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(74) Gemachtigde:
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(54) **A method performed by an information processing device, a program product, and a system for acquiring artificial intelligence from processing context related operational, human bio-signal and human conduct data.**

(57) A data processing method performed by an information processing device operating one or more data processing algorithms enabling artificial intelligence. Artificial Intelligence, AI, is acquired from sensing and associating related operational data originating from a context, and human bio-signal data and human conduct data relating to human participation with this context. A data processing algorithm comprising adificial intelligence acquired in accordance with the method, a program product, a method of processing operational data by a data processing algorithm comprising the acquired artificial intelligence, and a data processing system are also included.

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Title

A method performed by an information processing device, a program product, and a system for acquiring artificial intelligence from processing context related operational, human bio-signal and human conduct data.

Technical Field

The present application relates to data processing performed and implemented in an information processing device, such as but not limited to a computer, a computing device, a virtual machine, a server, or a plurality of cooperatively operating computers, computing devices, virtual machines, or servers. In particular, the present application relates to a method for creating, generating, modifying, and deploying artificial intelligence by an information processing device, involving a data processing algorithm enabling artificial intelligence. More specifically, the present application relates to acquiring and modifying artificial intelligence, by an information processing device, from processing context-related, and interrelated operational data and human participation data.

Background

In general, Artificial Intelligence, AI, technology comprises the use and development of computer systems that can learn and adapt to perform tasks without being explicitly programmed, by using algorithms and statistical models.

AI technology is already widely integrated in today's modern society. Data processing systems using AI technology have proven to handle and complete rather complex tasks commonly associated with human beings with more precision and in less time than would be possible for humans.

Learning or training is one of the fundamental building blocks of AI technology. From a conceptual standpoint, learning is a process that acquires or imparts and/or improves the knowledge of a data processing algorithm enabling artificial intelligence by making observations about its environment or context. From a technical/mathematical standpoint, AI learning comprises processing of a set of input-output pairs for a specific function for predicting the outputs of new inputs.

One category of AI systems presently available are so-called 'tasks intelligent systems', designed to automatically perform singular tasks, focused on highly specific technical domains, such as facial recognition, speech recognition/voice assistants, or searching the internet. Generally referred to as Artificial Narrow Intelligence, ANI, or weak AI.

Weak or narrow data processing algorithms enabling artificial intelligence are generally trained through many iterations of their respective task, receiving performance feedback from an evaluation function, or reward function, error function, etc. in order to reinforce or otherwise learn beneficial behavior and/or unlearn or disincentivize actions that do not lead to beneficial behavior or intended outcomes within the given context.

The need for an evaluation function is why many current AI applications are games such as chess or other two-dimensional games, where the final game outcome or continuous game score can serve to evaluate in-game behaviors. Furthermore, games represent a context of limited dimensionality in which the dependencies between AI actions, context parameters, and game outcome or score can be successfully mapped. The game speed can be increased arbitrarily to allow for more training iterations per unit of time.

However, more scenarios, handling multiple, versatile and/or non-predefined tasks, do not have an objective evaluation function like a game score, and cannot arbitrarily be sped up. To interpret actions in more scenarios in terms of goal achievement, benefit, or appropriateness within the current context or a larger strategy, a human is needed to perform that interpretation. Humans can distill relevant dimensions or key factors from situations and evaluate the facts or the events that are taking place accordingly.

Experiments have been performed to impart human intelligence data into the processing of a task intelligent AI system, by human evaluation of a task performed or proposed by the system, such as a game.

Human observers may, for example, monitor an AI data processing algorithm traversing a space performing various actions, and explicitly communicate whether or not each change in movement direction or each chosen action is conducive to the goal. In this way, by the active feedback or guidance provided by the human user, the system successively learns the best possible policy or policies to perform a respective task.

Similarly, there are other instances where human intelligence is still explicitly required or otherwise beneficial in the process of training an AI. For example, a human's general or specific understanding of the larger context, including the temporal evolution of events in a scene, may be needed to properly identify relevant objects or events, to correct automatic decisions made by the AI, or to resolve ambiguity.

This has led to AI training or learning scenarios where human observers press buttons or provide spoken input or otherwise perform explicit ratings to indicate what is appropriate/inappropriate behavior, to manually provide labels, or otherwise to generate additional input by explicitly generating descriptors for concrete pieces of data such as images, videos, or audio to train a data processing algorithm enabling artificial intelligence operated by an information processing device.

