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Drafting US Patent Claims for Artificial Intelligence Inventions in Healthcare

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Artificial Intelligence is Coming to Healthcare and Other Industries

Outline of the Presentation

- Introduction
- Relevant US Case Law
- Written Description and Functional Claiming with Artificial Intelligence
- Sample Artificial Intelligence Patents in Healthcare

Introduction

Training and Use of Machine Learning Program

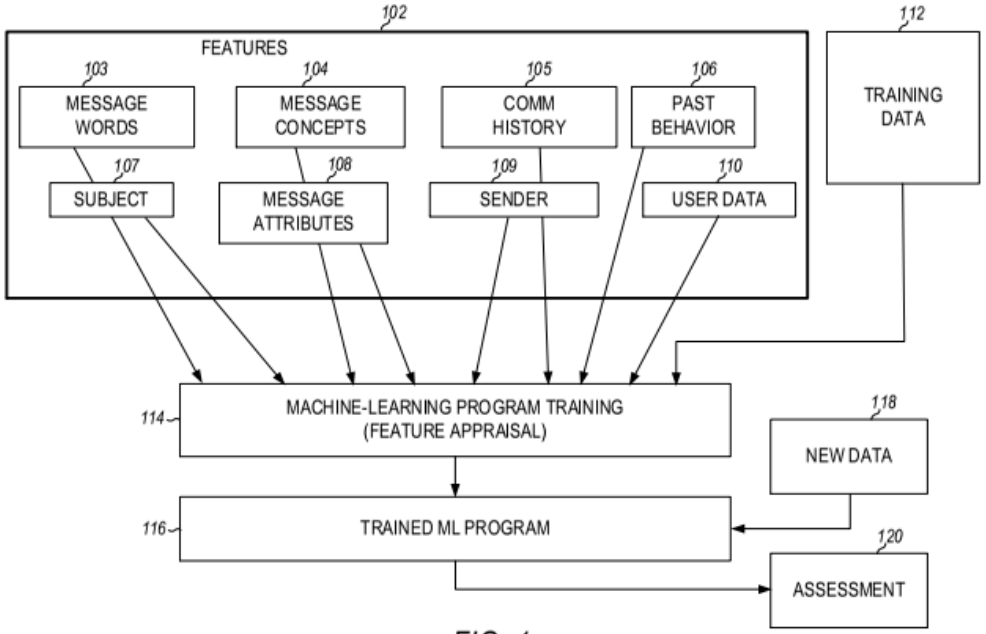

FIG. 1

General Rules

- Don’t leave the invention out of the claim
- Claim the “how to,” not just the “what”
- Tie in practical application
  - Balance the trade-off between breadth and patentability
- Consider detectability and infringement scenarios
  - Training vs. inference

Prosecution Obstacles

- Anything can be a model
  - Learning from data, not heuristics
- Done with pen and paper
  - No “machine learning” without “machine”
- Mention of machine learning in prior art reference implies all applications of machine learning are covered
  - Show distinguishing technical details
  - Show technical details in the claims
  - Focus on novelty

Relevant US Case Law

Enfish, LLC v. Microsoft Corp. (Fed Cir. 2016)

- U.S. Patent Nos. 6,151,604 and 6,163,775
- The claims recited a self-referential table, a specific type of data structure designed to improve the way a computer stores and retrieves data in memory.
  - "means for configuring"
  - Specification included a 4 step algorithm for configuring a self-referential table
- A self-referential table for a computer database
- Patent eligible because the claims are directed to an improvement of the functioning of the computer.
- Claims a specific improvement to computer technology

Thales Visionix, Inc. v. United States (Fed. Cir. 2017)

- U.S. Patent No. 6,474,159
- The claims disclose an inertial tracking system for tracking the motion of an object relative to a moving reference frame.
- Sensors that automatically calculated the position, orientation, and velocity of an object in 3-D space
- **Patent eligible because the claims are directed to systems and methods that use inertial sensors in a non-conventional manner to reduce errors in measuring the relative position and orientation of a moving object on a moving reference frame.**
- <u>Claims application or use of data, not just generation</u>

US Patent No. 6,474,159 – Claim 1

1. A system for tracking the motion of an object relative to a moving reference frame, comprising:

a first inertial sensor mounted on the tracked object;

a second inertial sensor mounted on the moving reference frame; and

an element adapted to receive signals from said first and second inertial sensors and configured to determine an orientation of the object relative to the moving reference frame based on the signals received from the first and second inertial sensors.

McRO, Inc. v. Bandai Namco Games America Inc. (Fed. Cir. 2016)

- U.S. Patent Nos. 6,307,576 and 6,611,278
- A patent claiming a method for automating part of a preexisting 3D animation
- Automating the facial expressions of animated characters through rule sets
- The court found that the process recites a combined order of specific rules that renders information into a specific format and was patent eligible.
- Include implementation details in the claims

US Patent No. 6,307,576 – Claim 1

Implementation details

1. A method for automatically animating lip synchronization and facial expression of three-dimensional characters comprising:

obtaining a first set of rules that define output morph weight set stream as a function of phoneme sequence and time of said phoneme sequence;

obtaining a timed data file of phonemes having a plurality of sub-sequences;

generating an intermediate stream of output morph weight sets and a plurality of transition parameters between two adjacent morph weight sets by evaluating said plurality of sub-sequences against said first set of rules;

generating a final stream of output morph weight sets at a desired frame rate from said intermediate stream of output morph weight sets and said plurality of transition parameters; and

applying said final stream of output morph weight sets to a sequence of animated characters to produce lip synchronization and facial expression control of said animated characters.

Vehicle Intelligence and Safety LLC v. Mercedes-Benz USA, LLC, (Fed. Cir. 2015)

- US Patent No. 7,394,392
- Claims methods and systems that screen equipment operators for impairment, selectively test those operators, and control the equipment if an impairment is detected.
- An “expert system” that detects potential impairment in an operator and controls the operation of equipment if an impairment is detected.
- Patent invalid for being drawn to a patent -ineligible concept, specifically the abstract idea of testing operators of any kind of physical or mental impairment.
- Avoid black box terminology

US Patent No. 7,394,392 – Claim 8

8. A method to screen an equipment operator for impairment, comprising:

screening an equipment operator by one or more expert systems to detect potential impairment of said equipment operator;

selectively testing said equipment operator when said screening of said equipment operator detects potential impairment of said equipment operator; and

controlling operation of said equipment if said selective testing of said equipment operator indicates said impairment of said equipment operator, wherein said screening of said equipment operator includes a time-sharing allocation of at least one processor executing at least one expert system.

