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Inventor(s)

Muthusamy; Ganesh et al.

Strategic and Tactical Intelligence in Dynamic Segmentation

Abstract

A system and method for performing tactical segmentation including a supply chain network having a tactical segmentation planner, an inventory system, a transportation network, supply chain entities and a computer. The computer performs multi-dimension segmentation on input data by computing feature importance to generate multi-dimensional segments, assigns policy parameters to the supply chain network based on the generated multi-dimensional segments, trains a machine learning model by applying a cyclic boosting process to the standardized features data, where the cyclic boosting process iteratively learns relationships associated with the generated multi-dimensional segments, stores the machine learning model in a database, performs multi-dimension segmentation based on the stored machine learning model, determines whether data drift has occurred in the input data and in response to determining that data drift has occurred, repeats the perform, assign, trains steps, and stores an updated machine learning model in the database.

Inventors: Muthusamy; Ganesh (Hyderabad, IN), Bulusu; Phani (Bangalore, IN), Puthiyapurayil; Rashid (Bangalore, IN), Singh; Abhishek (Bangalore, IN)

Applicant: Blue Yonder Group, Inc. (Scottsdale, AZ)

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 18/671,595, filed May 22, 2024, entitled “Strategic and Tactical Intelligence in Dynamic Segmentation,” which is a continuation of U.S. patent application Ser. No. 17/738,495, filed May 6, 2022, entitled “Strategic and Tactical Intelligence in Dynamic Segmentation,” now U.S. Pat. No. 12,008,592, which claims the benefit under 35 U.S.C. § 119 (e) to U.S. Provisional Application No. 63/185,566, filed May 7, 2021, entitled “Strategic and Tactical Intelligence in Dynamic Segmentation.” U.S. patent application Ser. No. 18/671,595, U.S. Pat. No. 12,008,592, and U.S. Provisional Application No. 63/185,566 are assigned to the assignee of the present application.

TECHNICAL FIELD

[0002] The present disclosure relates generally to segmentation planning and more specifically to generating and updating segments autonomously.

BACKGROUND

[0003] Segmentation refers to the process of dividing one or more target markets into sub-sections, or segments, that can be targeted with specific products, communications and communication channels, supply chain logistical procedures, and/or other business processes. Segmentation is a complex task when performed manually, so dynamic segmentation may be employed to speed up the process of segmentation. However, dynamic segmentation itself presents several problems. For example, use of existing dynamic segmentation systems may result in frequent changes to the segment boundaries, due to noise in the data or frequent, but insignificant, changes in the data. Such frequent changes may themselves result in longer lead times for planners to understand the segmentation boundaries, confusion in the results of the segmentation, and may trigger change management protocols even when such protocols are unnecessary and wasteful. These outcomes result in inefficient allocation of supply chain inventory and sub-optimal service levels, and are undesirable.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] A more complete understanding of the present invention may be derived by referring to the detailed description when considered in connection with the following illustrative figures. In the figures, like reference numbers refer to like elements or acts throughout the figures.

[0005] FIG. 1 illustrates an exemplary supply chain network, according to a first embodiment;

[0006] FIG. 2 illustrates the strategic and tactical segmentation planner of FIG. 1 in greater detail, in accordance with an embodiment;

[0007] FIG. 3 illustrates an exemplary segmentation workflow method, according to an embodiment;

[0008] FIG. 4 illustrates an exemplary strategic segment generation method, according to an embodiment;

[0009] FIG. 5 illustrates an exemplary comprehensive segment analysis method, according to an embodiment;

[0010] FIG. 6 illustrates an exemplary agile segment analysis method, according to an embodiment;

[0011] FIG. 7 illustrates a tactical segment prediction method, according to an embodiment;

[0012] FIG. 8 illustrates an initial segment configuration display, according to an embodiment; and

[0013] FIG. 9 illustrates an exemplary data drift display, according to an embodiment.

DETAILED DESCRIPTION

[0014] Aspects and applications of the invention presented herein are described below in the drawings and detailed description of the invention. Unless specifically noted, it is intended that the words and phrases in the specification and the claims be given their plain, ordinary, and accustomed meaning to those of ordinary skill in the applicable arts.

[0015] In the following description, and for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the various aspects of the invention. It will be understood, however, by those skilled in the relevant arts, that the present invention may be practiced without these specific details. In other instances, known structures and devices are shown or discussed more generally in order to avoid obscuring the invention. In many cases, a description of the operation is sufficient to enable one to implement the various forms of the invention, particularly when the operation is to be implemented in software. It should be noted that there are many different and alternative configurations, devices and technologies to which the disclosed inventions may be applied. The full scope of the inventions is not limited to the examples that are described below.

[0016] As described below, embodiments of the following disclosure provide a strategic and tactical segmentation system and method to provide dynamic, adaptable market segmentation decisions for supply chain networks and business environments without unnecessarily altering segmentation boundaries due to insignificant changes in the data. Embodiments may provide a strategic level segmentation planner and tactical segmentation predictions. At the strategic level, embodiments utilize a segmentation planner to manage input data in (1) a comprehensive scenario using all data available and more extensive computation time, and/or (2) an agile scenario using a representative sample of available data and a reduced computation requirement, as compared to the comprehensive scenario. Embodiments of the strategic level segmentation planner discover segmentation features relevant to input data, and pre-process the data before generating segments. Embodiments analyze the generated segments for one or more unimportant or no-longer-relevant features and, if one or more unimportant or no-longer-relevant features are detected, the segmentation planner drops the unimportant or no-longer-relevant features from the list of segments. Embodiments of the segmentation planner generate one or more graphical user interface (GUI) displays visualizing the segments at the strategic and the tactical level, and assign policy parameters to the segments. Embodiments also train one or more machine learning models and/or algorithms to make tactical segmentation predictions for new input data based on the list of generated segments.

[0017] At the tactical level, embodiments maintain the broad contours of segmentation boundaries, previously generated by the strategic level segmentation planner, while using the trained one or more machine learning models and/or algorithms to segment new input data and predict segment intersections based on changes in input data. Whereas the strategic level segmentation planner may require significant time and computational resources to generate segments, and may accordingly only be performed on an infrequent or an as-needed basis, the tactical segmentation prediction may predict segments based on changes in input data quickly, efficiently, and frequently (such as, for example, on a daily basis). When tactical segment prediction method determines that significant

changes in input data require the generation of new strategic segments, the strategic level simulation planner generates new segments using the full strategic segment generation process. [0018] Embodiments enable segmentation planners to segment markets efficiently and automatically at both the strategic level and the tactical level. At the strategic level, embodiments select a sufficient number of segmentation features to adequately segment a market without over-granulizing the market with unnecessary segmentation features. Embodiments autonomously update segmentation decisions as new data become available, circumstances change, and as customers and other businesses enter and exit the market over time, without requiring significant human intervention and/or oversight. Embodiments automatically detect the presence of non-critical features and segments, and remove non-critical features and segments from segmentation planning to reduce operating expenses. At the tactical level, embodiments efficiently segment new input data and predict segment intersections without requiring the resources and time required to complete strategic level segmentation.

[0019] FIG. 1 illustrates exemplary supply chain network **100** according to a first embodiment. Supply chain network **100** comprises strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, computer **150**, network **160**, and communication links **170A-170E**. Although a single strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, a single computer **150**, and a single network **160** are shown and described, embodiments contemplate any number of strategic and tactical segmentation planners **110**, inventory systems **120**, transportation networks **130**, supply chain entities **140**, computers **150**, or networks **160**, according to particular needs.

[0020] In one embodiment, strategic and tactical segmentation planner **110** comprises server **112** and database **114**. As described in more detail below, strategic and tactical segmentation planner **110** comprises one or more modules to, for example, perform a strategic multi-dimension segmentation to discover segmentation features, generate segments, and to compute the importance of one or more segmentation features; and perform a tactical segmentation of new input data **220** and prediction of segment intersections using one or more machine learning models and/or algorithms.

[0021] Inventory system **120** comprises server **122** and database **124**. Server **122** of inventory system **120** is configured to receive and transmit inventory data, including but not limited to item identifiers, pricing data, attribute data, features data **224**, inventory levels, and other like data about one or more items or products at one or more locations in supply chain network **100**. Server **122** stores and retrieves inventory data from database **124** or from one or more locations in supply chain network **100**.

[0022] According to embodiments, database **124** includes current or projected inventory quantities or states, order rules, or explanatory variables. For example, database **124** may comprise the current level of inventory for each item at one or more stocking points across supply chain network **100**. In addition, database **124** may comprise order rules that describe one or more rules or limits on setting an inventory policy, including, but not limited to, a minimum order quantity, a maximum order quantity, a discount, and a step-size order quantity, and batch quantity rules. According to some embodiments, database **124** may comprise explanatory variables that describe the data relating to specific past, current, or future indicators and the data of promotions, seasonality, special events (such as sporting events), weather, and the like. According to some embodiments, strategic and tactical segmentation planner **110** accesses and stores inventory data in database **124**, which may be used by strategic and tactical segmentation planner **110** to generate one or more segments according to the methods described herein. In addition, or as an alternative, the inventory data of database **124** may be updated by receiving current item quantities, mappings, or locations from inventory system **120**, transportation network **130**, and/or one or more supply chain entities **140**.

