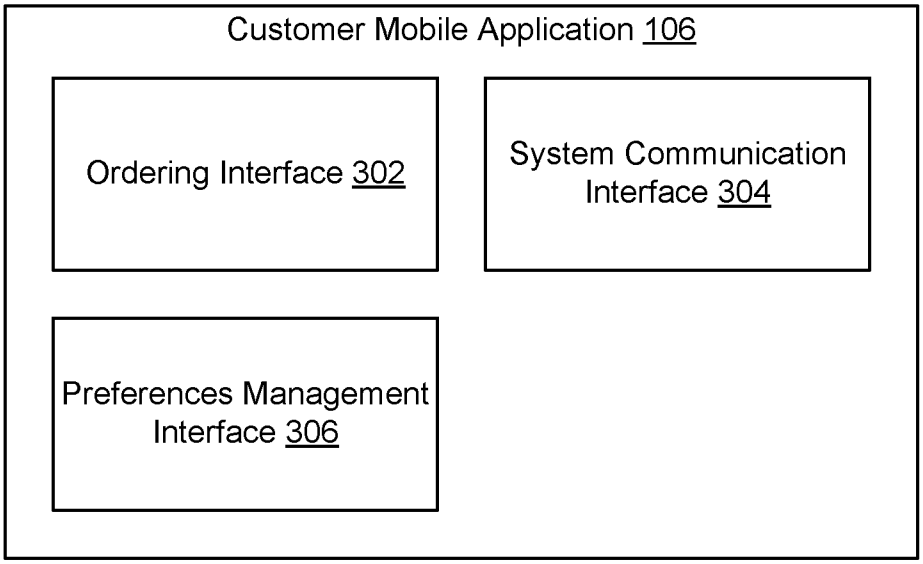

Customer Mobile Application 106
Ordering Interface 302
System Communication Interface 304
Preferences Management Interface 306

FIG. 3A

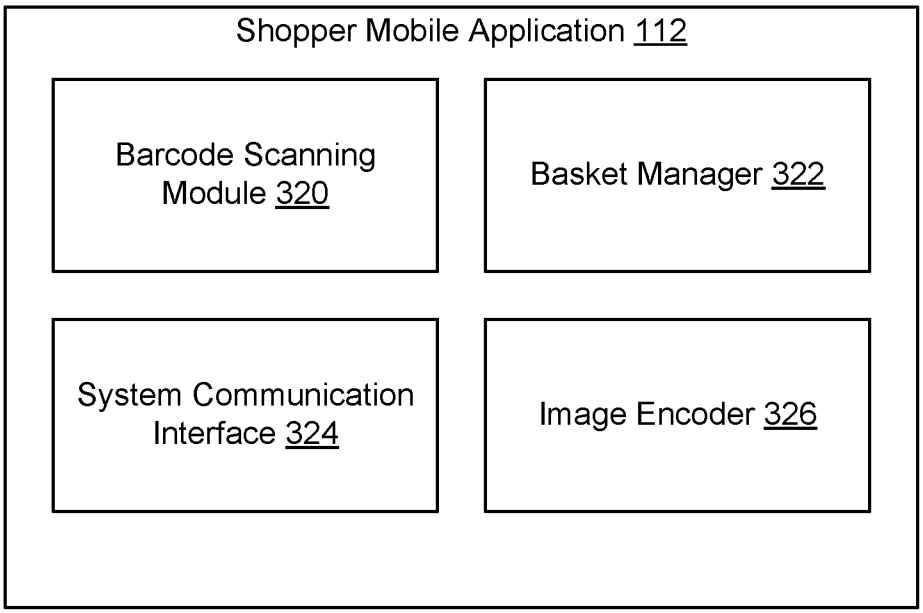

Shopper Mobile Application 112
Barcode Scanning Module 320
Basket Manager 322
System Communication Interface 324
Image Encoder 326