Written Description and Functional Claiming with Artificial Intelligence

Capturing AI Inventions Using Functional Claiming

35 USC 112: Written Description and Means + Function

- (a) The specification shall contain ***a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms*** to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.
- (f) An ***element in a claim for a combination may be expressed as a means*** or step for performing a specified function ***without the recital of structure***, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Functional Claiming Pre-*Williamson*: The Presumption

- A claim element that explicitly recites a **"means for"** performing a function is presumed to invoke the statutory construction of § 112(f) / Pre-AIA ¶ 6
- A claim element that lacks the word "means" is presumed <u>not</u> to invoke the statutory construction
  - ***Previously***, the presumption flowing from the absence of the term "means" was characterized as ***"a strong one that is not readily overcome."***
  - The statutory construction was not applied unless the limitation was "essentially …***devoid*** of anything that can be construed as structure."

Post-*Williamson*

- Abandons characterizing as “strong” the presumption that a limitation lacking “means” is not subject to § 112 (6)
- Overrules the strict requirement of a showing that the limitation essentially is ***devoid*** of anything that can be construed as structure
- Standard is instead: “…*whether the words of the claim are understood by persons of ordinary skill in the art to have* ***sufficiently definite*** *meaning as the name for structure*.”

"Nonce" Words (MPEP § 2181)

Courts have held the following to invoke § 112(f)/¶ 6:

- Module for
- Unit for
- Device for
- Mechanism for
- Element for
- System for
- Component for
- Member for
- Apparatus for
- Machine for

Courts have held the following not to invoke § 112(f)/¶ 6:

- Circuitry / circuit for
- Processor
- Computing unit
- Detent mechanism
- Digital detector for
- Reciprocating member
- Connector assembly
- Hanger member

MPEP 2181: §112(f) Claims Must Satisfy §112(b)

- "If one employs means plus function language in a claim, *one must set forth in the specification an adequate disclosure showing what is meant by that language.* If an applicant fails to set forth an adequate disclosure, the applicant has in effect failed to particularly point out and distinctly claim the invention as required by the second paragraph of section 112."
- **Test:** Is the corresponding structure of a means-plus function claim disclosed in the specification in a way that one skilled in the art will understand what structure will perform the recited function?
- If not, claim is indefinite and, therefore, invalid

Functional Claiming: Meeting Disclosure Requirements

- Need disclosure of structure that corresponds to the claimed function
- Disclosure of a general purpose computer not enough when element must be implemented in special purpose computer
- Requires an algorithm for performing the function expressed as: a formula, prose, flow charts, ...
- Expert declaration that a person of ordinary skill in the art would know what structure is needed is not enough:
  - Patentee's expert testified: "as one of ordinary skill in the art, reading the specification, I would know exactly how to program a computer to perform the recited functions…[and the structure could be either hardware or software]"
- Illustrations in the specification of the function being performed (e.g., displays) is not a substitute for disclosure of an algorithm

Additional § 112(f) Limitations in Software-Related Claims

- Programmed computer functions require a computer programmed with an "algorithm" to perform the function
  - Specialized functions: functions other than those commonly known in the art, often described by courts as requiring "special programming" for a general purpose computer.
    - E.g. "Event detection system that communicates network event information"
    - *Requires disclosure of an algorithm*
  - Non-specialized functions: functions known by those of ordinary skill in the art as being commonly performed by a general purpose computer or computer component
    - E.g. means for storing data

Avoiding Indefiniteness When Claiming AI

- *Gradient Enters. v. Skype Techs.*, 2015 U.S. Dist. LEXIS 126790 (W.D.N.Y. Sept. 22, 2015)
  - U.S. Patent No. 7,669,207 – Claim 27
  - Skype successfully argued the system claims, Claim 27 and its dependent claims, are invalid under *§ 112(f)* because the patent fails to disclose adequate structure corresponding to the claimed function.

US Patent No. 7,669,207 – Claim 27

27. A system for detecting, reporting and responding to network node-level occurrences on a network-wide level, the system comprising:

a plurality of mobile agents, each of the mobile agents is hosted by one of a plurality of nodes in a network which each detect for one or more events;

a designation system that designates one of the mobile agents hosted at one of the nodes as a controlling mobile agent and designates another one of the mobile agents hosted at another one of the nodes as the controlling mobile agent when the one of the mobile agents previously designated as the controlling mobile agent is unavailable;

an event detection system that communicates network event information associated with an event detected at one or more of the nodes in the network to the controlling mobile agent; and

“Designation System”

28. The system as set forth in claim **27** wherein the designation system determines which one of the nodes is best suited to host the controlling mobile agent and selects the one of the nodes to host the controlling mobile agent based on the determination.

29. The system as set forth in claim **28** wherein the designation system utilizes at least one of a voting and an artificial intelligence algorithm to determine which one or more of the nodes is best suited to host the controlling mobile agent.

32. The system as set forth in claim **27** wherein the designation system determines when the one of the mobile agents previously designated as the controlling mobile agent is unavailable.

Sample Artificial Intelligence Patents in Healthcare

To the best of my knowledge, none of these patents were drafted, prosecuted or assigned to SLW or Greg Rabin.

All statements about patent validity or patent scope are the speaker's opinion only and do NOT constitute legal advice.

US Patent No. 10,354,171

- Title: Deep learning medical systems and methods for image reconstruction and quality evaluation
- Assignee: General Electric Co.
- Claim 1 as allowed is almost identical to claim 1 as originally filed (minor readability amendment)

(12) **United States Patent**
Hsieh et al.

(10) **Patent No.: US 10,354,171 B2**
(45) **Date of Patent: *Jul. 16, 2019**

(54) **DEEP LEARNING MEDICAL SYSTEMS AND METHODS FOR IMAGE RECONSTRUCTION AND QUALITY EVALUATION**

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Jiang Hsieh**, Waukesha, WI (US); **Gopal Avinash**, San Ramon, CA (US); **Saad Sirohey**, Pewaukee, WI (US); **Xin Wang**, Clifton Park, NY (US); **Zhye Yin**, Schenectady, NY (US); **Bruno De Man**, Niskayuna, NY (US)

(73) Assignee: **General Electric Company**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/126,762**

(22) Filed: **Sep. 10, 2018**

(65) **Prior Publication Data**

US 2019/0026608 A1 Jan. 24, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/360,742, filed on Nov. 23, 2016, now Pat. No. 10,074,038.