[0023] Transportation network **130** comprises server **132** and database **134**. According to

embodiments, transportation network **130** directs one or more transportation vehicles to ship one or more items between one or more supply chain entities **140**, based, at least in part, on segments and/or instruction sets generated by strategic and tactical segmentation planner **110**. The transportation vehicles comprise, for example, any number of trucks, cars, vans, boats, airplanes, unmanned aerial vehicles (UAVs), cranes, robotic machinery, or the like. The transportation vehicles may comprise radio, satellite, or other communication systems that communicate location information (such as, for example, geographic coordinates, distance from a location, global positioning satellite (GPS) information, or the like) with strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, and/or one or more supply chain entities **140** to identify the location of the transportation vehicle and the location of any inventory or shipment located on the transportation vehicle. The number of items shipped by transportation vehicles in transportation network **130** may also be based, at least in part, on the number of items currently in stock at one or more supply chain entities **140**, the number of items currently in transit in transportation network **130**, a forecasted demand, a supply chain disruption, and the like.

[0024] As shown in FIG. **1**, supply chain network **100** operates on one or more computers **150** that are integral to or separate from the hardware and/or software that support strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, and one or more supply chain entities **140**. Supply chain network **100** comprising strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, and one or more supply chain entities **140** may operate on one or more computers **150** that are integral to or separate from the hardware and/or software that support strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, and one or more supply chain entities **140**. One or more computers **150** may include any suitable input device **152**, such as a keypad, mouse, touch screen, microphone, or other device to input information. One or more computers **150** may also include any suitable output device **154**, such as, for example, computer monitor, that may convey information associated with the operation of supply chain network **100**, including digital or analog data, visual information, or audio information. Computer **150** may include fixed or removable computer-readable storage media **156**, including a non-transitory computer readable medium, magnetic computer disks, flash drives, CD-ROM, in-memory device or other suitable media to receive output from and provide input to supply chain network **100**.

[0025] Computer **150** may include one or more processors and associated memory to execute instructions and manipulate information according to the operation of supply chain network **100** and any of the methods described herein. One or more processors may execute an operating system program stored in memory to control the overall operation of computer **150**. For example, one or more processors control the reception and transmission of signals within the system. One or more processors execute other processes and programs resident in memory, such as, for example, registration, identification or communication and moves data into or out of the memory, as required by an executing process. In addition, or as an alternative, embodiments contemplate executing the instructions on computer **150** that cause computer **150** to perform functions of the method. Further examples may also include articles of manufacture including tangible computer-readable media that have computer-readable instructions encoded thereon, and the instructions may comprise instructions to perform functions of the methods described herein.

[0026] In addition, supply chain network **100** may comprise a cloud-based computing system having processing and storage devices at one or more locations, local to, or remote from strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, and one or more supply chain entities **140**. In addition, each of One or more computers **150** may be a work station, personal computer (PC), network computer, notebook computer, tablet, personal digital assistant (PDA), cell phone, telephone, smartphone, wireless data port, augmented or virtual reality headset, or any other suitable computing device. In an embodiment, one or more users may be associated with strategic and tactical segmentation planner **110**, inventory system **120**,

transportation network **130**, and one or more supply chain entities **140**.

[0027] These one or more users may include, for example, a “manager” or a “planner” handling generation of segments, supply chain plans and instruction sets, managing the inventory of items, imaging items, managing storage and shipment of items, and/or one or more related tasks within supply chain network **100**. In addition, or as an alternative, these one or more users within supply chain network **100** may include, for example, one or more computers **150** programmed to autonomously handle, among other things, shelving resets, task management, communication and assignment of instructions, issue identification and resolution, controlling manufacturing equipment, and adjusting various levels of manufacturing and inventory levels at various stocking points and distribution centers **146**, and/or one or more related tasks within supply chain network **100**.

[0028] One or more supply chain entities **140** represent one or more supply chain networks **100**, including one or more enterprises, such as, for example networks of one or more suppliers **142**, manufacturers **144**, distribution centers **146**, retailers **148** (including brick and mortar and online stores), customers, and/or the like. Suppliers **142** may be any suitable entity that offers to sell or otherwise provides one or more items (i.e., materials, components, or products) to one or more manufacturers **144**. Suppliers **142** may comprise automated distribution systems **143** that automatically transport products to one or more manufacturers **144** based, at least in part, on supply chain plans and/or instruction sets determined by strategic and tactical segmentation planner **110** and/or one or more other factors described herein.

[0029] Manufacturers **144** may be any suitable entity that manufactures at least one product. Manufacturers **144** may use one or more items during the manufacturing process to produce any manufactured, fabricated, assembled, or otherwise processed item, material, component, good, or product. In one embodiment, a product represents an item ready to be supplied to, for example, one or more supply chain entities **140** in supply chain network **100**, such as retailers **148**, an item that needs further processing, or any other item. Manufacturers **144** may, for example, produce and sell a product to suppliers **142**, other manufacturers **144**, distribution centers **146**, retailers **148**, a customer, or any other suitable person or entity. Manufacturers **144** may comprise automated robotic production machinery **145** that produce products based, at least in part, on supply chain plans and/or instruction sets determined by strategic and tactical segmentation planner **110** and/or one or more other factors described herein.

[0030] Distribution centers **146** may be any suitable entity that offers to store or otherwise distribute at least one product to one or more retailers **148** and/or customers. Distribution centers **146** may, for example, receive a product from a first one or more supply chain entities **140** in supply chain network **100** and store and transport the product for a second one or more supply chain entities **140**. Distribution centers **146** may comprise automated warehousing systems **147** that automatically remove products from and place products into inventory based, at least in part, on one or more supply chain plans generated by strategic and tactical segmentation planner **110**.

[0031] Retailers **148** may be any suitable entity that obtains one or more products to sell to one or more customers. Retailers **148** may (like the other one or more supply chain entities **140**) comprise a corporate structure having a retail headquarters and one or more retail stores. Retail headquarters comprises a central planning office with oversight of one or more retail stores. Retailer **148** stores may comprise any online or brick-and-mortar store, including stores with shelving systems **149**. The one or more retail stores may sell products according to rules, strategies, orders, and/or guidelines developed by one or more retail headquarters. For example, retail headquarters may create supply chain plans that determine how the store will shelf or display one or more products. Although supply chain plan execution may be performed in part by one or more retail employees, embodiments contemplate automated configuration of shelving and retail displays. This may include, for example, automated robotic shelving machinery that places products on shelves or automated shelving that automatically adjusts based, at least in part, on the supply chain plans.

Shelving systems **149** may comprise, for example, various racks, fixtures, brackets, notches, grooves, slots, or other attachment devices for fixing shelves in various configurations. These configurations may comprise shelving with adjustable lengths, heights, and other arrangements. [0032] Although one or more supply chain entities **140** are shown and described as separate and distinct entities, the same entity may simultaneously act as any one of one or more supply chain entities **140**. For example, one or more supply chain entities **140** acting as a manufacturer can produce a product, and the same one or more supply chain entities **140** can act as a supplier to supply an item to itself or another one or more supply chain entities **140**. Although one example of supply chain network **100** is shown and described in FIG. **1**, embodiments contemplate any configuration of supply chain network **100**, without departing from the scope described herein. [0033] In one embodiment, each of strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, computer **150**, and supply chain entities **140** may be coupled with network **160** using communications link **170A-170E**, which may be any wireline, wireless, or other link suitable to support data communications between strategic and tactical segmentation planner **110** and network **160** during operation of supply chain network **100**. Although communication links **170A-170E** are shown as generally coupling strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** to network **160**, any of strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** may communicate directly with each other, according to particular needs. [0034] In another embodiment, network **160** includes the Internet and any appropriate local area networks (LANs), metropolitan area networks (MANs), or wide area networks (WANs) coupling strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150**. For example, data may be maintained locally to, or externally of strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** and made available to one or more associated users of strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** using network **160** or in any other appropriate manner. For example, data may be maintained in a cloud database at one or more locations external to strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** and made available to one or more associated users of strategic and tactical segmentation planner **110**, inventory system **120**, transportation network **130**, one or more supply chain entities **140**, and computer **150** using the cloud or in any other appropriate manner. Those skilled in the art will recognize that the complete structure and operation of network **160** and other components within supply chain network **100** are not depicted or described. Embodiments may be employed in conjunction with known communications networks and other components.

[0035] In accordance with the principles of embodiments described herein, strategic and tactical segmentation planner **110** may generate segments, supply chain plans, and/or instruction sets for the inventory of one or more supply chain entities **140** in supply chain network **100**. Furthermore, strategic and tactical segmentation planner **110**, inventory system **120**, and/or transportation network **130** may instruct automated machinery (i.e., robotic warehouse systems, robotic inventory systems, automated guided vehicles, mobile racking units, automated robotic production machinery **145**, robotic devices and the like) to adjust product mix ratios, inventory levels at various stocking points, production of products of manufacturing equipment, proportional or alternative sourcing of one or more supply chain entities **140**, the configuration and quantity of packaging and shipping of products, and the display of products at one or more retail locations based on one or more supply chain plans and instruction sets, generated plans and policies and/or current inventory or production levels. When the inventory of an item falls to a reorder point, strategic and tactical segmentation

planner **110** may automatically adjust product mix ratios, inventory levels, production of products of manufacturing equipment, and proportional or alternative sourcing of one or more supply chain entities **140** until the inventory is resupplied to a target quantity.