FIG. 3B

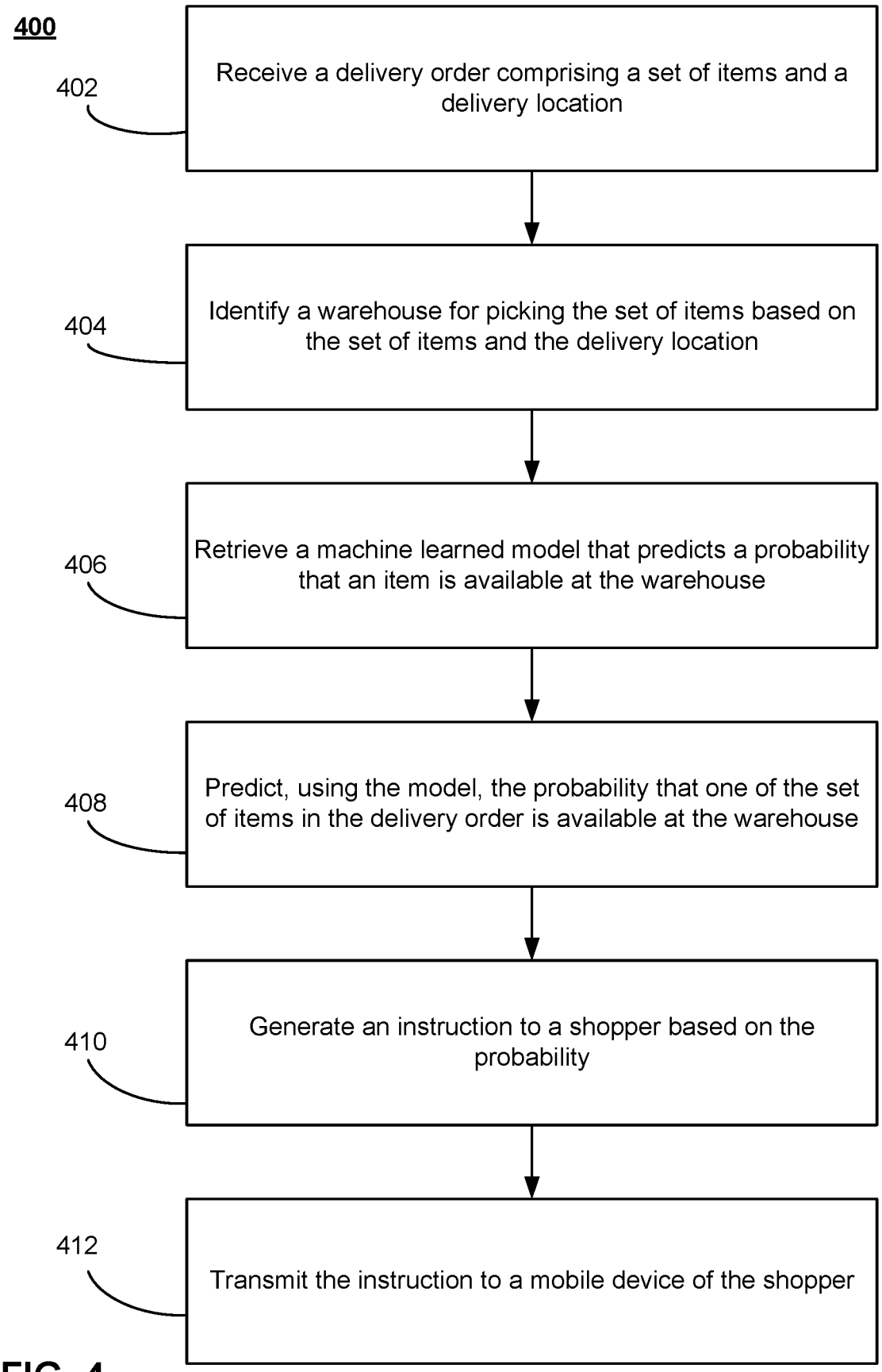

400
402
Receive a delivery order comprising a set of items and a delivery location
404
Identify a warehouse for picking the set of items based on the set of items and the delivery location
406
Retrieve a machine learned model that predicts a probability that an item is available at the warehouse
408
Predict, using the model, the probability that one of the set of items in the delivery order is available at the warehouse
410
Generate an instruction to a shopper based on the probability
412
Transmit the instruction to a mobile device of the shopper