(51) **Int. Cl.**
G06K 9/00 (2006.01)
G06K 9/62 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06K 9/6265*** (2013.01); ***G06K 9/036*** (2013.01); ***G06K 9/4604*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G06K 9/6265; G06K 9/4604; G06N 3/04; G06N 3/08; G06T 7/0012;
(Continued)

(56) **References Cited**

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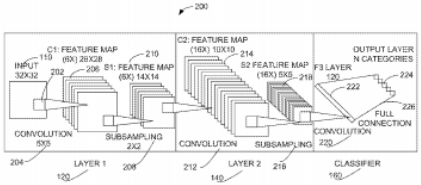
(Continued)

Primary Examiner — Shefali D Goradia
(74) *Attorney, Agent, or Firm* — Hanley, Flight and Zimmerman, LLC

(57) **ABSTRACT**

Methods and apparatus to automatically generate an image quality metric for an image are provided. An example method includes automatically processing a first medical image using a deployed learning network model to generate an image quality metric for the first medical image, the deployed learning network model generated from a digital learning and improvement factory including a training network, wherein the training network is tuned using a set of labeled reference medical images of a plurality of image types, and wherein a label associated with each of the labeled reference medical images indicates a central tendency metric associated with image quality of the image. The example method includes computing the image quality metric associated with the first medical image using the deployed learning network model by leveraging labels and associated central tendency metrics to determine the associated image quality metric for the first medical image.

20 Claims, 42 Drawing Sheets



US Patent No. 10,354,171

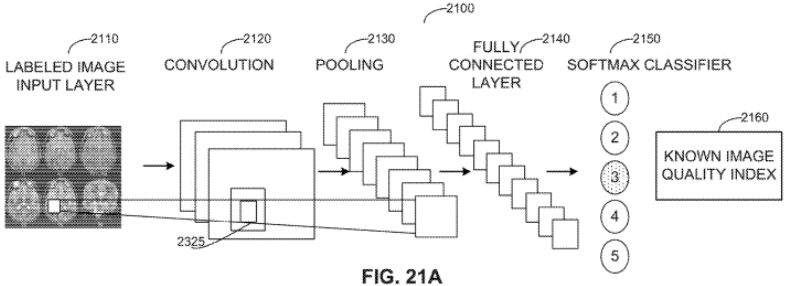


FIG. 21A

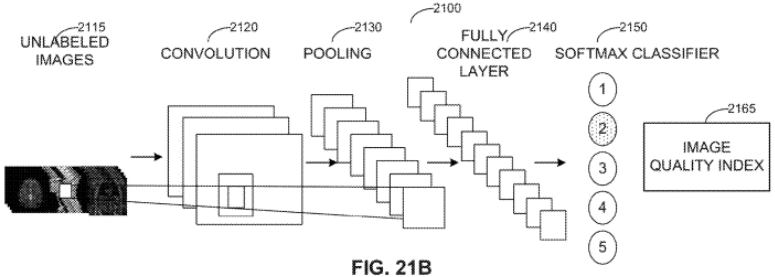


FIG. 21B

US Patent No. 10,354,171

1. An imaging system comprising:

at least one processor and at least one memory configured to implement a deployed learning network model, the deployed learning network model generated from a training network, wherein the training network is tuned using features extracted from a set of labeled reference medical images, and wherein a label associated with each of the labeled reference medical images indicates an image quality metric for the respective medical image, the features associated with a target value for the image quality metric, the at least one processor configured to at least:

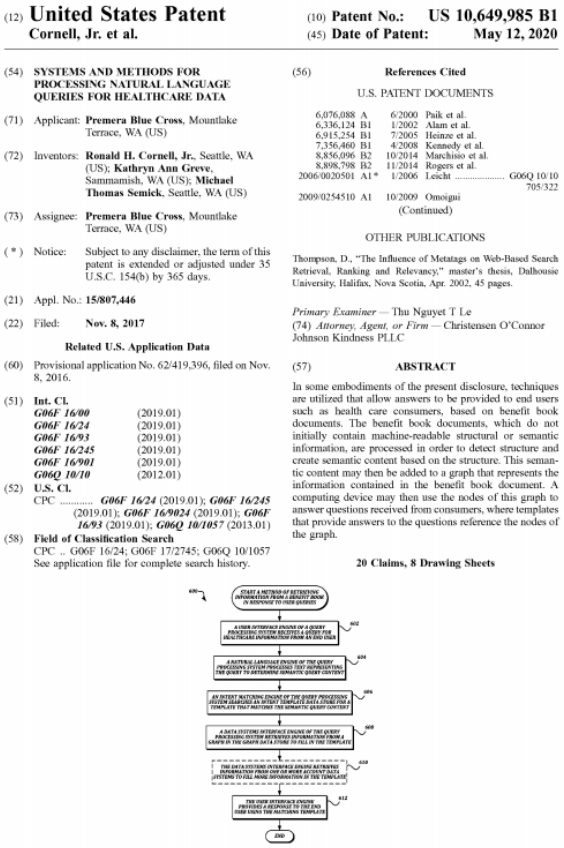
automatically process a first medical image using the deployed learning network model to generate an image quality metric for the first medical image; and

compute the image quality metric associated with the first medical image using the deployed learning network model by leveraging the features and associated target value for the image quality metric to determine the associated image quality metric for the first medical image; and

a display to output the first medical image and the associated image quality metric.

US Patent No. 10,649,985

- Title: Systems and methods for processing natural language queries for healthcare data
- Assignee:Premera Blue Cross
- Allowed as filed!



(12) **United States Patent**
Cornell, Jr. et al.

(10) **Patent No.: US 10,649,985 B1**
(45) **Date of Patent: May 12, 2020**

(54) **SYSTEMS AND METHODS FOR PROCESSING NATURAL LANGUAGE QUERIES FOR HEALTHCARE DATA**

(71) Applicant: **Premera Blue Cross**, Mountlake Terrace, WA (US)

(72) Inventors: **Ronald H. Cornell, Jr.**, Seattle, WA (US); **Kathryn Ann Greve**, Sammamish, WA (US); **Michael Thomas Semick**, Seattle, WA (US)

(73) Assignee: **Premera Blue Cross**, Mountlake Terrace, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 365 days.