[0036] For example, the methods described herein may include computers **150** receiving product data from automated machinery having at least one sensor and the product data corresponding to an item detected by the sensor of the automated machinery. The received product data may include an image of the item, an identifier, as described above, and/or other product data associated with the item (dimensions, texture, estimated weight, and any other like data). The method may further include computers **150** looking up the received product data in a database system associated with strategic and tactical segmentation planner **110**, inventory system **120**, and/or transportation network **130** to identify the item corresponding to the product data received from the automated machinery.

[0037] Computers **150** may also receive, from the automated machinery, a current location of the identified item. Based on the identification of the item, computers **150** may also identify (or alternatively generate) a first mapping in the database system, where the first mapping is associated with the current location of the item. Computers **150** may also identify a second mapping in the database system, where the second mapping is associated with a past location of the identified item. Computers **150** may also compare the first mapping and the second mapping to determine if the current location of the identified item in the first mapping is different than the past location of the identified item in the second mapping. Computers **150** may then send instructions to the automated machinery based, at least in part, on one or more differences between the first mapping and the second mapping such as, for example, to locate an item to add to or remove from a shelf or an inventory of or shipment for one or more supply chain entities **140**. In addition, or as an alternative, strategic and tactical segmentation planner **110** may monitor the supply chain constraints of one or more items at one or more supply chain entities **140** and adjusts the orders and/or inventory of one or more supply chain entities **140** based on the supply chain constraints.

[0038] Although the systems and methods are described below primarily in connection with supply chain network **100** solely for the sake of clarity, embodiments contemplate the systems and methods described herein generating segments and segmentation predictions in any business environment and with any number of participating customers, demographics, and/or other business entities, and in response to any number of features, intersections, products, and/or items.

[0039] FIG. 2 illustrates strategic and tactical segmentation planner **110** of FIG. 1 in greater detail in accordance with an embodiment. As described above, strategic and tactical segmentation planner **110** may comprise one or more computers **150** at one or more locations including associated input devices **152**, output devices **154**, non-transitory computer-readable storage media **156**, processors, memory, or other components for receiving, processing, storing, and communicating information according to the operation of supply chain network **100**. Additionally, strategic and tactical segmentation planner **110** comprises server **112** and database **114**. Although strategic and tactical segmentation planner **110** is shown as comprising a single server **112** and a single database **114**, embodiments contemplate any suitable number of computers **150**, servers **112**, or databases **114** internal to or externally coupled with strategic and tactical segmentation planner **110**. According to some embodiments, strategic and tactical segmentation planner **110** may be located internal to one or more retailers **148** of one or more supply chain entities **140**. In other embodiments, strategic and tactical segmentation planner **110** may be located external to one or more retailers **148** of one or more supply chain entities **140** and may be located in, for example, a corporate retailer of one or more retailers **148**, according to particular needs.

[0040] Server **112** of strategic and tactical segmentation planner **110** may comprise user interface module **210**, data management module **212**, features module **214**, data processing module **216**, and segmentation module **218**. Although server **112** is illustrated and described as comprising a single user interface module **210**, data management module **212**, features module **214**, data processing

module **216**, and segmentation module **218**, embodiments contemplate any suitable number or combination of these located at one or more locations, local to, or remote from strategic and tactical segmentation planner **110**, such as on multiple servers **112** or computers **150** at any location in supply chain network **100**.

[0041] According to embodiments, user interface module **210** receives and processes a user input, such as, for example, input received by input device **152** of one or more computers **150**. One or more computers **150** may transmit input to strategic and tactical segmentation planner **110** using one or more communication links **170A-170E**. User interface module **210** may register the input from one or more computers **150** and transmit the input to data management module **212** and/or features module **214**, data processing module **216**, and segmentation module **218**. In an embodiment, user interface module **210** generates and displays a user interface (UI), such as, for example, a graphical user interface (GUI), that displays one or more interactive visualizations of segmentations, features, intersections, and/or other data. User interface module **210** may generate one or more GUI displays. The one or more GUI displays may convey information, including supply chain plan data, strategic and/or tactical segmentation data **230**, and/or any other type of information about supply chain network **100** and segmentation.

[0042] Data management module **212** may access input data **220** stored in strategic and tactical segmentation planner database **114**, and may transform input data **220** to generate cleansed data **222**. In an embodiment, data management module **212** may also check cleansed data **222** for data drift by compare a first segment, subset, or portion of cleansed data **222** to a second segment, subset, or portion of cleansed data **222** and/or input data **220** to determine if the first segment, subset or portion has drifted far enough from the second segment, subset or portion as to require the generation of updated strategic segments.

[0043] Features module **214** may access cleansed data **222** and may analyze cleansed data **222** to locate one or more features. Having located one or more features, features module **214** may store the one or more features in features data **224** of strategic and tactical segmentation planner database **114**.

[0044] Data processing module **216** may access features data **224** and may perform pre-processing actions on features data **224** to generate pre-processed data **226**. Data processing module **216** may store pre-processed data **226** in strategic and tactical segmentation planner database **114** pre-processed data **226**. Data processing module **216** may train one or more machine learning models and/or other algorithms to perform a tactical segmentation of new data and predict segment intersections. In an agile scenario embodiment, data processing module **216** may train one or more supervised machine learning models and/or other algorithms, using a sample portion of data stored in input data **220**, pre-processed data **226**, and/or initial segmentation configuration data **236**, to (1) predict strategic segments for one or more remaining segment intersections, and/or (2) predict tactical segments, as described in greater detail below.

[0045] Segmentation module **218** may perform multi-dimension segmentation on pre-processed data **226** and may compute feature importance to generate segments, which segmentation module **218** may store in strategic segmentation data **228**, as described in greater detail below.

Segmentation module **218** may also use one or more machine learning models and/or algorithms to perform a tactical segmentation of new data and predict segment intersections.

[0046] Database **114** of strategic and tactical segmentation planner **110** may comprise one or more databases or other data storage arrangements at one or more locations, local to, or remote from, server **112**. Database **114** may comprise, for example, input data **220**, cleansed data **222**, features data **224**, pre-processed data **226**, strategic segmentation data **228**, tactical segmentation data **230**, algorithms data **232**, number of segments data **234**, initial segmentation configuration data **236**, assigned segments data **238**, and machine learning models data **240**. Although database **114** is shown and described as comprising input data **220**, cleansed data **222**, features data **224**, pre-processed data **226**, strategic segmentation data **228**, tactical segmentation data **230**, algorithms

data **232**, number of segments data **234**, initial segmentation configuration data **236**, assigned segments data **238**, and machine learning models data **240**, embodiments contemplate any suitable number or combination of these, located at one or more locations, local to, or remote from, strategic and tactical segmentation planner **110** according to particular needs.

[0047] Input data **220** may comprise, for example, any data relating to the supply chain system. Input data **220** may comprise data relating to supply chain entities **140**, previous supply chain plans, transactions and shipments between supply chain entities **140**, or past sales, past demand, purchase data, promotions, events, or the like of one or more products and/or one or more supply chain entities **140**. Input data **220** may comprise data regarding one or more features assigned to one or more products, items, or resources manufactured, transported, or sold throughout the supply chain system. Input data **220** may be stored and/or updated at time intervals such as, for example, by the minute, hour, daily, weekly, monthly, quarterly, yearly, or any suitable time interval, including substantially in real time.

[0048] Cleansed data **222** may comprise data in which data management module **212** has determined segment intersections, converted input data **220** from one data storage format into another data storage format, and/or executed any other data modification or cleansing actions.

[0049] Features data **224** may comprise data in which features module **214** has discovered one or more features, aggregated or dis-aggregated cleansed data **222**, and/or executed any other feature discovery actions.

[0050] Pre-processed data **226** may comprise data that have been pre-processed by data processing module **216** to standardize features data **224** (such as, for example, by standardizing the granularity of features data **224** and all features stored in features data **224**; standardizing units of measure or currency of features data **224** and all features stored in features data **224**; and/or performing any other pre-processing actions to standardize features data **224**).

[0051] Strategic segmentation data **228** may comprise data relating to one or more strategic segments generated by segmentation module **218** during the process of performing a strategic segment generation, as described in greater detail below.

[0052] Tactical segmentation data **230** may comprise data relating to one or more tactical segments and/or predictions generated by segmentation module **218** during the process of performing a tactical segment prediction.

[0053] Algorithms data **232** may comprise data related to one or more algorithms accessed by segmentation module **218** to perform autonomous segmentation. Segmentation module **218** may select an algorithm from algorithms data **232** based on whether the data to be processed is string-based or numerical-based, with some algorithms of algorithms data **232** tailored for use with string-based data and other algorithms of algorithms data **232** tailored for use with numerical-based data.

[0054] Number of segments data **234** may store the number of segments selected by segmentation module **218** during the activities of comprehensive segment analysis method described in greater detail below.

[0055] Initial segmentation configuration data **236** may comprise data related to one or more initial segment configurations, generated by segmentation module **218** during the activities of comprehensive segment analysis method.

[0056] Assigned segments data **238** comprises data related to one or more assigned segments generated by segmentation module **218** during the activities of comprehensive segment analysis method. According to embodiments, assigned segments data **238** may also comprise data relating to the relative importance of one or more features stored in assigned segments data **238**.