FIG. 4

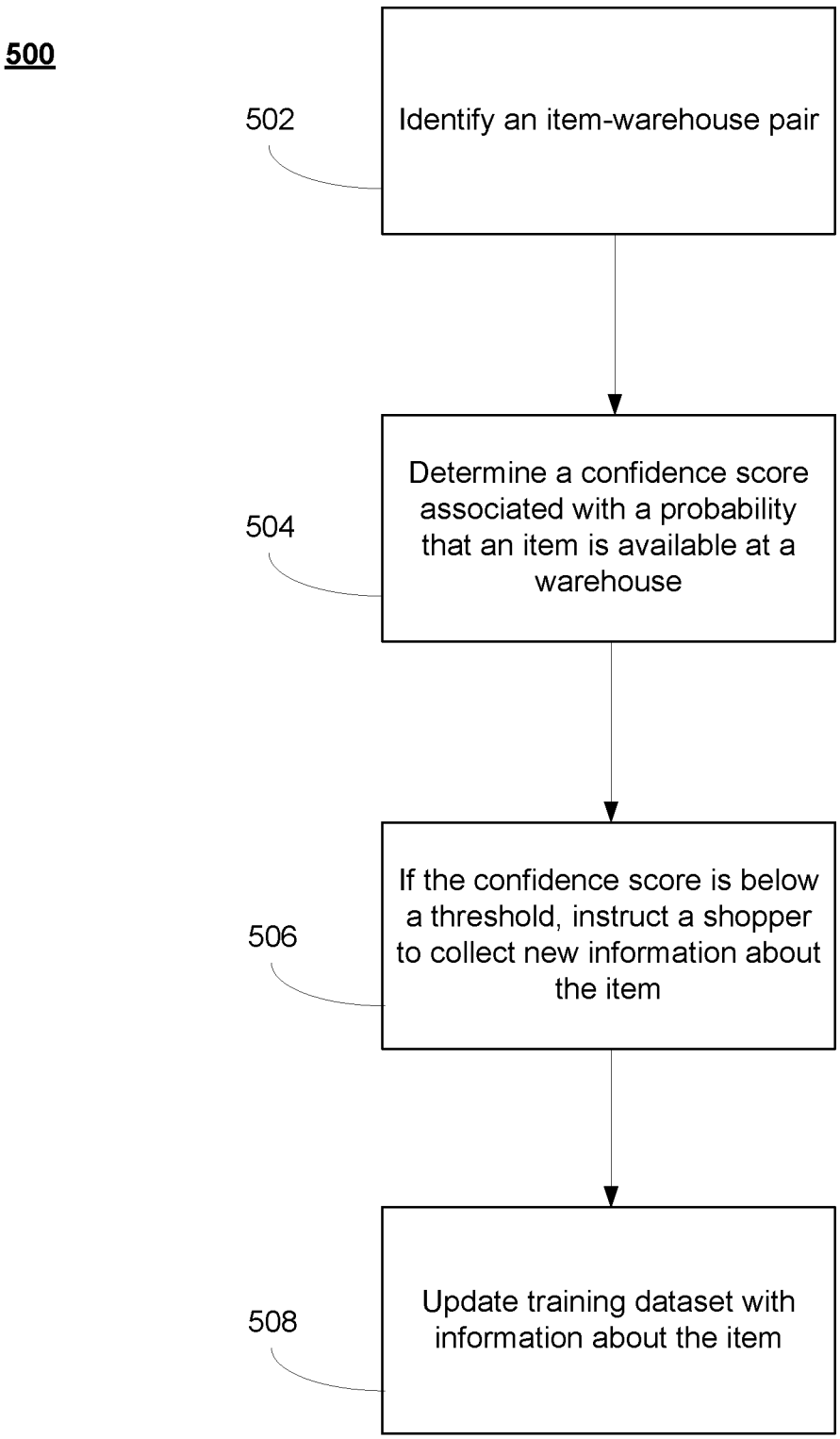

500
502
Identify an item-warehouse pair
504
Determine a confidence score associated with a probability that an item is available at a warehouse
506
If the confidence score is below a threshold, instruct a shopper to collect new information about the item
508
Update training dataset with information about the item