ANI has in recent years reached human-level or even greater performance in specific, well-defined tasks through advances in Machine Learning, ML, and deep learning in particular, by processing larger amounts of operational or contextual data, among which environmental data, information data, measurement data, control data and state data of a plurality of devices operating in a particular well-defined context or environment. Especially when such data is additionally combined or otherwise associated with data provided based on human intelligence, such as labels, descriptors, or judgements, can an algorithm enabling artificial intelligence effectively achieve or even surpass human-level performance.

While, human experts may perform or handle a complex task or operation in a versatile and/or well-defined context or environment, they may not always be able to explicitly indicate how they perform the task or operation and on the basis of which contextual parameters or variables their interpretation and evaluation of the task or operation is performed, i.e. how a decision or result is reached.

Non-limiting examples of such complex tasks or complex operations can be found in the field of healthcare diagnosis and troubleshooting, logistics planning and scheduling, financial decision making, driving a car on the road, etc.

In such cases, that is performing a rather complex task requiring human expert knowledge, the development of AI training or learning scenarios to train or learn a data processing algorithm enabling artificial intelligence to perform such an expert task or operation is very difficult and very time consuming because of the large training and calibration data sets involved, and sometimes hardly or even not feasible when the expert is not able to outline his/her strategy to perform the task or operation, for example.

Besides ANI systems, the broader and long-term goal is to create an AI for handling plural tasks in changing contexts with intelligence proportional to human general intelligence, also known as Artificial General Intelligence, AGI, or strong AI.

As will be appreciated, developing training or learning schemes for training data processing algorithms enabling artificial intelligence to operate in various contexts and environments reflecting the interpretations and decision making by a human user, including those human mental strategies that may not be explicitly expressible, or subjective human mental states such as error, surprise, agreement, understanding, or the like appears practically impossible using state of the art AI training or learning techniques.

Summary

It is an object of the present application to provide a method for creating, generating and/or modifying Artificial Intelligence, AI, involving a data processing algorithm enabling artificial intelligence operated by an information processing device. A data processing algorithm enabling artificial intelligence, hereinafter also referred to as an AI-enabled data processing algorithm, for the purpose of the present application, is any data processing algorithm that allows information processing devices or machines to process data replicating human intelligence.

It is noted that an AI-enabled data processing algorithm applied with the method according to the present application may possess already a certain level of artificial intelligence, for example in that the AI-enabled data processing algorithm is able to recognize objects, devices, living beings etc. that operate or participate in a context or in that the AI-enabled data processing algorithm has already been initialized according to any of the aspects outlined below.

As such, the act or process of acquiring AI for the purpose of this application includes all aspects commonly associated with the training of an AI-enabled data processing algorithm, including its initialization or initial creation and its later modification, also in a continuous fashion, i.e. continuous learning.

In a first aspect of the present application, there is provided a data processing method performed by an information processing device operating at least one data processing algorithm enabling artificial intelligence, the method comprises sensing operational data originating from a context and human bio-signal data and human conduct data relating to human participation with this context, wherein the artificial intelligence is acquired by the information processing device from associating related operational data, human bio-signal data and human conduct data.

The method presented is based on the insight that knowledge applied by a human participant in observing, operating or handling and completing a task or operation in a certain context can be efficiently acquired by sensing and associating human mental process data and human behavior or conduct data of the human in relation to respective operational data originating from or in that context while performing the task or operation.

The human brain evaluates perceived information automatically, according to a subjective/personalized model of the world that includes a value system. The human brain constantly generates and updates a mental state model of the environment or context, in neuroscience also known as predictive coding. Predictive coding is one of the main mechanisms enabling human intelligence.

Brain activity related to the generation, evaluation, or updating of these mental models may thus reveal aspects about the human interpretation of the environment and about their value system. Similarly, knowledge and expertise in a particular context is reflected in these models and in this value system and may thus by extension be reflected in related brain activity.

Other mental states, i.e., psychological, cognitive, affective, neurophysiological, or otherwise mind-related states, such as but not limited to agreement, surprise, arousal, confusion, nervousness, tension, understanding, or satisfaction, may also refer to an interpretation, evaluation, or judgement of perceived information, and are used in a similar manner. These and other mental states can also be identified using other electrophysiological measures aside from those measuring brain activity, including electromyography, electrocardiography, photoplethysmography, and electromyography, for example.

In general, mental states of a human while observing, performing or operating a task or operation may be deduced from monitoring a user's neurophysiological activity by sensing human bio-signal data. Bio-signals, in the context of the present application, are body signals that are generated by or from human beings, and that can be continuously measured and monitored by commercially available sensors and devices.