[0057] Machine learning models data **240** may comprise data relating to one or more machine learning models and/or one or more algorithms trained by data processing module **216**, as described in greater detail below.

[0058] FIG. **3** illustrates exemplary segmentation workflow method **300**, according to an embodiment. Segmentation workflow method **300** proceeds by one or more activities, which

although described in a particular order may be performed in one or more permutations, combinations, orders, or repetitions, according to particular needs.

[0059] At activity **302** of segmentation workflow method **300**, strategic and tactical segmentation planner **110** generates strategic segments. In an embodiment, strategic and tactical segmentation planner **110** may use strategic segment generation method **400**, illustrated by FIG. **4**, and comprehensive segment analysis method **500**, illustrated by FIG. **5**, to generate strategic segments. According to embodiments, strategic and tactical segmentation planner **110** may generate strategic segments at activity **302** of segmentation workflow method **300** in (1) a comprehensive scenario using all data available and more extensive computation time, and/or (2) an agile scenario using a representative sample of available data and a reduced computation requirement, as described in greater detail with reference to FIG. **4** below. Having generated strategic segments, strategic and tactical segmentation planner **110** stores the generated segments in strategic segmentation data **228**.

[0060] At activity **304** of segmentation workflow method **300**, strategic and tactical segmentation planner **110** performs tactical data segmentation and predicts one or more segments. In an embodiment, strategic and tactical segmentation planner **110** may use tactical segment prediction method **700**, illustrated by FIG. **7**, to predict one or more segments. Having predicted one or more segments, strategic and tactical segmentation planner **110** stores the one or more predicted segments in tactical segmentation data **230**.

[0061] At activity **306** of segmentation workflow method **300**, strategic and tactical segmentation planner **110** determines whether to update the strategic segments stored in strategic segmentation data **228**. In an embodiment, strategic and tactical segmentation planner **110** may perform tactical data segmentation on a frequent basis (such as, for example, hourly, daily, or weekly), and may generate strategic segments less frequently (such as, for example, monthly, quarterly, or yearly) in response to determining that data drift has occurred in input data **220** and/or cleansed data **222**, and that the generation of new strategic segments is necessary to preserve data integrity. In an embodiment, data management module **212** may compare a first segment, subset, or portion of input data **220** to a second segment, subset, or portion of input data **220** to determine if the first segment, subset or portion of data has drifted far enough from the second segment, subset or portion of data as to require the generation of updated strategic segments. For example, in an embodiment, strategic and tactical segmentation planner **110** may generate strategic segments using input data **220** that was current as of Jan. 1, 2021. Strategic and tactical segmentation planner **110** may continuously receive updated input data **220** as **2021** continues, and may repeatedly perform tactical data segmentation on the updated input data **220**, using the strategic segments generated with the Jan. 1, 2021 input data, while also determining whether to update the original strategic segments generated with the Jan. 1, 2021 input data. In this example, on Apr. 1, 2021, data management module **212** compares the Apr. 1, 2021 input data to the Jan. 1, 2021 input data, and determines the Apr. 1, 2021 input data has drifted a sufficiently significant distance from the Jan. 1, 2021 data so as to require the generation of updated strategic segments. In this example, strategic and tactical segmentation planner **110** halts further tactical data segmentation activities, and returns to activity **302** of segmentation workflow method **300** to generate updated strategic segments.

[0062] If strategic and tactical segmentation planner **110** determines that strategic segments should be updated, strategic and tactical segmentation planner **110** ceases further tactical data segmentation activities and returns to activity **302** of segmentation workflow method **300** to generate updated strategic segments. If, on the other hand, strategic and tactical segmentation planner **110** determines that no updates to strategic segments are required, strategic and tactical segmentation planner **110** may return to the activities of tactical segment prediction method **700** and may continue predicting one or more segments and/or tactical data segmentations.

[0063] FIG. **4** illustrates exemplary strategic segment generation method **400** in which strategic and tactical segmentation planner **110** generates and visualizes strategic-level segments, according to an embodiment. The following strategic segment generation method **400** proceeds by one or more

activities, which although described in a particular order may be performed in one or more permutations, combinations, orders, or repetitions, according to particular needs.

[0064] At activity **402** of strategic segment generation method **400**, data management module **212** selects a segmentation workflow depth, manages input data **220**, and generates cleansed data **222**. In an embodiment, data management module **212** selects a segmentation workflow depth by determining whether to generate segments utilizing the activities of strategic segment generation method **400** in (1) a comprehensive scenario using all data available and more extensive computation time, and/or (2) an agile scenario using a representative sample of data and a reduced computation requirement. Data management module **212** may respond to one or more inputs detected by user interface module **210**, including but not limited to input detected to one or more computer input devices **152**, to select either a comprehensive scenario or an agile scenario. In a comprehensive scenario, strategic segment generation method **400** utilizes all available input data **220** stored in strategic and tactical segmentation planner database **114** to execute the other activities of strategic segment generation method **400**. In an agile scenario, strategic segment generation method **400** selects a portion of the full data set available in input data **220** with which to execute the other activities of strategic segment generation method **400** and tactical segment prediction method **700**, described below.

[0065] Data management module **212** accesses input data **220** stored in strategic and tactical segmentation planner database **114**. In an embodiment, data management module **212** determines segment intersections based on input data **220**. For example, in an embodiment, input data **220** may comprise three items (Items A, B and C), each of which is stored in varying degrees of stock at three locations (Supplier X, Y, and Z). Data management module **212** may select granular intersections, in which the exact quantity of each of Items A, B and C at each of Suppliers X, Y, and Z is imported into cleansed data **222**. In other embodiments, data management module **212** may select broader, less granular intersections, in which only the total quantities of Items A, B and C across all three Suppliers X, Y, and Z are imported into cleansed data **222**. These examples are provided for illustrative purposes only, and embodiments contemplate data management module **212** selecting any form of segment intersections while generating cleansed data **222**, using any intersection selection criteria, according to particular needs. In some embodiments, user interface module **210** responds to input to one or more computer input devices **152**, and selects one or more segment intersections directly.

[0066] Data management module **212** may transform input data **220** to generate cleansed data **222**. Data transformation may comprise converting input data **220** from one data storage format into another data storage format; copying one or more pre-discovered features stored in input data **220** into cleansed data **222**; removing one or more pre-discovered features stored in input data **220**; and/or any other data modification or cleansing actions. In a comprehensive scenario, data management module **212** transforms all available input data **220** stored in strategic and tactical segmentation planner database **114** to generate cleansed data **222**. In an agile scenario, data management module **212** selects a representative sample of the full data set available in input data **220**, and performs a dimensionality reduction on the representative sample to generate cleansed data **222**. In either scenario, having generated cleansed data **222**, data management module **212** stores cleansed data **222** in strategic and tactical segmentation planner database **114** cleansed data **222**.

[0067] At activity **404** of strategic segment generation method **400**, features module **214** discovers features. Features module **214** accesses cleansed data **222** and discovers features in cleansed data **222** to generate features data **224**. In an embodiment, features module **214** accesses cleansed data **222** and aggregates or dis-aggregates cleansed data **222** based on one or more segment intersections to discover features and generate features data **224**. Features module **214** may aggregate or dis-aggregate cleansed data **222** based on, for example, a focus on one or more products or resources manufactured, transported, or sold throughout the supply chain system; one or more locations or

geographic regions throughout the supply chain system; or based on any other focus or intersection, according to particular needs. Features module **214** may aggregate or dis-aggregate cleansed data **222** using one or more direct input features (such as, for example, price), and/or one or more derived features that features module **214** may compute based on one or more other features stored in cleansed data **222**. Having discovered one or more features, features module **214** stores the one or more features in features data **224**. In an embodiment, user interface module **210** responds to input to one or more computer input devices **152**, and inputs one or more features directly into features data **224**.

[0068] At activity **406** of strategic segment generation method **400**, data processing module **216** pre-processes features data **224** to generate pre-processed data **226**. According to embodiments, data processing module **216** may access features data **224** and pre-process features data **224** in order to standardize features data **224** (such as, for example, by standardizing the granularity of features data **224** and all features stored in features data **224**; standardizing units of measure or currency of features data **224** and all features stored in features data **224**; and/or performing any other pre-processing actions to standardize features data **224**). In an embodiment, data processing module **216** reduces the dimensions of one or more features stored in features data **224** to emphasize one or more other features. Data processing module **216** may perform data interpretation on features data **224** to emphasize one or more numerical features, and/or one or more string features, in pre-processed data **226**. Having generated pre-processed data **226**, data processing module **216** stores pre-processed data **226** in strategic and tactical segmentation planner database **114** pre-processed data **226**.