FIG. 5

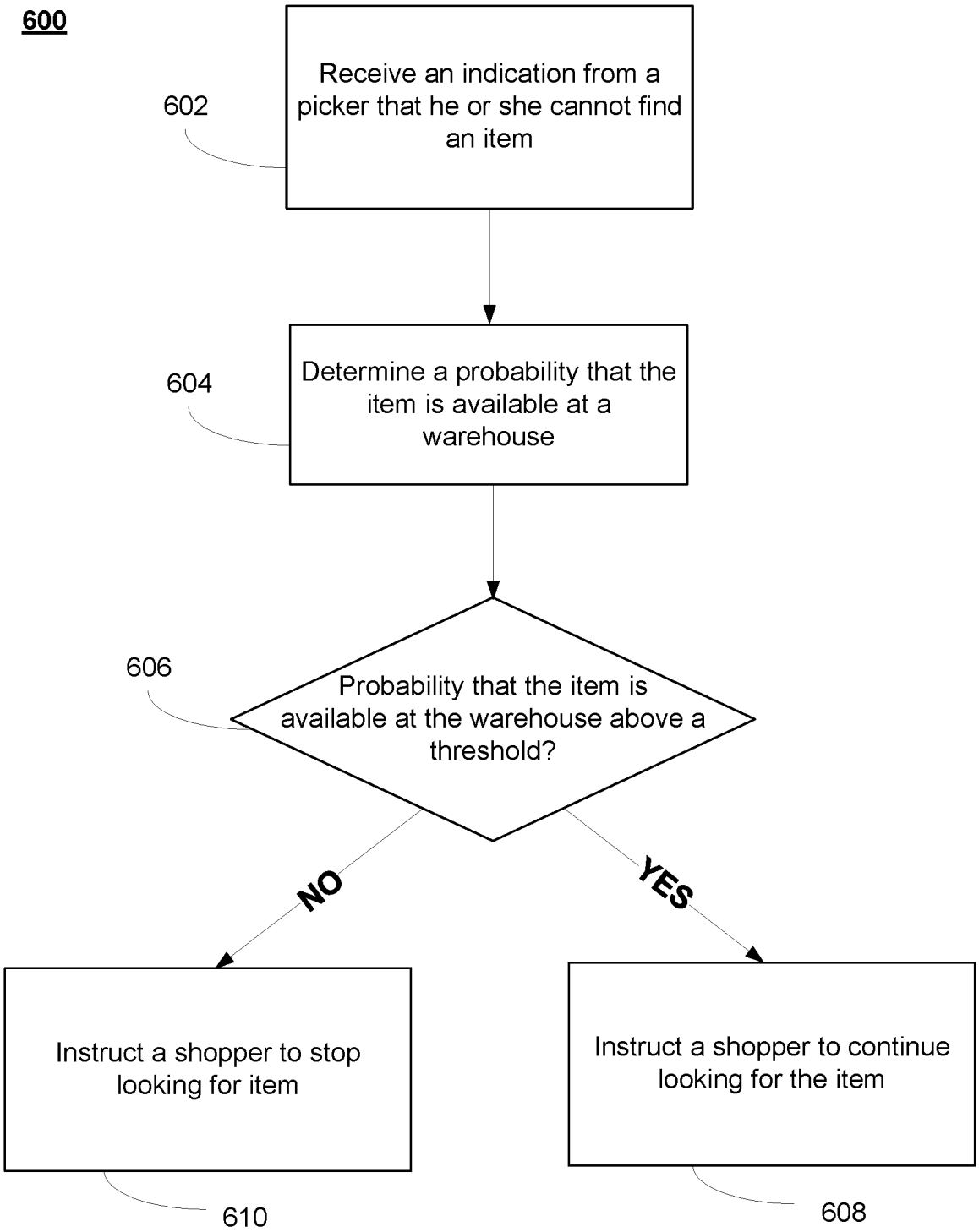

600
602
Receive an indication from a picker that he or she cannot find an item
604
Determine a probability that the item is available at a warehouse
606
Probability that the item is available at the warehouse above a threshold?
NO
YES
Instruct a shopper to stop looking for item
610
Instruct a shopper to continue looking for the item
608

FIG. 6

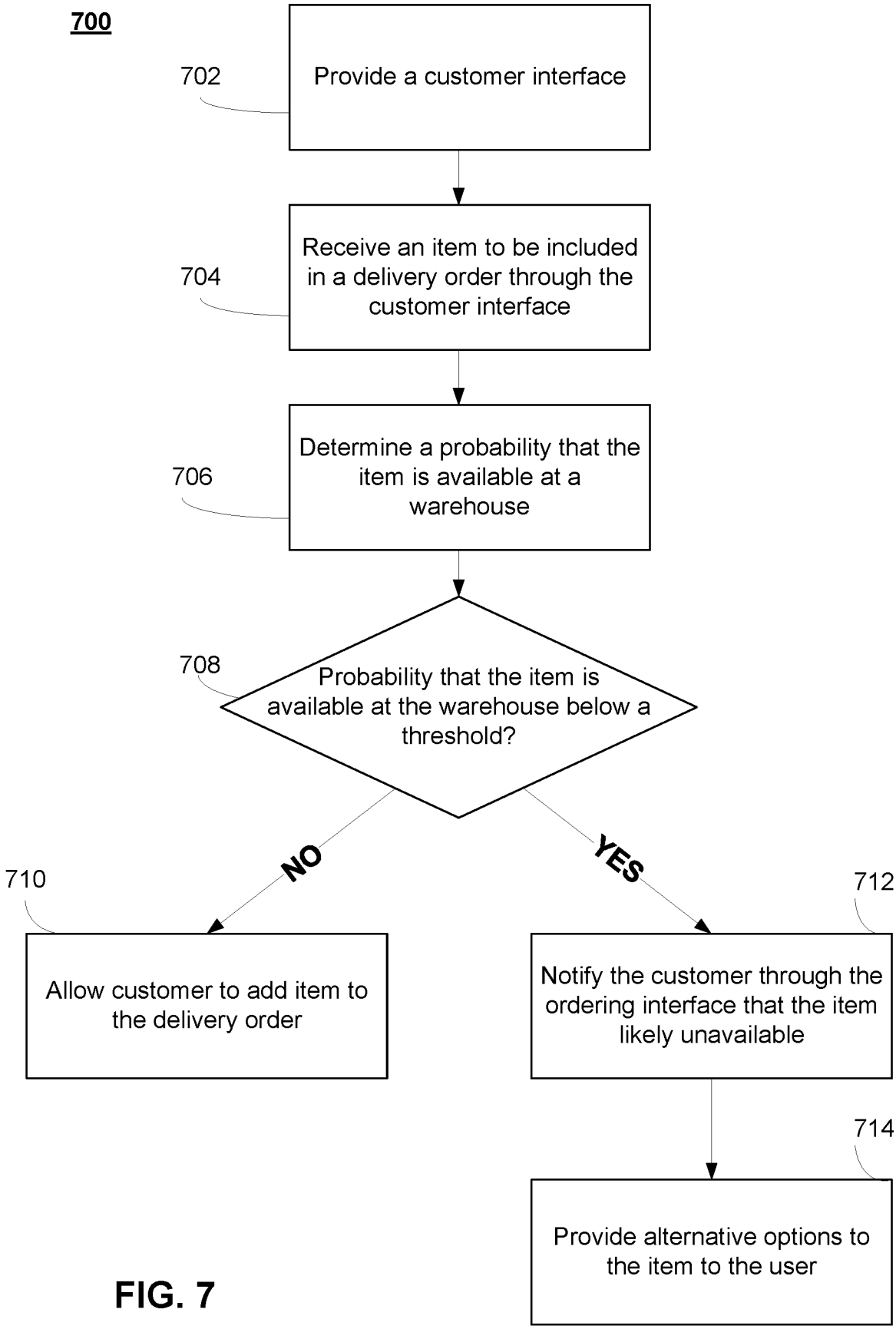

700
702
Provide a customer interface
704
Receive an item to be included in a delivery order through the customer interface
706
Determine a probability that the item is available at a warehouse
708
Probability that the item is available at the warehouse below a threshold?
NO
YES
710
Allow customer to add item to the delivery order
712
Notify the customer through the ordering interface that the item likely unavailable
714
Provide alternative options to the item to the user