The behavior or conduct of a human participating in a context not only may reveal which part of the context or environment, i.e. the applicable operational data, is perceived, attended to, or otherwise incorporated by the human while performing a task or operation, but may also be informative of the strategy, logic, or knowledge applied by the human. A human expert, for example, may observe just shortly or pay no or less attention to operational data that, according to his knowledge, are less or even not important to his final decision.

Rather than developing and applying complex, laborious and time-consuming AI training or learning scenarios to train or learn an AI-enabled data processing algorithm to perform a task or operation, the present method effectively associates sensed interrelated operational, human bio-signal and human conduct data to extract or deduct a strategy or strategies and decision-making processes from observing the human user to train the AI-enabled data processing algorithm. Hence, the method may also be referred to as observational learning.

The present method is versatile and applicable in a variety of contexts from which operational data originate, in particular data pertaining to technological states and technological state changes of a technical device or devices operating in a respective context, and more particular a device or devices controlled by the information processing device operating the at least one AI-enabled data processing algorithm.

For the purpose of the present application, technological states comprise any of but not limited to device input states, device output states, device operational states, device game states, computer aided design states, computer simulated design states, computer peripheral device states, and computer-controlled machinery states and respective state changes. A technological state change in a context is any action undertaken by a piece of technology.

The term technology collectively refers to any and all (connected) technological elements in any potential situation or context. With a technology's state being its specific current configuration, a technological state change is thus any change in configuration that the technology undergoes.

Operational data may comprise physical data and/or virtual data originating from the context. The term virtual data refers to data available from a software program or software application operating in a respective context. That is, for acquiring or sensing this type of data no separate sensors, measurement equipment or other peripheral data recording equipment are required.

In practice, physical operational data may be sensed by any number or types of sensors such as but not limited to cameras, thermal imagers, microphones, radar, lidar, chemical composition sensors, seismometers, gyroscopes, etc., and may thus be capable of recording a context and the events taking place within it to any possible degree of objective accuracy.

For the purpose of the present application, organisms or living beings may also form part of a context and the acts performed thereby and behavior observed thereof are likewise considered as operational data originating form that context.

It is noted that operational data in the light of the present method also refers to information relating to a context as such, i.e. environmental information obtained from sources not directly controlled by the information processing device, such as the presence, appearance, and behavior of non-technological or non-context connected elements, or a weather forecast, for example. As such, the present method is similarly versatile and applicable in a variety of contexts from which operational data can be obtained by technology using any number and type of sensors.

The term bio-signals refers to both electrical and non-electrical time-varying signals comprising any of human body bio-signals and measurements of human physiological structure and function, including but not limited to at least one of direct and indirect measurements of electro-cardiac activity, body temperature, eye movements, pupillometric, hemodynamic, electromyographic, electrodermal, oculomotor, respiratory, salivary, gastrointestinal, genital activity and brain activity. Brain waves and other measures of brain activity are also bio-signals for the purpose of the present method.

The term indirect measurements here also refers to derivate measures of bio-signals, including physiological parameters such as heart rate variability, gaze, peak amplitudes, power in specific frequency bands, and signal rise and recovery times, for example.

Human conduct data comprises any human expression, communication and physical activity by a human participant while observing, operating or handling and completing a task or operation in a certain context, such as gestures, body motions, facial expressions, etc. In the present method, intermediate or final decisions made and communicated through respective conduct by the human participant are also regarded as belonging to human conduct data.

Human conduct data may be monitored or sensed by a number of commercially available sensors operatively connected with the human participant, i.e. worn by or aimed at the human participant, including but not limited to input modalities comprising a keyboard, push buttons, switches, touch screen, mouse, joystick, electronic pencil/stylus, laser pointer, motion controller, game controller, microphones, cameras, thermal imagers, motion capture devices, pressure sensors, gyroscopes or other equipment for signaling a selection or decision for example.

Non-limiting examples of contexts or fields at which the present method can be applied for already solving existing problems or extend the AI capabilities of given systems are human-computer interaction, human-machine systems, human-robotic interaction, robotics, assistive technologies, medical technology, treatment/curing of health conditions, cyber security and cyber technology, as well as in the sectors of law enforcement and interrogation, border security systems at airports, mind control, psychological modification and weapon systems, or combinations of such fields.

In a further facet of the present method, a selection of the related operational data, human bio-signal data and human conduct data is associated by the information processing device, this selection being based on at least one of the sensed operational data, human bio-signal data and human conduct data.