[0069] At activity **408** of strategic segment generation method **400**, segmentation module **218** performs multi-dimension segmentation on pre-processed data **226** and computes feature importance to generate segments. Segmentation module **218** may access pre-processed data **226** and perform the activities of a comprehensive segment analysis method **500**, described in greater detail below and illustrated by FIG. 5, to generate segments. In a comprehensive scenario embodiment in which segmentation module **218** uses all data available and a more extensive computation time, segmentation module **218** may access pre-processed data **226** and utilize all pre-processed data **226** to generate segments, as described in greater detail below. In other embodiments in which an agile scenario with a reduced computation requirement uses a representative sample of available data to generate segments, segmentation module **218** accesses a portion of the full data set stored in input data **220** and/or pre-processed data **226**, and uses the portion of the full data set as a representative sample from which to (1) train a machine learning model to generate segmentation output and (2) predict remaining segments using the trained segmentation output, while also (3) utilizing the trained machine learning model to predict tactical segments using tactical segment prediction method **700**, described in greater detail in reference to FIGS. 6 and 7 below. Having generated one or more segments, segmentation module **218** stores the one or more segments in strategic segmentation data **228**.

[0070] At activity **410** of strategic segment generation method **400**, user interface module **210** visualizes segment output. User interface module **210** accesses strategic segmentation data **228** and generates one or more GUI displays, suitable for output on one or more computer **150** output devices, to visualize the segment output.

[0071] At activity **412** of strategic segment generation method **400**, user interface module **210** assigns policy parameters to strategic segmentation data **228**. In an embodiment, user interface module **210** responds to input to one or more computer input devices **152**, and assigns one or more policy parameters to one or more segments stored in strategic segmentation data **228**. By way of example and not by way of limitation, policy parameters may comprise assigning service levels of 90%, 95%, 99%, or any other level to one or more segments.

[0072] At activity **414** of strategic segment generation method **400**, data processing module **216** trains one or more machine learning models and/or other algorithms to predict the tactical

segmentation of new data and/or to predict segment intersections, based on the generated segments stored in strategic segmentation data **228**. In an embodiment, data processing module **216** uses a cyclic boosting process to train one or more machine learning models and/or other algorithms; in other embodiments, data processing module **216** utilizes any machine learning training processing, including but not limited to a deep learning process and/or a neural network, to train the one or more machine learning models and/or other algorithms. Data processing module **216** stores the one or more trained machine learning models and/or algorithms in machine learning models data **240**. In an embodiment in which strategic and tactical segmentation planner **110** selected an agile scenario in which to execute the activities of strategic segment generation method **400**, segmentation module **218** may access the one or more machine learning models and/or algorithms stored in machine learning models data **240** and may use the one or more machine learning models and/or algorithms to predict additional segments, segment intersections, and/or other segmentation data for the full data set available in input data **220**, and may store the segments, segment intersections, and/or other segmentation data in strategic segmentation data **228**. Having trained one or more machine learning models and/or algorithms, strategic and tactical segmentation planner **110** terminates strategic segment generation method **400**.

[0073] FIG. **5** illustrates exemplary comprehensive segment analysis method **500** in which strategic and tactical segmentation planner **110** analyzes segments in a comprehensive scenario, according to an embodiment. The following comprehensive segment analysis method **500** proceeds by one or more activities, which although described in a particular order may be performed in one or more permutations, combinations, orders, or repetitions, according to particular needs.

[0074] At activity **502** of comprehensive segment analysis method **500**, segmentation module **218** selects an algorithm with which to perform auto-segmentation at activity **504** of comprehensive segment analysis method **500**. In an embodiment, segmentation module **218** accesses algorithms data **232**, and selects an algorithm from a selection of one or more algorithms stored in algorithms data **232**, to perform auto-segmentation. According to embodiments, segmentation module **218** may select an algorithm based on whether the data stored in pre-processed data **226** is string-based or numerical-based. In other embodiments, user interface module **210** may respond to input made to one or more computer input devices **152**, and may directly select an algorithm from a selection of one or more algorithms stored in algorithms data **232**.

[0075] At activity **504** of comprehensive segment analysis method **500**, segmentation module **218** determines whether to proceed to activity **506** of comprehensive segment analysis method **500** and receive a specified number of segments from user interface module **210**, or to proceed to activity **510** of comprehensive segment analysis method **500** and perform autonomous multi-dimensional segmentation, including but not limited to computing a number of segments autonomously. Segmentation module **218** may respond to input from user interface module **210**, including but not limited to input to one or more computer input devices **152** detected by user interface module **210**, to determine whether to proceed to activity **506** or activity **510** of comprehensive segment analysis method **500**.

[0076] At activity **506** of comprehensive segment analysis method **500**, segmentation module **218** receives a specified number of segments from user interface module **210**. In an embodiment, user interface module **210** detects input to one or more computer input devices **152** that specifies a given quantity of segments (such as, for example, ten, twenty, fifty, or any other number). User interface module **210** transmits the specified number of segments to segmentation module **218**. Segmentation module **218** stores the specified number of segments in number of segments data **234**, and proceeds to activity **508** of comprehensive segment analysis method **500** to perform multi-dimensional segmentation.

[0077] At activity **508** of comprehensive segment analysis method **500**, segmentation module **218** performs multi-dimensional segmentation. Segmentation module **218** accesses number of segments data **234** and generates an initial segmentation configuration using the number of segments stored

in number of segments data **234**. Segmentation module **218** stores the initial segmentation configuration in initial segmentation configuration data **236**, and proceeds to segment visualization. [0078] In other embodiments in which segmentation module **218** does not receive a specified number of segments from user interface module **210**, segmentation module **218** proceeds from activity **504** of comprehensive segment analysis method **500** to activity **510** of comprehensive segment analysis method **500** and performs autonomous multi-dimensional segmentation.

According to embodiments, segmentation module **218** may use any method or process to perform autonomous multi-dimensional segmentation and compute a number of segments autonomously, including but not limited to an artificial intelligence (AI) or machine learning (ML) segmentation with autonomous selection of features. Having autonomously computed a number of segments, segmentation module **218** stores the number of segments in number of segments data **234**.

Segmentation module **218** may generate an initial segmentation configuration using the number of segments stored in number of segments data **234**. Segmentation module **218** stores the initial segmentation configuration in initial segmentation configuration data **236**, and proceeds to activity **512** of comprehensive segment analysis method **500**.

[0079] At activity **512** of comprehensive segment analysis method **500**, strategic and tactical segmentation planner **110** publishes the number of segments that were computed during activity **510** of comprehensive segment analysis method **500**. According to embodiments, user interface module **210** may access the number of segments stored in number of segments data **234**, and may generate one or more GUI displays visualizing the number of segments stored in number of segments data **234**. Strategic and tactical segmentation planner **110** proceeds to segment visualization.

[0080] At activity **514** of comprehensive segment analysis method **500**, segmentation module **218** and user interface module **210** perform multi-dimensional segment visualization. User interface module **210** accesses the initial segmentation configuration stored in initial segmentation configuration data **236**, and generates a GUI display visualizing the initial segmentation configuration.

[0081] At activity **516** of comprehensive segment analysis method **500**, segmentation module **218** assigns segments to intersections. In an embodiment, segmentation module **218** accesses initial segmentation configuration data **236** and pre-processed data **226**, and assigns segments from initial segmentation configuration data **236** to item and/or product intersections, as well as one or more features, stored in pre-processed data **226**. Segmentation module **218** stores the assigned segments from initial segmentation configuration data **236** in assigned segments data **238** of strategic and tactical segmentation planner database **114**.

[0082] At activity **518** of comprehensive segment analysis method **500**, segmentation module **218** computes the relative importance of one or more features stored in assigned segments data **238**. According to embodiments, segmentation module **218** may use one or more of any algorithms or processes to compute the relative importance of one or more features stored in assigned segments data **238**, including but not limited to a boundary analysis of how each feature participates in interacting with one or more segments. Segmentation module **218** computes a relative importance score for each of the one or more features stored in assigned segments data **238**. Segmentation module **218** stores the relative importance score for each feature associated with each feature in assigned segments data **238**.

[0083] At activity **520** of comprehensive segment analysis method **500**, segmentation module **218** determines whether to proceed to activity **522** of comprehensive segment analysis method **500** and drop one or more unimportant features, or to proceed to activity **524** of comprehensive segment analysis method **500** and retain assigned segments, features, and intersections. In an embodiment, user interface module **210** may generate a GUI display to visualize one or more relative importance scores for one or more features. Segmentation module **218** may respond to input from user interface module **210**, including but not limited to input to one or more computer input devices **152**

detected by user interface module **210**, to determine whether to proceed to activity **522** or activity **524** of comprehensive segment analysis method **500**.

[0084] At activity **522** of comprehensive segment analysis method **500**, segmentation module **218** drops one or more features. According to embodiments, segmentation module **218** may access the segments, features, intersections, and feature relative importance scores stored in assigned segments data **238**. Segmentation module **218** may drop one or more features associated with relative importance scores lower than a defined threshold. Having dropped one or more features, segmentation module **218** may return to activity **504** of comprehensive segment analysis method **500**, and continue the activities described above.

[0085] At activity **524** of comprehensive segment analysis method **500**, segmentation module **218** retains the assigned segments, features, and intersections. Segmentation module **218** accesses the assigned segments, features, and intersections stored in assigned segments data **238**, and stores data associated with the assigned segments, features, and intersections in strategic segmentation data **228**. Segmentation module **218** then terminates comprehensive segment analysis method **500**.

[0086] FIG. **6** illustrates exemplary agile segment analysis method **600** in which strategic and tactical segmentation planner **110** analyzes segments in an agile scenario, according to an embodiment. The following agile segment analysis method **600** proceeds by one or more activities, which although described in a particular order may be performed in one or more permutations, combinations, orders, or repetitions, according to particular needs.

