[0072] As used herein, the term “computing device” may refer to one or more electronic devices configured to process data. A computing device may, in some examples, include the necessary components to receive, process, and output data, such as a processor, a display, a memory, an input device, a network interface, and/or the like. A computing device may be a mobile device. As an example, a mobile device may include a cellular phone (e.g., a smartphone or standard cellular phone), a portable computer (e.g., laptop computer, a tablet computer, and/or the like), a wearable device (e.g., watches, glasses, lenses, clothing, and/or the like), a personal digital assistant (PDA), and/or other like devices. A computing device may also be a desktop computer or other form of non-mobile computer.

[0073] As used herein, the term “server” may refer to or include one or more computing devices that are operated by or facilitate communication and processing for multiple parties in a network environment, such as the Internet, although it will be appreciated that communication may be facilitated over one or more public or private network environments and that various other arrangements are possible. Further, multiple computing devices (e.g., servers, point-of-sale (POS) devices, mobile devices, etc.) directly or indirectly communicating in the network environment may constitute a “system.”

[0074] As used herein, the term “system” may refer to one or more computing devices or combinations of computing devices (e.g., processors, servers, client devices, software applications, components of such, and/or the like). Reference to “a device,” “a server,” “a processor,” and/or the like, as used herein, may refer to a previously-recited device, server, or processor that is recited as performing a previous step or function, a different device, server, or processor, and/or a combination of devices, servers, and/or processors. For example, as used in the specification and the claims, a first device, a first server, or a first processor that is recited as performing a first step or a first function may refer to the same or different device, server, or processor recited as performing a second step or a second function.

[0075] Non-limiting embodiments or aspects of the disclosed subject matter are directed to systems, methods, and computer program products for generating and improving multitask learning models. For example, non-limiting embodiments or aspects of the disclosed subject matter provide determining a baseline accuracy metric based on multiple single-task machine learning models, receiving a first multitask learning model with at least one shared layer, determining a number of

connection, indirectly via communication network 112, and/or the like). For example, user device 106 may include a computing device, such as a mobile device, a portable computer, a desktop computer, and/or other like devices. Additionally or alternatively, each user device 106 may include a device capable of receiving information from and/or communicating information to other user devices 106 (e.g., directly via wired or wireless communication connection, indirectly via communication network 112, and/or the like). In some non-limiting embodiments or aspects, user device 106 may be part of machine learning model system 102 and/or part of the same system as machine learning model system 102. For example, machine learning model system 102, database 104, and user device 106 may all be (and/or be part of) a single system and/or a single computing device.

[0083] Communication network 112 may include one or more wired and/or wireless networks. For example, communication network 112 may include a cellular network (e.g., a long-term evolution (LTE®) network, a third generation (3G) network, a fourth generation (4G) network, a fifth generation (5G) network, a code division multiple access (CDMA) network, and/or the like), a public land mobile network (PLMN), a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), a telephone network (e.g., the public switched telephone network (PSTN)), a private network (e.g., a private network associated with a transaction service provider), an ad hoc network, an intranet, the Internet, a fiber optic-based network, a cloud computing network, and/or the like, and/or a combination of these or other types of networks.

[0084] The number and arrangement of systems and devices shown in FIG. 1 are provided as an example. There may be additional systems and/or devices, fewer systems and/or devices, different systems and/or devices, and/or differently arranged systems and/or devices than those shown in FIG. 1. Furthermore, two or more systems or devices shown in FIG. 1 may be implemented within a single system or device, or a single system or device shown in FIG. 1 may be implemented as multiple, distributed systems or devices. Additionally or alternatively, a set of systems (e.g., one or more systems) or a set of devices (e.g., one or more devices) of system 100 may perform one or more functions described as being performed by another set of systems or another set of devices of system 100.

[0085] Referring now to FIG. 2A, shown is an example process 200a for generating and improving multitask learning models, according to some non-limiting embodiments or aspects. The steps shown in FIG. 2A are for example purposes only.