This embodiment provides a reduction in the amount of data used for the training or learning of an AI-enabled data processing algorithm. Selection based on operational data allows, for example, objects with specific features to be included in further processing. Selection based on bio-signal data allows parts of the operational data to be identified that were associated with specific features in related bio-signal data.

As such, a selection based on human bio-signal data in particular allows data to be selected that could not have been identified on the basis of operational data or other overtly observable data, for example only selecting sensed operational data that relate to a mental surprise state or arousal state of a human participant.

Selection based on human conduct data allows the AI-enabled data processing algorithm to, for example, only consider operational data related to specific human actions. Combinations of these selection approaches give rise to a variety of selection and data reduction procedures available to the AI-enabled data processing algorithm or the human configurator thereof.

This can be advantageous, for example, when not all available data bears relevance to, or otherwise carries information pertaining to, the task the AI is learning to solve, thus providing a data filtering, selection, or reduction technique. Similarly, it can be advantageous, for example, while updating an already acquired AI or in case of limited processing power and/or limited data memory available to the data processing device, such as in mobile equipment, for example.

In another facet of the present method, the artificial intelligence is acquired by the information processing device, based on at least one mental category, wherein a mental category comprises part of the operational data associated with at least one of the human bio-signal data and the human conduct data corresponding to this mental category.

This embodiment is based on the insight that meaning can be provided to the sensed operational data by organizing same in mental categories. Humans can recognize features from people, objects, things, concepts, actions, et cetera, and associate these with previously learned similar features, leading to the formation or refinement of mental categories. Conversely, pre-existing or previously formed mental categories can be used to infer features from previously unexperienced objects, et cetera. Specifically, hierarchically inferior, more specific mental categories can inherit features and properties of hierarchically superior, more general mental categories. These mental categories thus represent logical units used internally by humans in the process of reasoning, perceiving, thinking, and decision making, for example.

In humans, such mental categories are created based on how the brain considers people, objects and actions et cetera are related and reflect what kind of learning may be going on in the brain, as these mental categories are created through experience, training, and instruction, for example.

In the present method, a mental category is based on and associated with respective human bio-signal data and/or human conduct data sensed from a human participating in a task or operation performed. Operational data is associated, either categorically or probabilistically, with at least one mental category.

In accordance with a facet of the present application, the operational data may be organized based on at least one predetermined mental category. For example, one or more mental categories related to known emotional states of the human participant may be predetermined to form one or more mental categories. Providing such a predetermined mental category may, for example, guide the AI-enabled data processing algorithm to utilize a specific representation of the operational data possibly with associated predetermined logic, or to ignore particular operational data, for example, and may significantly reduce processing time by the information processing device.

In another facet of the present application, the at least one mental category is formed by the information processing device based on at least one of the human bio-signal data and the human conduct data and related operational data.

In this embodiment, mental categories are formed by the information processing device automatically, from analyzing and organizing the sensed bio-signal data and/or human conduct data, and the related sensed operational data. Analyzing may involve, for example, detection of respective co-occurring bio-signal data and/or human conduct data, certain patterns occurring in these data, etc.

For example, with access to human bio-signal data numerically representing various specific mental states constituting a mental state space, a mental category may be formed that comprises all operational data that relates to a specific location or set of locations in the mental state space covered by the bio-signal data. The automatic formation of mental categories may comprise multiple iterations of, for example, selecting, categorizing, clustering, projecting, and transforming the categories and their constituent elements based on features and patterns in the operational data, human bio-signal data, and human conduct data.

A partial or complete rank or hierarchy may be provided to mental categories, for example based on patterns observed in at least one of bio-signal data and operational data reflecting the rank, generality, specificity, selectivity, similarity, dissimilarity, overlap, or separation of mental categories. A partial or complete rank or hierarchy may furthermore be imposed on mental categories, for example based on either one or both of predetermined bio-signal data and predetermined human conduct data. Mentals states having a relative higher rank or hierarchical position may give rise to a higher relevance or a higher priority or immediacy of an action or operation by the AI-enabled data processing algorithm, for example, or may be used to transfer mental categories between contexts.

Hence, in a further facet of the present application, the at least one mental category is formed by the information processing device based on at least one of predetermined bio-signal data and predetermined human conduct data.

This embodiment is also advantageous for guiding the training of the AI-enabled data processing algorithm and reducing processing time by the information processing device, in particular when it is known beforehand that certain bio-signal data and/or human conduct data are representative for the human participation in a certain context.