FIG. 7

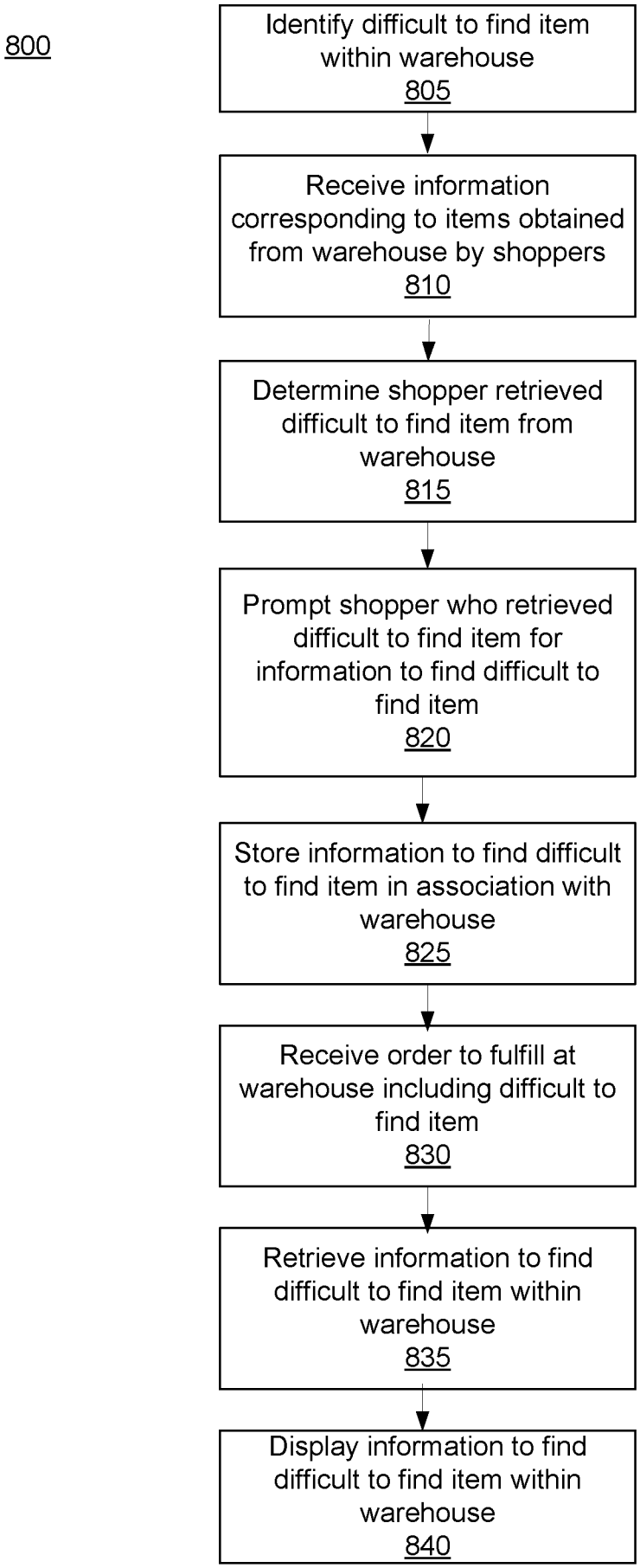

800
Identify difficult to find item within warehouse
805
Receive information corresponding to items obtained from warehouse by shoppers
810
Determine shopper retrieved difficult to find item from warehouse
815
Prompt shopper who retrieved difficult to find item for information to find difficult to find item
820
Store information to find difficult to find item in association with warehouse
825
Receive order to fulfill at warehouse including difficult to find item
830
Retrieve information to find difficult to find item within warehouse
835
Display information to find difficult to find item within warehouse
840