[0109] In some non-limiting embodiments or aspects, determining a value (e.g., target value) for each sharing weight may include at least some steps of process 200c of FIG. 2C, as described herein.

[0110] In some non-limiting embodiments or aspects, the at least one third accuracy metric may include a plurality of accuracy metrics, as described herein. Machine learning model system 102 may determine a range of values for the plurality of sharing weights, as described herein. Machine learning model system 102 may determine the plurality of accuracy metrics comprising a respective accuracy metric associated with each respective sharing weight of the plurality of sharing weights having a respective value within the range of values, as described herein. Machine learning model system 102 may determine the value for each sharing weight of the plurality of sharing weights based on the plurality of accuracy metrics.

[0111] As shown in FIG. 2A, at step 212, process 200a may include receiving (and/or generating) a combined multitask learning model with shared layer(s), sharing weights, and task-specific layers. For example, machine learning model system 102 may receive a combined multitask learning model comprising a plurality of shared layers based on the determined (e.g., target) number of shared layers, a second plurality of sharing weights based on the determined (e.g., target) value for each sharing weight of the plurality of sharing weights, and a third plurality of task-specific layers. Each task-specific layer of the third plurality of task-specific layers associated with one of the plurality of tasks.

[0112] In some non-limiting embodiments or aspects, the combined multitask learning model may include a third deep neural network. For example, the third multitask learning model may include at least one of a neural network, a fully connected neural network, a convolutional neural network, a tree-based encoder, a cross-stitch network, any combination thereof, and/or the like.

[0113] In some non-limiting embodiments or aspects, the combined multitask learning model may be the same as or similar to combined multitask learning model 500c of FIG. 5C. Referring now to FIG. 5C, and with continued reference to FIG. 2A, FIG. 5C shows a schematic diagram of combined multitask learning model 500c, according to some non-limiting embodiments or aspects. As shown in FIG. 5C, multitask learning model 500c may include an input layer 531, at least one shared layer 532 (e.g., a plurality of shared layers 532), a plurality of task-specific layers (e.g., first task-specific layers 533-1 and second task-specific layers 533-2, individually

[0168] Communication network 312 may include one or more wired and/or wireless networks. For example, communication network 312 may include a cellular network (e.g., a long-term evolution (LTE®) network, a third generation (3G) network, a fourth generation (4G) network, a fifth generation (5G) network, a code division multiple access (CDMA) network, and/or the like), a public land mobile network (PLMN), a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), a telephone network (e.g., the public switched telephone network (PSTN)), a private network (e.g., a private network associated with a transaction service provider), an ad hoc network, an intranet, the Internet, a fiber optic-based network, a cloud computing network, and/or the like, and/or a combination of these or other types of networks.

[0169] For the purpose of illustration, processing a transaction may include generating a transaction message (e.g., authorization request and/or the like) based on an account identifier of a customer (e.g., associated with customer device 306 and/or the like) and/or transaction data associated with the transaction. For example, merchant system 308 (e.g., a client device of merchant system 308, a POS device of merchant system 308, and/or the like) may initiate the transaction, e.g., by generating an authorization request (e.g., in response to receiving the account identifier from a portable financial device of the customer and/or the like). Additionally or alternatively, merchant system 308 may communicate the authorization request to acquirer system 310. Additionally or alternatively, acquirer system 310 may communicate the authorization request to transaction service provider system 302. Additionally or alternatively, transaction service provider system 302 may communicate the authorization request to issuer system 304. Issuer system 304 may determine an authorization decision (e.g., authorize, decline, and/or the like) based on the authorization request, and/or issuer system 304 may generate an authorization response based on the authorization decision and/or the authorization request. Additionally or alternatively, issuer system 304 may communicate the authorization response to transaction service provider system 302. Additionally or alternatively, transaction service provider system 302 may communicate the authorization response to acquirer system 310, which may communicate the authorization response to merchant system 308.