[0087] At activity **602** of agile segment analysis method **600**, segmentation module **218** selects an algorithm with which to perform auto-segmentation at activity **606** of agile segment analysis method **600**. In an embodiment, segmentation module **218** accesses algorithms data **232**, and selects an algorithm from a selection of one or more algorithms stored in algorithms data **232**, to perform auto-segmentation. According to embodiments, segmentation module **218** may select an algorithm based on whether the data stored in pre-processed data **226** is string-based or numerical-based, with some algorithms tailored for use with string-based data and other algorithms tailored for use with numerical-based data. In other embodiments, user interface module **210** may respond to input made to one or more computer input devices **152**, and may directly select an algorithm from a selection of one or more algorithms stored in algorithms data **232**.

[0088] At activity **604** of agile segment analysis method **600**, segmentation module **218** selects a representative sample from the full data population on which to perform the subsequent activities of agile segment analysis method **600**. At activity **606** of agile segment analysis method **600**, segmentation module **218** determines whether to proceed to activity **608** of agile segment analysis method **600** and receive a specified number of segments from user interface module **210**, or to proceed to activity **612** of agile segment analysis method **600** and perform autonomous multi-dimensional segmentation, including but not limited to computing a number of segments autonomously. Segmentation module **218** may respond to input from user interface module **210**, including but not limited to input to one or more computer input devices **152** detected by user interface module **210**, to determine whether to proceed to activity **608** or activity **612** of agile segment analysis method **600**.

[0089] At activity **608** of agile segment analysis method **600**, segmentation module **218** receives a specified number of segments from user interface module **210**. In an embodiment, user interface module **210** detects input to one or more computer input devices **152** that specifies a given quantity of segments (such as, for example, ten, twenty, fifty, or any other number). User interface module **210** transmits the specified number of segments to segmentation module **218**. Segmentation module **218** stores the specified number of segments in number of segments data **234**, and proceeds to activity **610** of agile segment analysis method **600** to perform multi-dimensional segmentation.

[0090] At activity **610** of agile segment analysis method **600**, segmentation module **218** performs multi-dimensional segmentation. Segmentation module **218** accesses number of segments data **234** and generates an initial segmentation configuration using the number of segments stored in number

of segments data **234**. Segmentation module **218** stores the initial segmentation configuration in initial segmentation configuration data **236**, and proceeds to activity **618** of agile segment analysis method **600** to perform multi-dimensional segment visualization.

[0091] In other embodiments in which segmentation module **218** does not receive a specified number of segments from user interface module **210**, segmentation module **218** proceeds from activity **606** of agile segment analysis method **600** to activity **612** of agile segment analysis method **600** and performs autonomous multi-dimensional segmentation. According to embodiments, segmentation module **218** may use any method or process to perform autonomous multi-dimensional segmentation and compute a number of segments autonomously, including but not limited to an artificial intelligence (AI) or machine learning (ML) segmentation with autonomous selection of features. Having autonomously computed a number of segments, segmentation module **218** stores the number of segments in number of segments data **234**. Segmentation module **218** may generate an initial segmentation configuration using the number of segments stored in number of segments data **234**. Segmentation module **218** stores the initial segmentation configuration in initial segmentation configuration data **236**, and proceeds to activity **614** of agile segment analysis method **600**.

[0092] At activity **614** of agile segment analysis method **600**, strategic and tactical segmentation planner **110** publishes the number of segments that were computed during activity **612** of agile segment analysis method **600**. According to embodiments, user interface module **210** may access the number of segments stored in number of segments data **234**, and may generate one or more GUI displays visualizing the number of segments stored in number of segments data **234**. Strategic and tactical segmentation planner **110** proceeds to activity **616** of agile segment analysis method **600** to perform multi-dimensional segment visualization.

[0093] At activity **616** of agile segment analysis method **600**, segmentation module **218** and user interface module **210** perform multi-dimensional segment visualization. User interface module **210** accesses the initial segmentation configuration stored in initial segmentation configuration data **236**, and generates a GUI display visualizing the initial segmentation configuration.

[0094] At activity **618** of agile segment analysis method **600**, segmentation module **218** assigns segments to intersections. In an embodiment, segmentation module **218** accesses initial segmentation configuration data **236** and pre-processed data **226**, and assigns segments from initial segmentation configuration data **236** to item and/or product intersections, as well as one or more features, stored in pre-processed data **226**. Segmentation module **218** stores the assigned segments from initial segmentation configuration data **236** in assigned segments data **238** of strategic and tactical segmentation planner database **114**.

[0095] At activity **620** of agile segment analysis method **600**, segmentation module **218** computes the relative importance of one or more features stored in assigned segments data **238**. According to embodiments, segmentation module **218** may use one or more of any algorithms or processes to compute the relative importance of one or more features stored in assigned segments data **238**, including but not limited to a boundary analysis of how each feature participates in interacting with one or more segments. Segmentation module **218** computes a relative importance score for each of the one or more features stored in assigned segments data **238**. Segmentation module **218** stores the relative importance score for each feature associated with each feature in assigned segments data **238**.

[0096] At activity **622** of agile segment analysis method **600**, segmentation module **218** determines whether to proceed to activity **624** of agile segment analysis method **600** and drop one or more unimportant features, or to proceed to activity **626** of agile segment analysis method **600** and retain assigned segments, features, and intersections. In an embodiment, user interface module **210** may generate a GUI display to visualize one or more relative importance scores for one or more features. Segmentation module **218** may respond to input from user interface module **210**, including but not limited to input to one or more computer input devices **152** detected by user

interface module **210**, to determine whether to proceed to activity **624** or activity **626** of agile segment analysis method **600**.

[0097] At activity **624** of agile segment analysis method **600**, segmentation module **218** drops one or more features. According to embodiments, segmentation module **218** may access the segments, features, intersections, and feature relative importance scores stored in assigned segments data **238**. Segmentation module **218** may drop one or more features associated with relative importance scores lower than a defined threshold. Having dropped one or more features, segmentation module **218** may return to activity **606** of agile segment analysis method **600**, and continue the activities described above.

[0098] At activity **626** of agile segment analysis method **600**, segmentation module **218** retains the assigned segments, features, and intersections. Segmentation module **218** accesses the assigned segments, features, and intersections stored in assigned segments data **238**, and stores data associated with the assigned segments, features, and intersections in strategic segmentation data **228**.

[0099] At activity **628** of agile segment analysis method **600**, data processing module **216** trains one or more supervised machine learning models using the initial segment configuration stored in initial segmentation configuration data **236**. In an embodiment, data processing module **216** trains one or more supervised machine learning models using a sample portion of data stored in input data **220**, pre-processed data **226**, and/or initial segmentation configuration data **236**, stores the one or more supervised machine learning models in machine learning models data **240**, and proceeds to activity **630** of agile segment analysis method **600**.

[0100] At activity **630** of agile segment analysis method **600**, segmentation module **218** predicts segments for one or more remaining segment intersections using the one or more supervised machine learning models. Segmentation module **218** accesses one or more supervised machine learning models stored in machine learning models data **240**, and applies input data **220**, pre-processed data **226**, and/or initial segment configuration data to the one or more supervised machine learning models to predict segments for one or more remaining segment intersections that did not previously receive assigned segments. Segmentation module **218** stores the predicted segments in initial segmentation configuration data **236**. In an embodiment, segmentation module **218** may subsequently use the one or more supervised machine learning models to predict tactical segments while executing activity **706** of tactical segment prediction method **700**, described in greater detail below.

[0101] At activity **632** of agile segment analysis method **600**, segmentation module **218** assigns predicted segments, generated at activity **630** of agile segment analysis method **600**, to intersections. In an embodiment, segmentation module **218** accesses the predicted segments in initial segmentation configuration data **236**, and assigns predicted segments from initial segmentation configuration data **236** to item and/or product intersections, as well as one or more features, stored in pre-processed data **226**. Segmentation module **218** stores the assigned segments from initial segmentation configuration data **236** in assigned segments data **238** of strategic and tactical segmentation planner database **114**, and terminates agile segment analysis method **600**.

[0102] FIG. 7 illustrates tactical segment prediction method **700**, according to an embodiment. The following tactical segment prediction method **700** proceeds by one or more activities, which although described in a particular order may be performed in one or more permutations, combinations, orders, or repetitions, according to particular needs.

[0103] At activity **702** of tactical segment prediction method **700**, data management module **212** manages input data **220** and generates cleansed data **222**. Data management module **212** accesses input data **220** stored in strategic and tactical segmentation planner database **114**, which may, in an embodiment, comprise new data, updated data, or data that is otherwise different, more recent, or more up-to-date than input data **220** previously used during strategic segment generation method **400**. In an embodiment, data management module **212** determines segment intersections based on

input data **220**. Data management module **212** may also transform input data **220** to generate cleansed data **222**. Data transformation may comprise converting input data **220** from one data storage format into another data storage format; copying one or more pre-discovered features stored in input data **220** into cleansed data **222**; removing one or more pre-discovered features stored in input data **220**; and/or any other data modification or cleansing actions. Having generated cleansed data **222**, data management module **212** stores cleansed data **222** in strategic and tactical segmentation planner database **114** cleansed data **222**.