FIG. 8

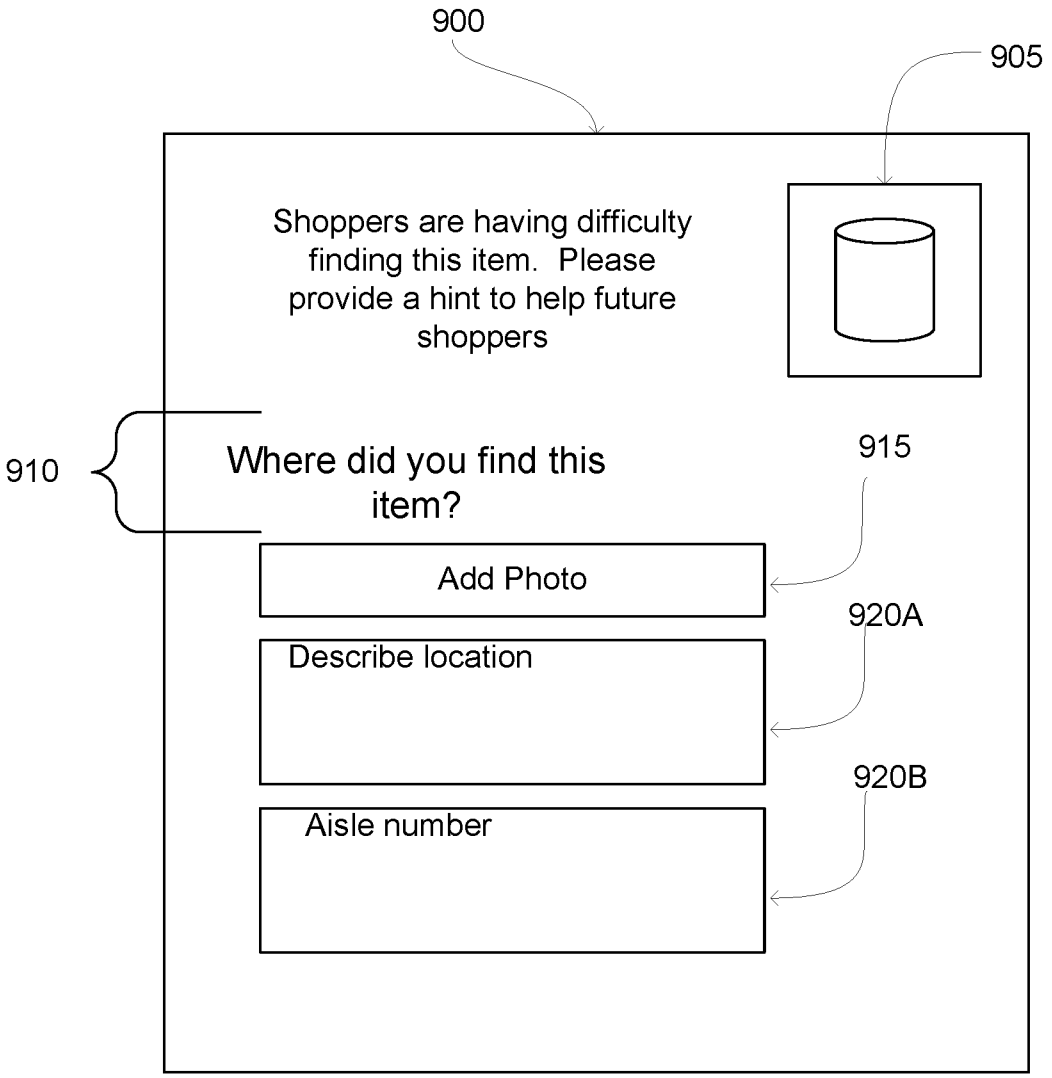

900
905
Shoppers are having difficulty finding this item. Please provide a hint to help future shoppers
910
Where did you find this item?
915
Add Photo
920A
Describe location
920B
Aisle number