(21) Appl. No.: **15/807,446**

(22) Filed: **Nov. 8, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/419,396, filed on Nov. 8, 2016.

(51) **Int. Cl.**
G06F 16/00 (2019.01)
G06F 16/24 (2019.01)
G06F 16/93 (2019.01)
G06F 16/245 (2019.01)
G06F 16/901 (2019.01)
G06Q 10/10 (2012.01)

(52) **U.S. Cl.**
CPC ***G06F 16/24*** (2019.01); ***G06F 16/245*** (2019.01); ***G06F 16/9024*** (2019.01); ***G06F 16/93*** (2019.01); ***G06Q 10/1057*** (2013.01)

(58) **Field of Classification Search**
CPC .. G06F 16/24; G06F 17/2745; G06Q 10/1057
See application file for complete search history.

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Primary Examiner — Thu Nguyet T Le
(74) *Attorney, Agent, or Firm* — Christensen O'Connor Johnson Kindness PLLC

(57) **ABSTRACT**

In some embodiments of the present disclosure, techniques are utilized that allow answers to be provided to end users such as health care consumers, based on benefit book documents. The benefit book documents, which do not initially contain machine-readable structural or semantic information, are processed in order to detect structure and create semantic content based on the structure. This semantic content may then be added to a graph that represents the information contained in the benefit book document. A computing device may then use the nodes of this graph to answer questions received from consumers, where templates that provide answers to the questions reference the nodes of the graph.

20 Claims, 8 Drawing Sheets

US Patent No. 10,649,985

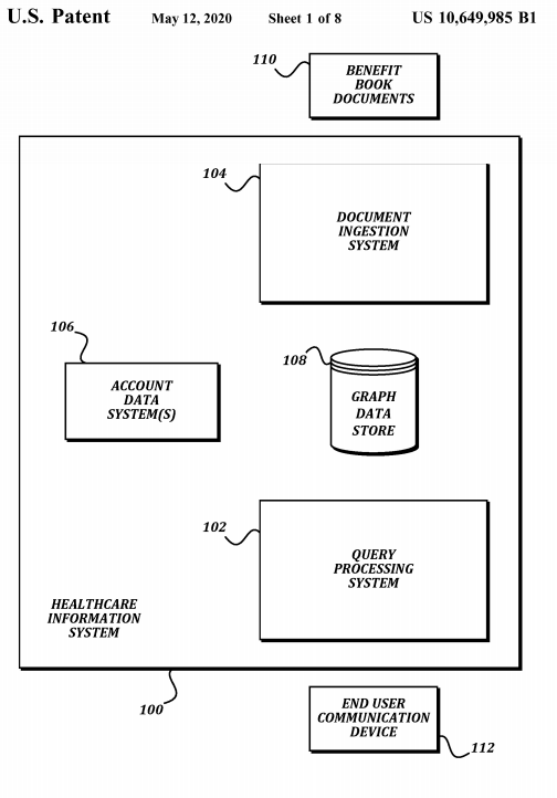


FIG. 1

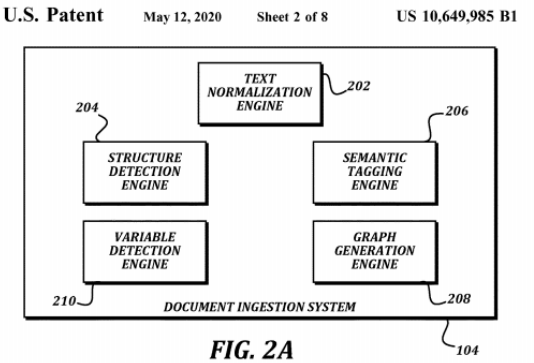


FIG. 2A

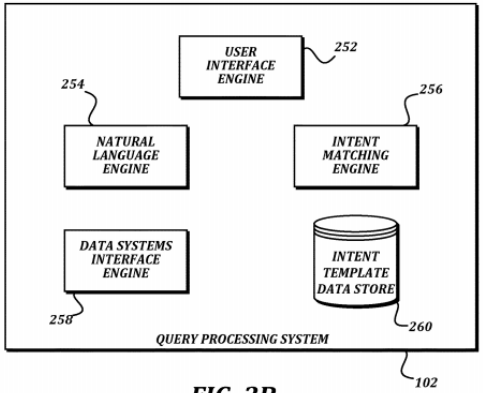
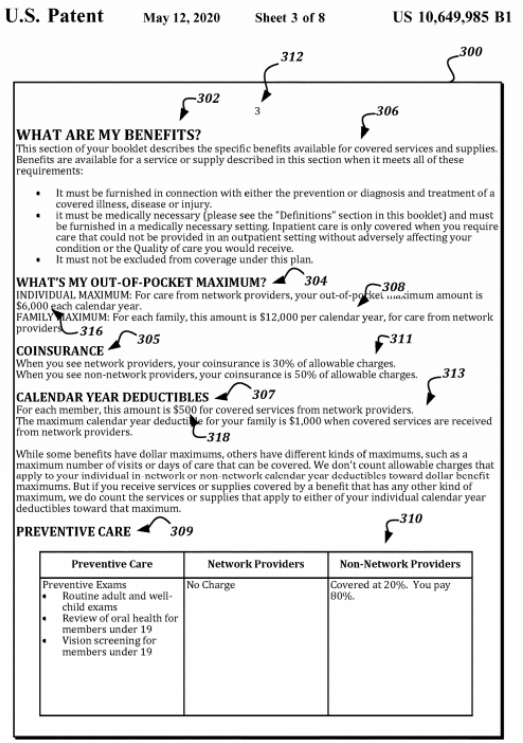


FIG. 2B

US Patent No. 10,649,985



U.S. Patent May 12, 2020 Sheet 3 of 8 US 10,649,985 B1

312 300 302 306

3

WHAT ARE MY BENEFITS?

This section of your booklet describes the specific benefits available for covered services and supplies. Benefits are available for a service or supply described in this section when it meets all of these requirements:

- It must be furnished in connection with either the prevention or diagnosis and treatment of a covered illness, disease or injury.
- It must be medically necessary (please see the "Definitions" section in this booklet) and must be furnished in a medically necessary setting. Inpatient care is only covered when you require care that could not be provided in an outpatient setting without adversely affecting your condition or the Quality of care you would receive.
- It must not be excluded from coverage under this plan.