[0104] At activity **704** of tactical segment prediction method **700**, data management module **212** checks cleansed data **222** for data drift. In an embodiment, data management module **212** checks cleansed data **222** for data drift by executing activity **306** of segmentation workflow method **300**, described in greater detail above, to compare a first segment, subset, or portion of cleansed data **222** to a second segment, subset, or portion of cleansed data **222** and/or input data **220** to determine if the first segment, subset or portion has drifted far enough from the second segment, subset or portion as to require the generation of updated strategic segments. In other embodiments, data management module **212** may use any method to check any data for data drift, according to particular needs. If data management module **212** determines that significant data drift has occurred, data management module **212** terminates the activities of tactical segment prediction method **700** and strategic and tactical segmentation planner **110** returns to activity **302** of segmentation workflow method **300** to generate updated strategic segments. However, if data management module **212** determines that no significant drift has occurred, strategic and tactical segmentation planner **110** proceeds to activity **706** of tactical segment prediction method **700**.

[0105] At activity **706** of tactical segment prediction method **700**, segmentation module **218** predicts tactical segments. In an embodiment, segmentation module **218** accesses cleansed data **222**, as well as one or more machine learning models and/or algorithms stored in machine learning models data **240**. Segmentation module **218** uses the one or more machine learning models and/or algorithms to predict one or more tactical segments, tactical segmentation predictions, tactical segment intersections, and/or other tactical segmentation data **230**. In an agile scenario embodiment, segmentation module **218** may use one or more supervised machine learning models, previously trained by data processing module **216** during the activities of agile segment analysis method **600**, to predict tactical segments.

[0106] At activity **708** of tactical segment prediction method **700**, segmentation module **218** stores the one or more tactical segments, tactical segmentation predictions, tactical segment intersections, and/or other tactical segmentation data **230** in tactical segmentation data **230** of the strategic and technical segmentation planner database **114**, and outputs the one or more tactical segments, tactical segmentation predictions, tactical segment intersections, and/or other tactical segmentation data **230** for use throughout supply chain network **100**. As compared to the frequency at which the strategic and technical segmentation planner may generate strategic segments using strategic segment generation method **400**, the strategic and technical segmentation planner may generate and output tactical segmentation predictions more frequently (such as, in an embodiment, generating tactical segmentation predictions daily or weekly). Strategic and tactical segmentation planner **110** may then terminate the activities of tactical segment prediction method **700**.

[0107] To illustrate the operation of strategic and tactical segmentation planner **110** executing the activities of strategic segment generation method **400**, comprehensive segment analysis method **500**, and tactical segment prediction method **700**, the following example is provided. In this example, strategic and tactical segmentation planner **110** accesses input data **220** and generates, at the strategic level on Dec. 1, 2019, five segments **804a-804e** for input data **220** comprising four features (Orders; Forecast Volume; Average Demand Interval (ADI), which represents the number of months in a year, from 1 to 12, in which an item is ordered; and Coefficient of Variation (COV), which represents the volatility of demand for each item sold). In this example, strategic and tactical segmentation planner **110** then executes the activities of tactical segment prediction method **700**

once a day, beginning on Dec. 2, 2019, to predict tactical segments for updated input data **220** without requiring the full re-generation of new strategic segments. Although a particular example of strategic and tactical segmentation planner **110** generating strategic segments and tactical segment predictions is provided herein, embodiments contemplate strategic and tactical segmentation planner **110** implementing the activities of strategic segment generation method **400**, comprehensive segment analysis method **500**, and/or tactical segment prediction method **700**, in any order and with respect to any input data **220**, features, intersections, or other circumstances, according to particular needs.

[0108] In this example, at activity **402** of strategic segment generation method **400**, data management module **212** selects a segmentation workflow depth, manages input data **220**, and generates cleansed data **222**. Data management module **212** responds to input detected by user interface module **210** to select a comprehensive scenario utilizing all available input data **220** on Dec. 1, 2019. Data management module **212** accesses input data **220** stored in strategic and tactical segmentation planner database **114**. In this example, input data **220** comprises Orders data, Forecast Volume data, ADI data, and COV data for a collection of products sold in and transported throughout a supply chain network **100**. Data management module **212** generates cleansed data **222** in a single data storage format and stores cleansed data **222** in strategic and tactical segmentation planner database **114**.

[0109] Continuing the example, at activity **404** of strategic segment generation method **400**, features module **214** discovers features. Features module **214** accesses cleansed data **222** and discovers features in cleansed data **222** to generate features data **224**. In this example, features module **214** discovers four features: Orders, Forecast Volume, ADI, and COV.

[0110] Continuing the example, at activity **406** of strategic segment generation method **400**, data processing module **216** pre-processes features data **224** to generate pre-processed data **226**. At activity **408** of strategic segment generation method **400**, segmentation module **218** performs multi-dimension segmentation on pre-processed data **226** and computes feature importance to generate segments. In this example, segmentation module **218** accesses pre-processed data **226** and performs comprehensive segment analysis method **500** described above to generate segments. Segmentation module **218** begins activity **502** of comprehensive segment analysis method **500** and selects an algorithm with which to perform auto-segmentation at activity **504** of comprehensive segment analysis method **500**. In this example, pre-processed data **226** is numerical-based, and segmentation module **218** selects a numerical-based algorithm with which to perform auto-segmentation.

[0111] Continuing the example, at activity **504** of comprehensive segment analysis method **500**, segmentation module **218** determines that user interface module **210** has not specified a number of segments to use during comprehensive segment analysis method **500**. Segmentation module **218** moves to activity **510** of comprehensive segment analysis method **500** and performs autonomous multi-dimensional segmentation. Segmentation module **218** autonomously computes a number of segments. In the embodiment illustrated by this example, segmentation module **218** chooses, and stores in number of segments data **234**, five segments **804a-804e** at activity **510** of comprehensive segment analysis method **500**. Segmentation module **218** accesses number of segments data **234** and generates an initial segmentation configuration using five segments **804a-804e** stored in number of segments data **234**. Segmentation module **218** stores the initial segmentation configuration in initial segmentation configuration data **236**, and proceeds to activity **512** of comprehensive segment analysis method **500**. At activity **512** of comprehensive segment analysis method **500**, strategic and tactical segmentation planner **110** publishes the number of segments that were computed during activity **510** of comprehensive segment analysis method **500**, and proceeds to activity **514** of comprehensive segment analysis method **500**.

[0112] Continuing the example, at activity **514** of comprehensive segment analysis method **500**, segmentation module **218** and user interface module **210** perform multi-dimensional segment visualization. User interface module **210** accesses the initial segmentation configuration stored in

initial segmentation configuration data **236**, and generates an initial segment configuration display **800** visualizing the initial segmentation configuration.

[0113] FIG. **8** illustrates initial segment configuration display **800**, according to an embodiment. Initial segment configuration display **800** may display for visualization one or more segments and one or more features, according to embodiments. Although particular examples of initial segment configuration displays **800** are illustrated and described herein, embodiments contemplate user interface module **210** generating initial segment configuration displays **800** in any configuration and displaying any data, according to particular needs.

[0114] Continuing the example, initial segment configuration display **800** illustrates five segments **804A-804E** chosen by segmentation module **218** with respect to each segment's relationship to each of Orders **802A**, Forecast Volume **802B**, Average Demand Interval (ADI) **802C**, and Coefficient of Variation (COV) **802D** with respect to the number of SKUs in each segment (SKU Count). ADI indicates the frequency of placing orders in a year for a specific item at a specific location, indexed by a number of months in which an order is placed for an item, that is, from 0 (months) to 12 (months). COV indicates the volatility in demand for a specific item. In an embodiment, COV varies from 0 to 1.

[0115] As illustrated in FIG. **8**, segment **1 804A**, for example, includes 35% of SKUs across all segments, but only 30% of all orders **802A**, 20 of forecast volume **802B**, 10 of ADI **802C**, but 35% of COV **802D**. Similarly, each of segment **804B-804D** show varying levels across measures Orders **802A**, Forecast Volume **802B**, ADI **802C**, and COV **802D**.

[0116] At activity **516** of comprehensive segment analysis method **500**, segmentation module **218** assigns segments to intersections and features. Segmentation module **218** accesses initial segmentation configuration data **236** and pre-processed data **226**, and assigns segments from initial segmentation configuration data **236** to item and/or product intersections, as well as one or more features, stored in pre-processed data **226**. Segmentation module **218** stores the assigned segments from initial segmentation configuration data **236** in assigned segments data **238** of strategic and tactical segmentation planner database **114**.

[0117] Continuing the example, at activity **518** of comprehensive segment analysis method **500**, segmentation module **218** computes the relative importance of one or more features stored in assigned segments data **238**. Segmentation module **218** stores the relative importance score for each feature in assigned segments data **238**. At activity **520** of comprehensive segment analysis method **500**, segmentation module **218** determines that all features are important, and proceeds to activity **524** of comprehensive segment analysis method **500**. Segmentation module **218** retains the assigned segments, features, and intersections, and stores data associated with the assigned segments, features, and intersections in strategic segmentation data **228**. Segmentation module **218** then terminates comprehensive segment analysis method **500**.