FIG. 9

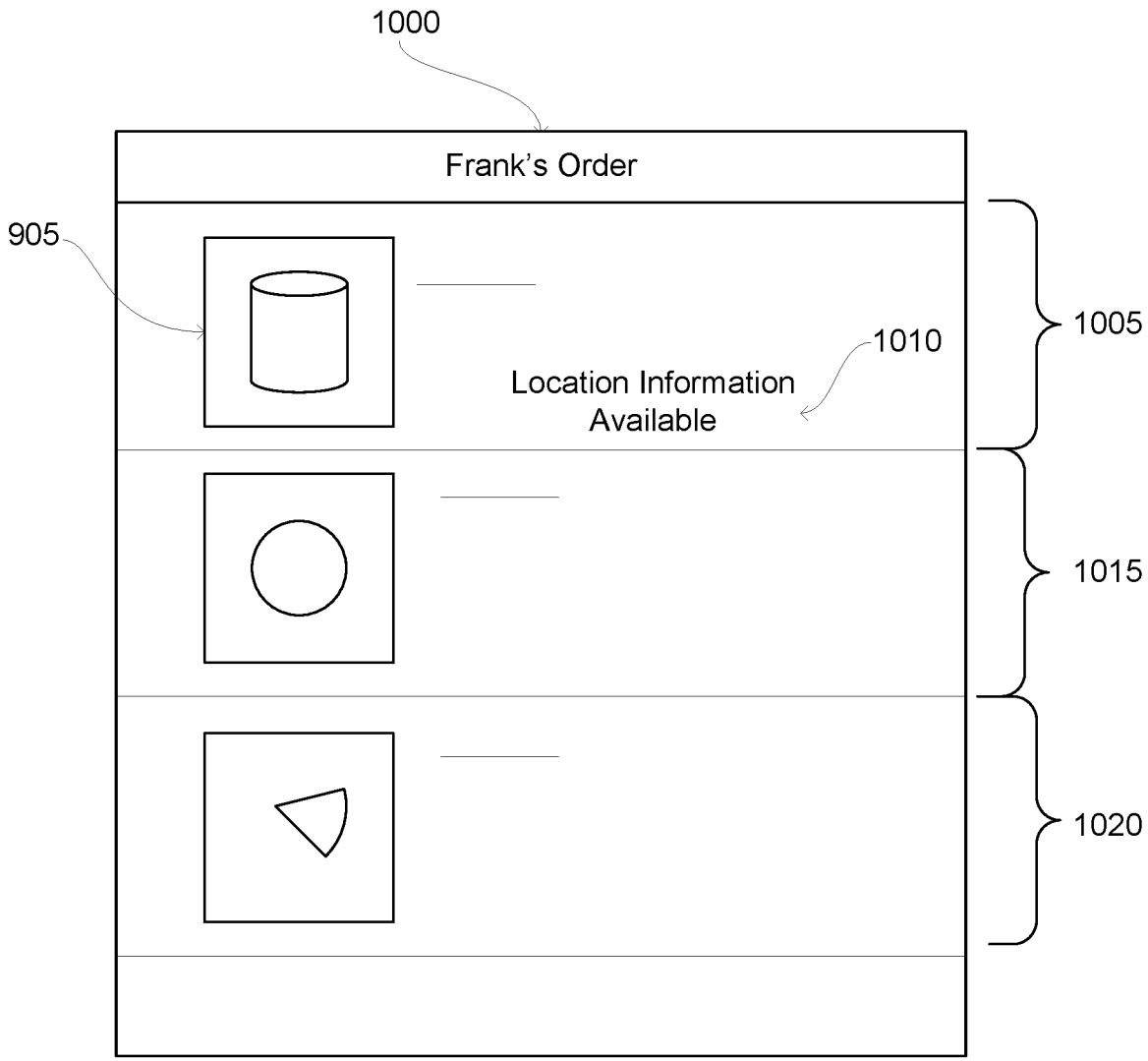

1000
Frank's Order
905
1010
Location Information Available
1005
1015
1020

FIG. 10

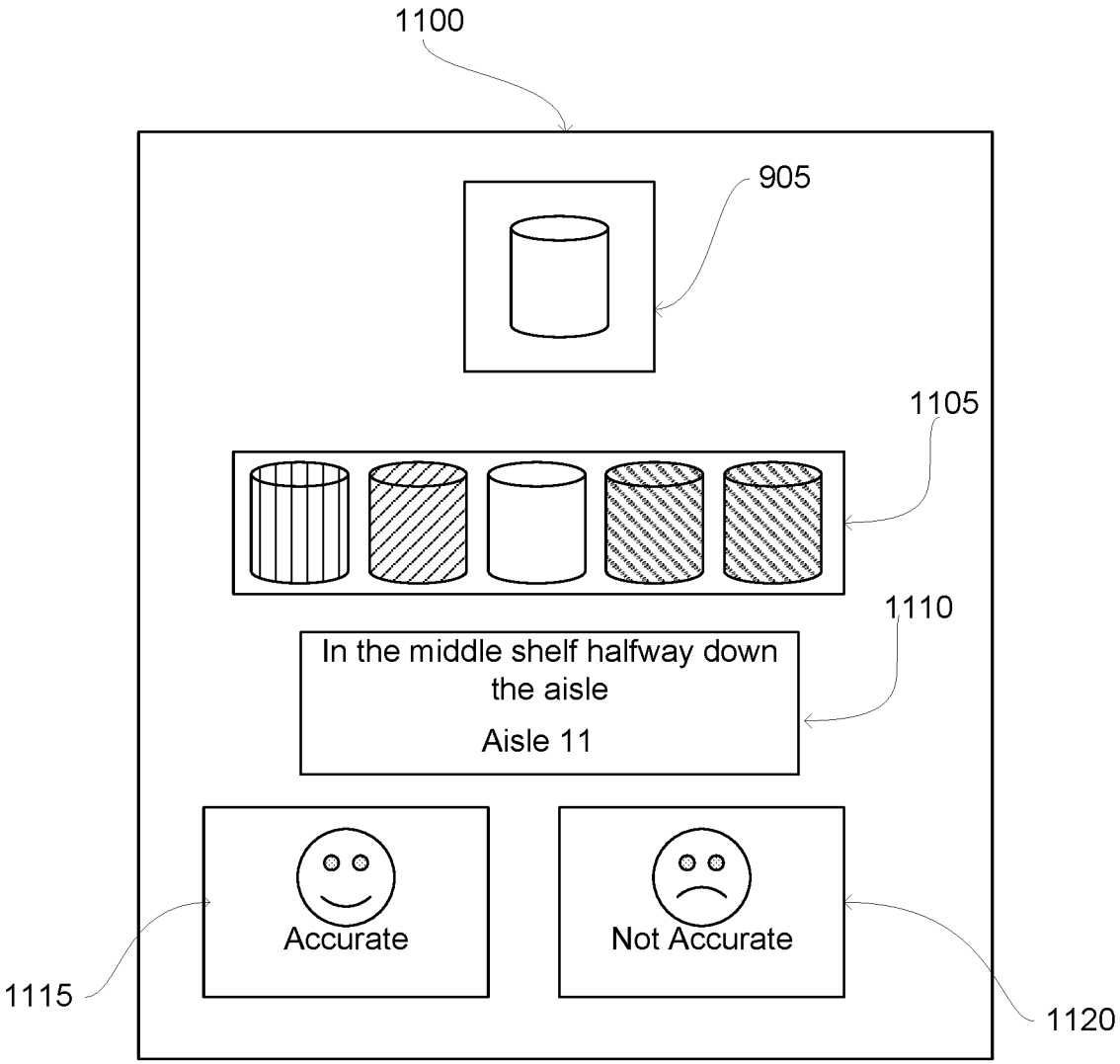
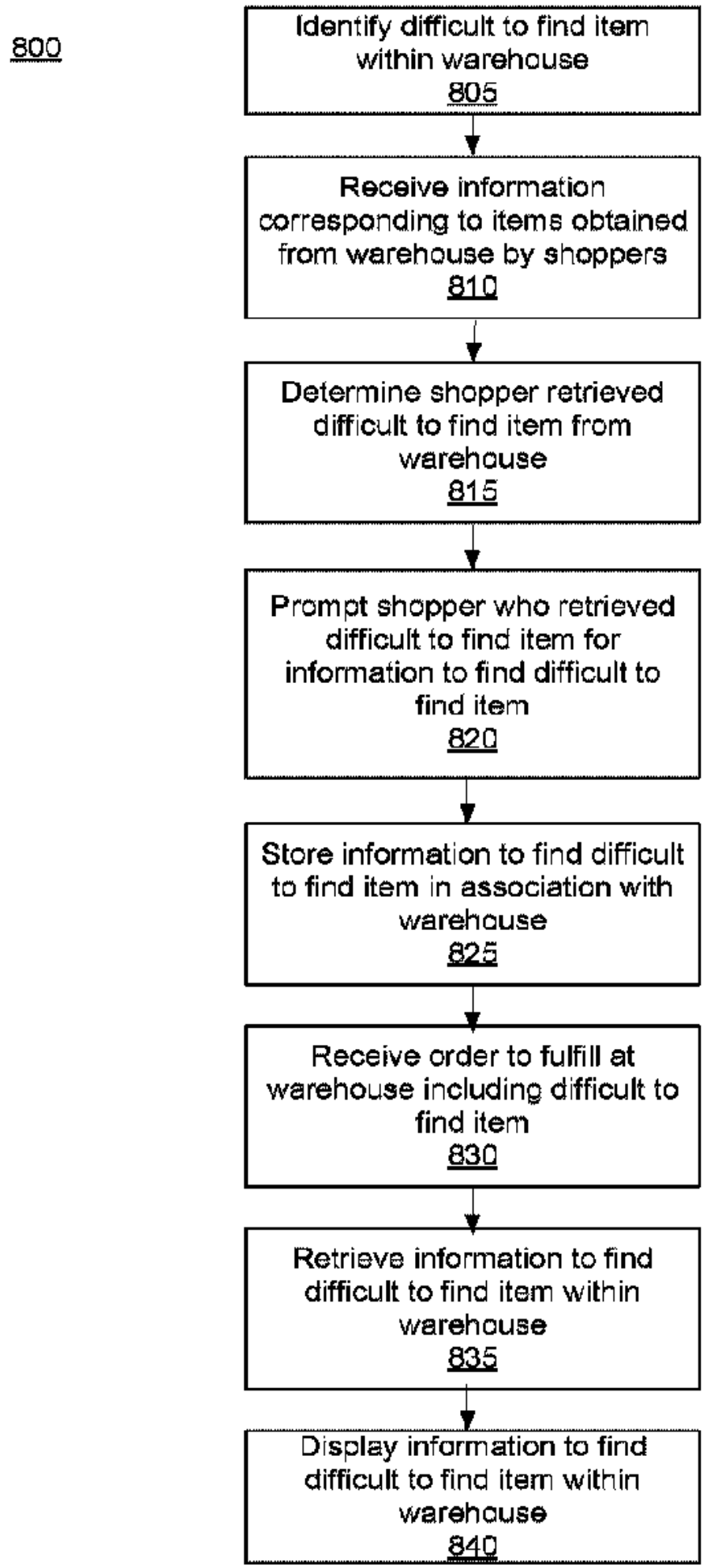

1100
905
1105
1110
In the middle shelf halfway down the aisle
Aisle 11
Accurate
Not Accurate
1115
1120

FIG. 11


800
Identify difficult to find item within warehouse
805
Receive information corresponding to items obtained from warehouse by shoppers
810
Determine shopper retrieved difficult to find item from warehouse
815
Prompt shopper who retrieved difficult to find item for information to find difficult to find item
820
Store information to find difficult to find item in association with warehouse
825
Receive order to fulfill at warehouse including difficult to find item
830
Retrieve information to find difficult to find item within warehouse
835
Display information to find difficult to find item within warehouse
840