WHAT'S MY OUT-OF-POCKET MAXIMUM? 304 308

INDIVIDUAL MAXIMUM: For care from network providers, your out-of-pocket maximum amount is $6,000 each calendar year.
FAMILY MAXIMUM: For each family, this amount is $12,000 per calendar year, for care from network providers. 316

COINSURANCE 305 311

When you see network providers, your coinsurance is 30% of allowable charges.
When you see non-network providers, your coinsurance is 50% of allowable charges. 313

CALENDAR YEAR DEDUCTIBLES 307

For each member, this amount is $500 for covered services from network providers.
The maximum calendar year deductible for your family is $1,000 when covered services are received from network providers. 318

While some benefits have dollar maximums, others have different kinds of maximums, such as a maximum number of visits or days of care that can be covered. We don't count allowable charges that apply to your individual in-network or non-network calendar year deductibles toward dollar benefit maximums. But if you receive services or supplies covered by a benefit that has any other kind of maximum, we do count the services or supplies that apply to either of your individual calendar year deductibles toward that maximum.

PREVENTIVE CARE 309 310

Preventive Care	Network Providers	Non-Network Providers
Preventive Exams • Routine adult and well-child exams • Review of oral health for members under 19 • Vision screening for members under 19	No Charge	Covered at 20%. You pay 80%.

FIG. 3

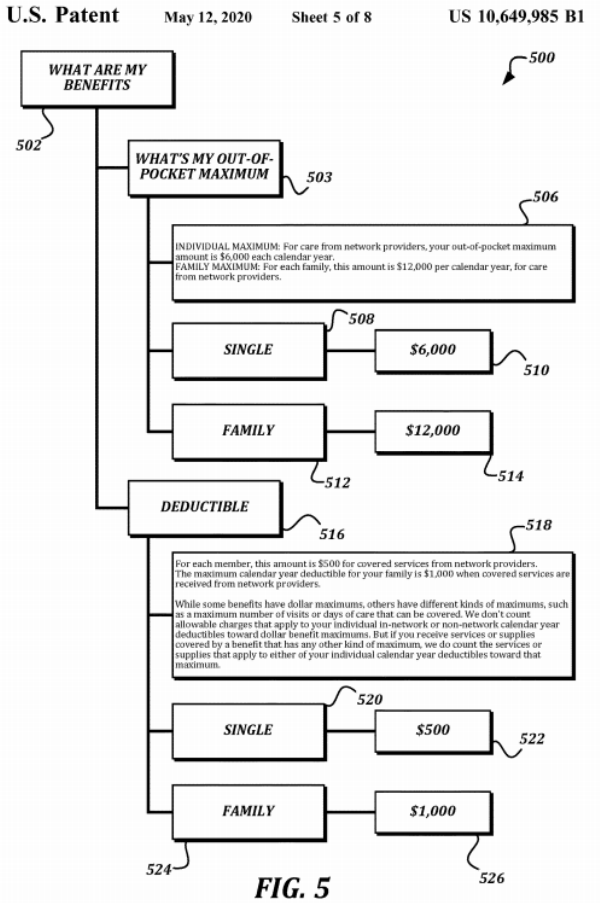
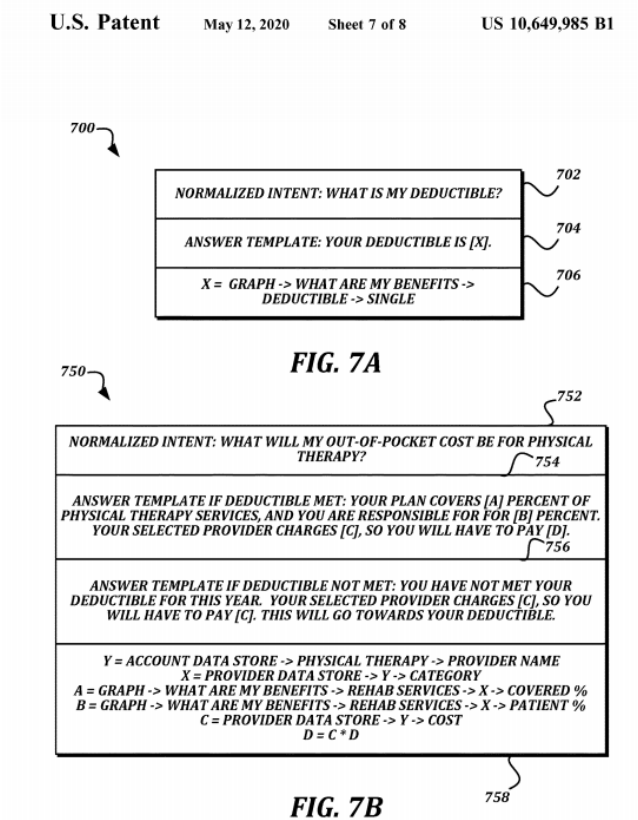


FIG. 5

US Patent No. 10,649,985



US Patent No. 10,649,985

1. A computer-implemented method of enabling one or more computing devices of a healthcare information system to retrieve information from a benefit book document that represents healthcare benefit information in, response to a query, the method comprising:

generating, by a computing device, a set of structure tags that mark structures within the benefit book document;

determining, by a computing device, a set of semantic tags associated with the benefit book document using the set of structure tags and one or more of string matching, format matching, or page placement matching;

building, by a computing device, a graph of information in the benefit book document using the semantic tags;

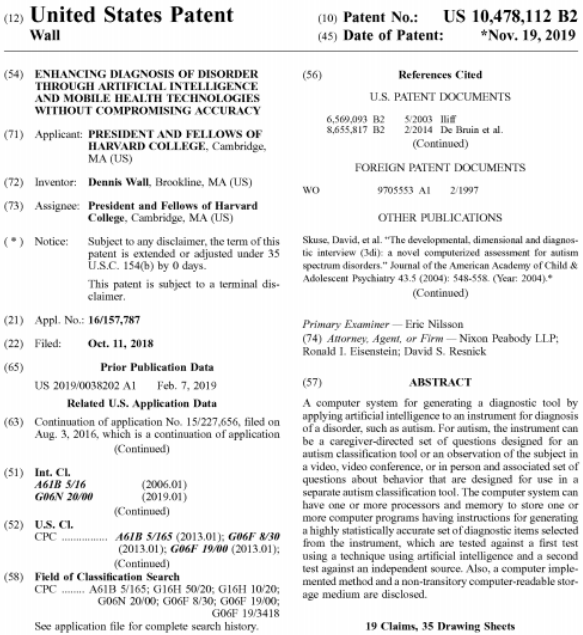
determining, by a computing device, an intent associated with a query for information contained in the benefit book document;

matching, by a computing device, the intent to a template, the template including a reference to a value in the graph of information; and

transmitting, by a computing device, a response to the query that includes the value from the benefit book document as indicated by the graph of information.