[0118] Continuing the example, at activity **410** of strategic segment generation method **400**, user interface module **210** visualizes segment output. User interface module **210** accesses strategic segmentation data **228** and generates one or more GUI displays, suitable for output on one or more computer **150** output devices, to visualize the segment output. At activity **412** of strategic segment generation method **400**, user interface module **210** assigns policy parameters to strategic segmentation data **228**. At activity **414** of strategic segment generation method **400**, data processing module **216** trains a machine learning models (henceforth, "Model X") to predict the tactical segmentation of new data based on the generated segments stored in strategic segmentation data **228**.

[0119] Continuing the example, at activity **702** of tactical segment prediction method **700**, on Dec. 2, 2019, data management module **212** manages input data **220** and generates cleansed data **222**. Data management module **212** accesses input data **220** stored in strategic and tactical segmentation planner database **114**, which in this example contains updated data to reflect data accumulated and uploaded to input data **220** on Dec. 2, 2019. Data management module **212** transforms the Dec. 2,

2019 input data to generate Dec. 2, 2019 cleansed data. Data management module **212** stores the Dec. 2, 2019 cleansed data in strategic and tactical segmentation planner database **114** cleansed data **222**.

[0120] Continuing the example, at activity **704** of tactical segment prediction method **700**, data management module **212** checks the Dec. 2, 2019 cleansed data for data drift. In this example, data management module **212** checks the Dec. 2, 2019 cleansed data for data drift by comparing the Dec. 2, 2019 cleansed data to input data **220** available on Dec. 1, 2019 to determine if the Dec. 2, 2019 cleansed data has drifted far enough from the Dec. 1, 2019 input data so as to require the generation of updated strategic segments. In this example, data management module **212** determines that minimal data drift has occurred, and strategic and tactical segmentation planner **110** proceeds to activity **706** of tactical segment prediction method **700**.

[0121] Continuing the example, at activity **706** of tactical segment prediction method **700**, segmentation module **218** predicts tactical segments for the Dec. 2, 2019 cleansed data. Segmentation module **218** accesses the Dec. 2, 2019 cleansed data and Model X stored in machine learning models data **240**. In this example, segmentation module **218** uses Model X to predict tactical segments and tactical segment intersections related to the Dec. 2, 2019 cleansed data.

[0122] Continuing the example, at activity **708** of tactical segment prediction method **700**, segmentation module **218** stores the predicted tactical segments and tactical segment intersections relating to the Dec. 2, 2019 cleansed data in tactical segmentation data **230**. In this example, strategic and tactical segmentation planner **110** continues to execute the activities of tactical segment prediction method **700** on a daily basis (beginning with Dec. 3, 2019, and continuing daily thereafter) to predict tactical segments and tactical segment intersections for the up-to-date cleansed data. In this example, this methodology continues until Jan. 1, 2020, on which day data management module **212** determines, at activity **704** of tactical segment prediction method **700**, that significant data drift has occurred between the Jan. 1, 2020 cleansed data and the Dec. 1, 2019 input data. In this example, user interface module **210** accesses input data **220** and cleansed data **222**, and generates data drift display **900**, illustrated by FIG. 9, to visualize the data drift between the Dec. 1, 2019 input data and the Jan. 1, 2020 cleansed data.

[0123] FIG. 9 illustrates exemplary data drift display **900**, according to an embodiment. Data drift display **900** comprises histograms of intersections **902A** and **902B** for the ADI and COV features from Dec. 1, 2019 to Jan. 1, 2020. Although FIG. 9 illustrates data drift display **900** in a particular configuration, embodiments contemplate strategic and tactical segmentation planner **110** generating and displaying data drift displays **900** in any configuration and displaying any database data, according to particular needs.

[0124] In this embodiment, strategic and tactical segmentation planner **110** has performed a drift analysis and determined that ADI and COV are the most important features over the relevant data set. The data drift analysis indicates that the ADI and COV features have experienced significant drift from the **2019** dataset to the **2020** dataset. In this embodiment, and as shown in FIG. 9, monthly demand, order quantities and order lines distributions remain similar. In general, if a drift analysis indicates that data drift has occurred, a strategic segmentation run may be appropriate. The example shown in FIG. 9 shows a strong data drift has occurred, indicating that a strategic, rather than tactical, segmentation run is appropriate for the dataset shown in FIG. 9. If a data drift analysis showed there was little or no data drift, a more light-weight tactical segmentation run could instead be performed.

[0125] Concluding the example, data management module **212** determines that significant data drift has occurred, terminates the activities of tactical segment prediction method **700**, and strategic and tactical segmentation planner **110** returns to activity **302** of segmentation workflow method **300** to generate updated strategic segments and continue the activities described above.

[0126] Reference in the foregoing specification to “one embodiment”, “an embodiment”, or “some embodiments” means that a particular feature, structure, or characteristic described in connection

with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase “in one embodiment” in various places in the specification are not necessarily all referring to the same embodiment.

[0127] While the exemplary embodiments have been shown and described, it will be understood that various changes and modifications to the foregoing embodiments may become apparent to those skilled in the art without departing from the spirit and scope of the present invention.

Claims

1. A system for comprehensive segment analysis, comprising: a supply chain network comprising a segmentation planner, an inventory system, a transportation network and one or more supply chain entities, the segmentation planner further comprising a computer and a database, the computer comprising a memory and a processor, the computer configured to: select an algorithm with which to perform auto-segmentation; in response to receiving a selection, autonomously perform multi-dimensional segmentation to compute a number of segments; in response to receiving a specified number of segments, generate an initial segmentation configuration using the specified number of segments; perform multi-dimensional segment visualization based on the received selection or based on the received specified number of segments; assign segments to item and product intersections; compute a relative importance of one or more features; drop any feature associated with a relative importance score lower than a defined threshold; and retain and store the assigned segments, the item and product intersections and any feature which has not been dropped.
2. The system of claim 1, wherein the algorithm is selected based on whether data stored in pre-processed data is string-based or numerical-based.
3. The system of claim 1, wherein the computer is further configured to: assign segments to the one or more features.
4. The system of claim 1, wherein the relative importance score is computed based on a boundary analysis of how each feature participates in interacting with one or more segments.
5. The system of claim 1, wherein the one or more features comprise one or more of: orders, forecast volume, average demand interval and coefficient of variation.
6. The system of claim 1, wherein the computer is further configured to: in response to one or more features being dropped, repeat the receiving a selection.
7. The system of claim 1, wherein the computer is further configured to: in response to one or more features being dropped, repeat the receiving a specified number of segments.
8. A computer-implemented method for comprehensive segment analysis, comprising: selecting, by a computer comprising a memory and a processor, an algorithm with which to perform auto-segmentation; in response to receiving a selection, autonomously performing, by the computer, multi-dimensional segmentation to compute a number of segments; in response to receiving a specified number of segments, generating, by the computer, an initial segmentation configuration using the specified number of segments; performing, by the computer, multi-dimensional segment visualization based on the received selection or based on the received specified number of segments; assigning, by the computer, segments to item and product intersections; computing, by the computer, a relative importance of one or more features; dropping, by the computer, any feature associated with a relative importance score lower than a defined threshold; and retaining and storing, by the computer, the assigned segments, the item and product intersections and any feature which has not been dropped.
9. The computer-implemented method of claim 8, wherein the algorithm is selected based on whether data stored in pre-processed data is string-based or numerical-based.
10. The computer-implemented method of claim 8, further comprising: assigning, by the computer, segments to the one or more features.
11. The computer-implemented method of claim 8, wherein the relative importance score is

- computed based on a boundary analysis of how each feature participates in interacting with one or more segments.
- 12.** The computer-implemented method of claim 11, wherein the one or more features comprise one or more of: orders, forecast volume, average demand interval and coefficient of variation.
- 13.** The computer-implemented method of claim 12, further comprising: in response to one or more features being dropped, repeating, by the computer, the receiving a selection.
- 14.** The computer-implemented method of claim 8, further comprising: in response to one or more features being dropped, repeating, by the computer, the receiving a specified number of segments.
- 15.** A non-transitory computer-readable medium embodied with software for comprehensive segment analysis, the software when executed using one or more computers is autonomously configured to: select an algorithm with which to perform auto-segmentation; in response to receiving a selection, autonomously perform multi-dimensional segmentation to compute a number of segments; in response to receiving a specified number of segments, generate an initial segmentation configuration using the specified number of segments; perform multi-dimensional segment visualization based on the received selection or based on the received specified number of segments; assign segments to item and product intersections; compute a relative importance of one or more features; drop any feature associated with a relative importance score lower than a defined threshold; and retain and store the assigned segments, the item and product intersections and any feature which has not been dropped.
- 16.** The non-transitory computer-readable medium of claim 15, wherein the algorithm is selected based on whether data stored in pre-processed data is string-based or numerical-based.
- 17.** The non-transitory computer-readable medium of claim 15, further comprising: assigning, by the computer, segments to the one or more features.
- 18.** The non-transitory computer-readable medium of claim 15, wherein the relative importance score is computed based on a boundary analysis of how each feature participates in interacting with one or more segments.
- 19.** The non-transitory computer-readable medium of claim 18, wherein the one or more features comprise one or more of: orders, forecast volume, average demand interval and coefficient of variation.
- 20.** The non-transitory computer-readable medium of claim 19, wherein the software when executed is further configured to: in response to one or more features being dropped, repeat the receiving a selection; or in response to one or more features being dropped, repeat the receiving a specified number of segments.
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