In the human brain, mental categories are sorted based on logical relationships, such as temporal relationships, which means that the brain recognizes that they tend to - or tend not to - pop up near one another at specific times, for example. A series of experiences that usually occur together, i.e. that are temporally related or interrelated, form an event until a non-temporally related experience occurs and marks the start of a new event. It has been found that the brain breaks experiences into events or related groups that help to mentally organize situations, using subconscious mental categories it creates.

Hence, in a yet further facet of the present application, artificial intelligence is acquired based on a collection of mental categories, wherein a collection of mental categories is at least one of a set of operational data associated with mental categories and a set of collections of mental categories.

In this manner events and other logically connected parts of operational data can be formed, detected, represented and used by the artificial intelligence of an AI-enabled data processing algorithm.

The term 'collection of mental categories' in the light of the present application not only refers to a temporal relationship between mental categories, or between or within collections of mental categories, but also to logic relationships, including informal logic, formal logic, symbolic logic and mathematical logic, cause and effect relationships, hierarchical relationships, et cetera, all contributing to the knowledge of a human participant in performing a task or operation.

In a particular facet of the present application, the artificial intelligence is acquired based on a collection of mental categories and corresponding human conduct data. By associating the way a human participant conducts or behaves in connection with a collection of mental categories, i.e. an event, information can be deduced about the relevance, meaning, importance and/or demarcation of a particular event in performing a task, operation or observation, specifically with respect to the human's subjective interpretation of such event.

Other forms of prior art supervised AI use labels to learn to identify, localize, differentiate between, or recommend different kinds of objects or events. This requires that humans manually provide these labels by explicitly generating descriptors for concrete pieces of data such as images, videos, text, or audio, for example.

In accordance with a further facet of the present application, acquiring of artificial intelligence comprises enhancing labels based on at least one of a mental category and a collection of mental categories.

With the present method, based on the mental categories disclosed above, such labelling is supported and performed faster for some types of descriptors, and may even provide descriptors that may not be possible to generate in any other way. The term enhancing may include creating, refinement, qualification, augmenting, ranking, et cetera of labels or descriptors used by an AI-enabled data processing algorithm.

As mentioned in the Background part above, human experts may not always be able to explicitly indicate how they perform the task or operation and on the basis of which contextual parameters or variables and their interpretation and evaluation the task or operation is performed, i.e. how a decision or result is reached. With the present method, training of the AI-enabled data processing algorithm is not limited those data that can be consciously, explicitly generated by the human.

In another facet of the present method, operational data are provoked by the information processing device.

For example, in case the AI-enabled data processing algorithm misses information to complete a task or process at hand or is otherwise not able to process data with sufficient quality and reliability, for example, aspects of the context may be momentarily adapted by the information processing device to provoke operational data to retrieve the required or missing information. That is, an aspect or aspects of the context may be adapted by introducing, changing, or deleting information, processes, tasks, events etc. or by otherwise initiating a technological state change to invoke a response of the participating human, either consciously or subconsciously.

This facet of the method in part relies on the insight that any such provoked operational data may be perceived, attended to, or otherwise incorporated by the human, and may thus automatically provoke related human bio-signal data and/or human conduct data. Such adaptation may involve any of the momentary actions or processes handled, a momentary technological state of devices operating in the context, but also adaptations to provoke virtual operational data.

In a yet further facet of the present application, operational data are provoked by the information processing device to evoke at least one mental category or at least one collection of mental categories.

That is, the evocation of operational data serves a specific purpose identified by any of the algorithms operated on the information processing device, for example the purpose to invoke a particular mental response of the participating human, for example to complete, to enhance, to investigate, to test and/or to delete a particular collection of mental categories.

As another example, operational data may be provoked to aid the learning of the AI-enabled data processing algorithm, for example when it is identified that additional data may help to update, optimize, or otherwise fulfil specific criteria of any of its internal parameters or representations.

In this way, like in humans, knowledge, proclivities, preferences, and moral values can be built up interactively by the AI-enabled data processing algorithm, even on a trial-and-error basis, both during the training of the algorithm and while performing operations in contexts to improve itself by means of interactive learning, continuous learning, and cognitive/affective probing, i.e. during the deployment of the algorithm in contexts.

Hence, among others, the AI-enabled data processing algorithm may learn to incorporate moral values, problem solving strategies, preferences, associations, distributions of degrees of acceptance, etc. such that a convergence of human and machine intelligence is initiated and continuously pursued. Over time the AI-enabled data processing algorithm may learn about the human's subjective interpretations in a bigger scale, building up a profile/model of that human's subjective interpretations within single or across multiple contexts.