US Patent No. 10,478,112

- Title: Enhancing diagnosis of disorder through artificial intelligence and mobile health technologies without compromising accuracy
- Assignee: Harvard College
- Allowed after one office action and response.
- Filing date: 11 Oct 2018
- Priority date: 24 Oct 2011



(12) **United States Patent**
Wall

(10) **Patent No.: US 10,478,112 B2**
(45) **Date of Patent: *Nov. 19, 2019**

(54) **ENHANCING DIAGNOSIS OF DISORDER THROUGH ARTIFICIAL INTELLIGENCE AND MOBILE HEALTH TECHNOLOGIES WITHOUT COMPROMISING ACCURACY**

(71) Applicant: **PRESIDENT AND FELLOWS OF HARVARD COLLEGE**, Cambridge, MA (US)

(72) Inventor: **Dennis Wall**, Brookline, MA (US)

(73) Assignee: **President and Fellows of Harvard College**, Cambridge, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/157,787**

(22) Filed: **Oct. 11, 2018**

(65) **Prior Publication Data**

US 2019/0038202 A1 Feb. 7, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/227,656, filed on Aug. 3, 2016, which is a continuation of application

(Continued)

(51) **Int. Cl.**
A61B 5/16 (2006.01)
G06N 20/00 (2019.01)

(Continued)

(52) **U.S. Cl.**
CPC ***A61B 5/165*** (2013.01); ***G06F 8/30*** (2013.01); ***G06F 19/00*** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC A61B 5/165; G16H 50/20; G16H 10/20; G06N 20/00; G06F 8/30; G06F 19/00; G06F 19/3418

See application file for complete search history.

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(Continued)

Primary Examiner — Eric Nilsson
(74) *Attorney, Agent, or Firm* — Nixon Peabody LLP; Ronald I. Eisenstein; David S. Resnick

(57) **ABSTRACT**

A computer system for generating a diagnostic tool by applying artificial intelligence to an instrument for diagnosis of a disorder, such as autism. For autism, the instrument can be a caregiver-directed set of questions designed for an autism classification tool or an observation of the subject in a video, video conference, or in person and associated set of questions about behavior that are designed for use in a separate autism classification tool. The computer system can have one or more processors and memory to store one or more computer programs having instructions for generating a highly statistically accurate set of diagnostic items selected from the instrument, which are tested against a first test using a technique using artificial intelligence and a second test against an independent source. Also, a computer implemented method and a non-transitory computer-readable storage medium are disclosed.

19 Claims, 35 Drawing Sheets

US Patent No. 10,478,112

1. (Currently amended) A computer-implemented method for evaluating an individual for a behavioral disorder, developmental delay, or neurological impairment, said method comprising:

(a) displaying a plurality of questions relating to said behavioral disorder, developmental delay, or neurological impairment;

(b) receiving input comprising a response to at least one of said plurality of questions;

(c) generating, using a machine learning software module, an output comprising an ~~indicating~~ indication of whether said ~~individual has said~~ behavioral disorder, developmental delay, or neurological impairment is present in said individual based on said input, wherein said output is determined by said machine learning software module with a statistical accuracy of at least 90%.

US Patent No. 10,478,112

- Office Action included rejections under 35 USC 101/Alice and 35 USC 102/103.
- Applicant overcame these rejections after responding to the office action.

US Patent No. 10,478,112 – Attorney arguments regarding 35 USC 101

The instant computer implemented method of claim 1 utilizes a "machine learning software module" to provide a ***technical solution*** to the technological problem of accurately diagnosing and treating individuals with a behavioral disorder, developmental delay, or neurologic impairment. More specifically, claim 1 recites that an output comprising an indication of whether said behavioral disorder, developmental delay, or neurological impairment is present in said individual **is generated by said machine learning software module, with a statistical accuracy of at least 90%.** That is, the innovative method of claim 1 uses a machine learning software module to determine an indication of a presence of a behavioral disorder, developmental delay, or neurological impairment with a high degree of accuracy whereas traditional methods of evaluation are inaccurate with respect to behavioral disorders, developmental delays, and neurological impairments.

US Patent No. 10,478,112: Attorney arguments regarding 35 USC 101

Applicant further points to the USPTO 2019 Revised Patent Subject Matter Eligibility Guidance (the "2019 Guidance"), which states:

> In the context of revised Step 2A, the following exemplary considerations are indicative that an additional element (or combination of elements)[24] may have integrated the exception into a practical application: an additional element reflects an improvement in the functioning of a computer, or an improvement to other technology *or technical field*. Page 19 of the 2019 Guidance (emphasis added).

As explained above, Claim 1 (as well as the teaching of the application as a whole) provides an improvement to the *technical field* of patient evaluation by reciting a computer implemented method that utilizes a machine learning software module to provide an improvement to the technical field of accurate evaluation of individuals having a behavior disorder, developmental delay, or neurological impairment. As such, even if, *arguendo,* claim 1 recites an abstract idea, the claimed method represents an improvement to the technical field of evaluation of individuals with behavioral disorders, developmental delays, or neurological impairments and, therefore, in accordance with the 2019 Guidance, claim 1 is patent eligible subject matter at least because it integrates an alleged exception into a computer implemented improvement to a technical field.