[0170] For the purpose of illustration, clearing and/or settlement of a transaction may include generating a message (e.g., clearing message and/or the like) based on an account identifier of a customer (e.g., associated with customer device 306 and/or

WHAT IS CLAIMED IS:

1. A computer-implemented method, comprising:

determining, with at least one processor, a first accuracy metric based on at least two machine learning models performing a plurality of tasks, each machine learning model of the at least two machine learning models associated with a single task of the plurality of tasks, each machine learning model of the at least two machine learning models having a number of layers;

receiving, with at least one processor, a multitask learning model comprising at least one shared layer and a plurality of task-specific layers, each task-specific layer of the plurality of task-specific layers associated with one of the plurality of tasks;

initializing, with at least one processor, a counter variable;

determining, with at least one processor, a second accuracy metric based on the multitask learning model having a first number of shared layers equal to the number of layers minus the counter variable;

determining, with at least one processor, a third accuracy metric based on the multitask learning model having a second number of shared layers equal to the counter variable plus one;

comparing, with at least one processor, the first accuracy metric, the second accuracy metric, and the third accuracy metric;

repeating, with at least one processor, until at least one termination condition is satisfied:

incrementing the counter variable;

at least one of determining the second accuracy metric or determining the third accuracy metric based on comparing the first accuracy metric, the second accuracy metric, and the third accuracy metric and incrementing the counter variable; and

comparing the first accuracy metric, the second accuracy metric, and the third accuracy metric; and

determining, with at least one processor, a target number of shared layers for the multitask learning model based on at least one of the second accuracy metric, the third accuracy metric, the first number of shared layers, the second number of shared layers, or any combination thereof.

2. The method of claim 1, wherein the multitask learning model comprises a deep neural network.

3. The method of claim 2, wherein the deep neural network comprises:

an input layer;

the at least one shared layer; and

the plurality of task-specific layers, wherein the plurality of task-specific layers comprise at least one first task-specific layer associated with a first task of the plurality of tasks and at least one second task-specific layer associated with a second task of the plurality of tasks.

4. The method of claim 3, wherein the at least one first task-specific layer comprises a first task-specific output layer, and

wherein the at least one second task-specific layer comprises a second task-specific output layer.

5. The method of claim 1, wherein the first accuracy metric comprises an average accuracy metric based on a respective accuracy metric for each respective machine learning model of the at least two machine learning models.

6. The method of claim 5, wherein the average accuracy metric comprises a first F1 score,

wherein each respective accuracy metric comprises a respective F1 score for the respective machine learning model of the at least two machine learning models,

wherein the second accuracy metric comprises a second F1 score, and

wherein the third accuracy metric comprises a third F1 score.

7. The method of claim 1, wherein comparing the first accuracy metric, the second accuracy metric, and the third accuracy metric comprises determining that the second accuracy metric is greater than the first accuracy metric and the third accuracy metric,

wherein repeating at least one of determining the second accuracy metric or determining the third accuracy metric comprises:

replacing the first accuracy metric with the second accuracy metric; and

repeating determining the second accuracy metric.

8. The method of claim 1, wherein comparing the first accuracy metric, the second accuracy metric, and the third accuracy metric comprises determining that the third accuracy metric is greater than the first accuracy metric and the second accuracy metric,

wherein repeating at least one of determining the second accuracy metric or determining the third accuracy metric comprises:

replacing the first accuracy metric with the third accuracy metric; and

repeating determining the third accuracy metric.

9. The method of claim 1, wherein comparing the first accuracy metric, the second accuracy metric, and the third accuracy metric comprises determining that the first accuracy metric is greater than the second accuracy metric and the third accuracy metric,

wherein repeating at least one of determining the second accuracy metric or determining the third accuracy metric comprises:

repeating determining the second accuracy metric and determining the third accuracy metric.

10. A system comprising:

at least one processor configured to perform the method of any of claims 1-9.

11. A computer program product comprising at least one non-transitory computer-readable medium including program instructions that, when executed by at least one processor, cause the at least one processor to perform the method of any of claims 1-9.