US Patent No. 10,478,112

- Suggestions to strengthen claim 1 (if supported in specification)
- Provide details of how the “machine learning software module” is built.
- Neural network structure?
- More details of training algorithm or feature vector?
- Remove “statistical accuracy of at least 90%”

US Patent No. 10,687,751 (Continuation of US 10,478,112)

1. A computer system for diagnosing a behavioral disorder, a developmental delay, or a neurological impairment of a subject with a diagnostic tool comprising a classifier and a set of diagnostic questions, the computer system comprising:

a processor; and

a non-transitory computer readable medium that stores instructions that when executed by the processor causes the processor to:

display the set of diagnostic questions;

receive responses to the set of diagnostic questions;

provide the responses as an input to the classifier, wherein the classifier is trained with data from a plurality of individuals having the behavioral disorder, the developmental delay, or the neurological impairment, and wherein the classifier has an accuracy of at least 90%;

evaluate the responses with the classifier; and

generate an output indicating whether there is an indication that the subject has the behavioral disorder, the developmental delay, or the neurological impairment.

US Patent No. 10,682,093

- Title: Digital platform to identify health conditions and therapeutic interventions using an automatic and distributed artificial intelligence system
- Assignee: Spiral Physical Therapy, Inc.
- Allowed as filed.
- Filing date: 26 Apr 2019

(12) **United States Patent**
Stein et al.

(10) **Patent No.: US 10,682,093 B1**
(45) **Date of Patent: *Jun. 16, 2020**

(54) **DIGITAL PLATFORM TO IDENTIFY HEALTH CONDITIONS AND THERAPEUTIC INTERVENTIONS USING AN AUTOMATIC AND DISTRIBUTED ARTIFICIAL INTELLIGENCE SYSTEM**

(71) Applicant: **Spiral Physical Therapy, Inc.**, Del Mar, CA (US)

(72) Inventors: **Spencer Stein**, Del Mar, CA (US); **Stephen Moxey**, Carlsbad, CA (US); **Lee Stein**, Del Mar, CA (US)

(73) Assignee: **Spiral Physical Therapy, Inc.**, Del Mar, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/396,411**

(22) Filed: **Apr. 26, 2019**

Related U.S. Application Data

(63) Continuation of application No. 16/228,169, filed on Dec. 20, 2018, now Pat. No. 10,327,697.

(51) **Int. Cl.**
G06K 9/00 (2006.01)
A61B 5/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 5/486*** (2013.01); ***A61B 5/0064*** (2013.01); ***A61B 5/1071*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61B 5/7267
See application file for complete search history.

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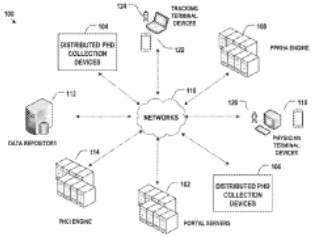
Primary Examiner — Oneal R Mistry
(74) *Attorney, Agent, or Firm* — Brinks Gilson & Lione

(57) **ABSTRACT**

This disclosure is directed to method and system for automatic, distributed, computer-aided, and intelligent data collection/analytics, health monitoring, health condition identification, and patient preventive/remedial health advocacy. The system integrates (1) distributed patient health data collection devices, (2) centralized or distributed data servers running various intelligent and predictive data analytics engines for health screening, assessment, patient health condition identification, and patient preventive/remedial health advocacy, 3) specifically designed data structures including quantized health indicator vectors, patient health condition identification matrices and patient health condition vectors, (4) portal servers configured to interface with (5) distributed physician terminal devices and (6) distributed patient terminal devices for delivering health condition identification, health interventions and patient preventive/remedial health advocacy, and for monitoring and tracking patient activities. The various intelligent and predictive engines are configured to learn and extract hidden features
(Continued)



US Patent No. 10,682,093

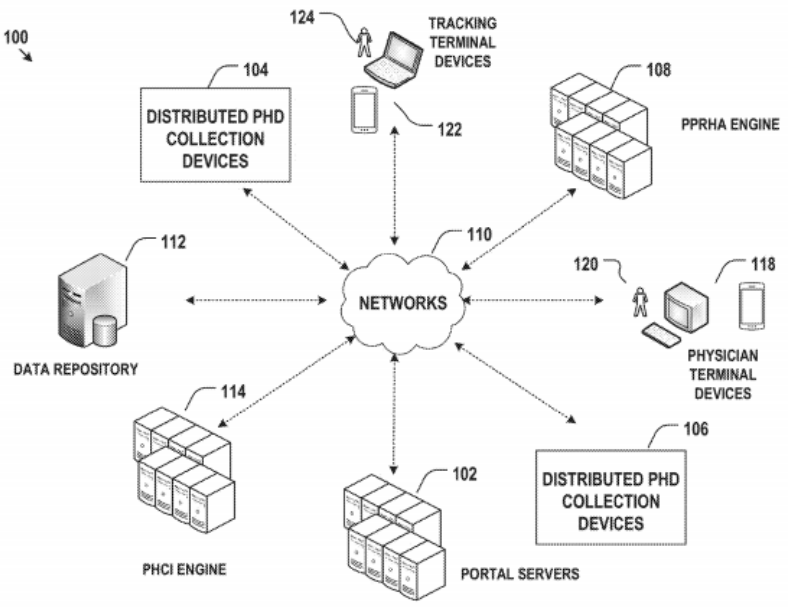


Figure 1

US Patent No. 10,682,093

1. A system for automatic and intelligent patient health condition identification (PHCI) and patient preventive/remedial health advocacy (PPRHA), comprising:

a scanning platform having a plurality of optical sensors and a force plate;

a data repository;

a communication interface; and

processing circuitry in communication with the scanning platform, the data repository and the communication interface, wherein the processing circuitry is configured to:

receive body topography data for a target patient from the plurality of optical sensors via the communication interface;

receive force data from the force plate via the communication interface;

execute a data segmentation model trained based on a first machine learning algorithm to automatically identify a predetermined set of body landmarks of the target patient and identify a set of representations corresponding to the predetermined set of body landmarks of the target patient;

associate each of a plurality of predetermined health conditions with quantized values in a quantized health indicator vector space to generate a quantized PHCI matrix;

derive a health indicator vector in the quantized health indicator vector space based on the set of representations and the force data;

quantize the health indicator vector into the quantized health indicator vector space to obtain a quantized health indicator vector;

store the quantized health indicator vector and data from the scanning platform in the data repository;

automatically generate a patient health condition (PHC) vector comprising a plurality of components each corresponding to one of the plurality of predetermined health conditions; and

automatically generate a PPRHA item from the PHC vector using a PPRHA model trained by a second machine learning algorithm.

US Patent No. 10,682,093

- How to strengthen claim 1:
- Do not claim the “scanning platform,” “data repository,” and “communication interface” as explicit components of the system.
- Instead claim a system comprising a processing circuitry and memory that communicate with the “scanning platform,” “data repository,” and “communication interface.” This avoids divided infringement.

US Patent No. 10,068,494

- Title: Artificial intelligence based health coaching based on ketone levels of participants
- Assignee:Invoy Holdings, Inc.
- Allowed after one office action and response, and one Examiner's amendment.
- Filing date: 5 May 2017

(12) **United States Patent**
Ahmad et al.

(10) **Patent No.: US 10,068,494 B2**
(45) **Date of Patent: Sep. 4, 2018**

(54) **ARTIFICIAL INTELLIGENCE BASED HEALTH COACHING BASED ON KETONE LEVELS OF PARTICIPANTS**

(71) Applicant: **Invoy Holdings, LLC**, Aliso Viejo, CA (US)

(72) Inventors: **Lubna Ahmad**, Chandler, AZ (US); **Salman Ahmad**, Chandler, AZ (US)

(73) Assignee: **Invoy Holdings, LLC**, Aliso Viejo, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/588,414**

(22) Filed: **May 5, 2017**

(65) **Prior Publication Data**

US 2018/0108272 A1 Apr. 19, 2018

Related U.S. Application Data

(60) Provisional application No. 62/408,208, filed on Oct. 14, 2016.

(51) **Int. Cl.**

G09B 5/02 (2006.01)
G09B 19/00 (2006.01)
G06N 5/02 (2006.01)

(52) **U.S. Cl.**

CPC ***G09B 19/0092*** (2013.01); ***G06N 5/02*** (2013.01); ***G09B 5/02*** (2013.01); *G09B 19/00* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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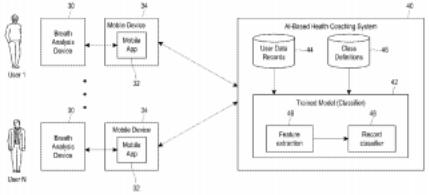
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear, LLP

(57) **ABSTRACT**

A system is disclosed that uses profiles of users, including monitored ketone levels of the users, to assess effectiveness levels of health programs (such as weight loss programs) assigned to the users, and to select health program modifications for the users. The system may use a machine learning (artificial intelligence) algorithm to adaptively learn how to classify users and to select messaging and behavioral modifications for the users. For example, in some embodiments the system classifies the users and provides associated health program recommendations using a computer model trained with expert-classified user data records. As another example, a set of rules may be used to generate the health program recommendations and related messaging, and the set of rules may automatically be modified over time based on feedback data reflective of health program effectiveness levels produced by such rules. In some embodiments the system includes a mobile application that runs on mobile devices of users and communicates wirelessly with breath analysis
(Continued)



US Patent No. 10,068,494

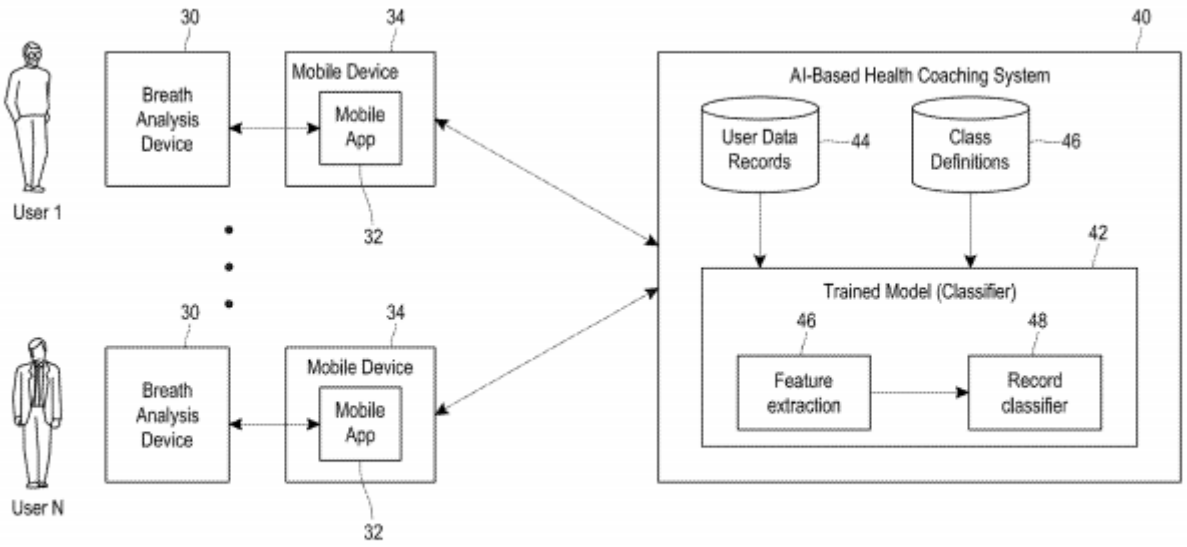


FIG. 1

US Patent No. 10,068,494

1. A system capable of using artificial intelligence to provide health coaching based on breath ketone levels of users, the system comprising:

a plurality of portable breath analysis devices, each breath analysis device comprising a ketone sensor capable of measuring ketone levels in breath samples of users to generate ketone measurements of the users, the ketone measurements reflective of effectiveness levels of current health programs assigned to the users, each breath analysis device comprising a wireless transceiver capable of wirelessly transmitting the ketone measurements of the users; and

a computing system that hosts an automated health coaching system, the automated health coaching system configured to use a machine learning process to classify the users based, at least partly, on data records of the users, the data records including the ketone measurements of the users and including other profile data of the users, the automated health coaching system further configured to use at least the classifications to select health program modifications, including diet modifications, for particular users, and to output an indication of the selected health program modifications for display to the respective users via a user interface, the computing system comprising one or more physical servers;

wherein the computing system is programmed with executable instructions to use a trained model to classify the users based on the data records of the users, the trained model comprising (1) a feature extractor that extracts features from the data records of the users, the features including features based on the ketone measurements and other profile data of the users, and (2) a classifier that classifies the users using a set of weights that specify amounts of weight to apply to particular extracted features, the weights learned by applying a machine learning algorithm to classified user data records, wherein the machine learning algorithm comprises a neural network algorithm, a Support Vector Machine algorithm, a Probabilistic Graphic Model algorithm, or a Decision Tree model algorithm.

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Questions?