By iteratively learning, provoking data, and learning from the provoked data, the AI-enabled data processing algorithm not only processes more data to become more intelligent but also, because of the provocation of specific mental categories and collections of mental categories from the human, learns to mimic the human's preferences, behaviors, interpretations, norms, and values given a respective context, thus becoming more alike in its own interpretations and actions to the human it learned from. The more data that become available from a person over time and in different contexts, the more history can build up a profile/model of that human's interpretations, knowledge, et cetera, that can be referred to as a cognitive copy

The present method is practically applicable in various scenarios or contexts where humans interact with machines, personal computers, robots, avatars, and many other technical applications. Which type or types of bio-signal sensor is or are to be used, and/or how the sensing of human conduct data is to be performed, may be selected based on a particular context and/or a specific human participation, for example.

In a facet of the present application, human brain activity data are processed by at least one Brain-Computer Interface, BCI, in particular at least one passive Brain-Computer Interface, pBCI, operating at least one classifier responsive to the human brain activity.

A BCI and a pBCI are tools to assess information about brain activity of an individual. A BCI, i.e. an active or reactive BCI, is built on brain activity that is generated or modulated, directly or indirectly, by a user with the intention to transfer specific control signals to a computer system, thereby replacing other means of input such as a keyboard or computer mouse.

A pBCI differs significantly from a BCI in that pBCI data are based on implicit or passive, involuntary, unintentional, or subconscious human participation with a context, different from explicit or active, i.e. conscious, voluntary, intentional, human interaction with the context. Instead of explicitly generated or modulated brain activity, a pBCI is designed to be responsive to naturally-occurring mental states that were not intended for communication or control, but that can nonetheless be detected, decoded, and used as input to technology.

A pBCI distinguishes between different cognitive or affective aspects of a human user state, typically recorded through an electroencephalogram, EEG. An immediate neurophysiological activity of the human user in a context may be associated to the current mental state or specific aims of a user, by a respective classifier or classifiers operated by the pBCI. For the purpose of the present application, multiple pBCIs each operating a different classifier directed to sense different brain activity associated with different specific mental states of a human participant may be used. In practice, tens or hundreds of classifiers may be deployed.

The method presented is not limited to the processing of operational data, human bio-signal data and human conduct data of a single human individual participating in a context, but may also be practiced for the processing of operational data, human bio-signal data and human conduct data sensed of two or more, i.e. a group of individuals participating in a respective context. In the case of driving a car, for example, artificial intelligence by the AI-enabled data processing algorithm may be acquired from both the driver of the car and a passenger or passengers.

That is, the artificial intelligence acquired by an AI-enabled data processing algorithm may be based on the judgement, knowledge and skills of a plurality of persons. By processing data sensed of multiple persons involved, training of an AI-enabled data processing algorithm can be significantly speeded up compared to training by a single user or the training can make use of a group consensus or a majority vote rather than individual judgements, thus making the artificial intelligence acquired more reliable, more robust or more general, for example.

Likewise, in operation, differences in the evaluation and perception of operations and interactions among individuals of a group participating in a common context, such as differences in the mental categories and collections of mental categories among the individuals of a group, may reveal additional information for adapting the AI-enabled data processing algorithm more quickly compared to an individual user, for example.

Human bio-signal data and human conduct data may be sensed from each individual of a group separately, while operational data originating from the context may be sensed for the group as a whole, for a sub-group or for each individual separately. This, dependent on a particular context, as will be appreciated.

Note that in the case of several human individuals participating in a context these humans need not necessarily be located at a same geographic location. In such a case, some or all or a group of human individuals may participate in the context in that same is replicated or is otherwise partly or completely virtually made available to respective human individuals.

The method according to the present application is excellently applicable for processing operational data, human bio-signal data and human conduct data in real-time or quasi real-time, and in particular for the processing of data pertaining to a time-critical context.

Because the assessed human bio-signal data and human conduct data can not only be interpreted in binary form, such as correct or wrong, accept or reject, expected or unexpected, et cetera, but also continuously, i.e. any number between 0 and 1, or even minus infinity and infinity, for example, indicating a degree of subjective perception, reaction, or interpretation related to the perceived contextual event, the method presently presented may be used to support a wide variety of AI-enabled data processing algorithms for handling plural tasks in contexts with intelligence proportional to human general intelligence.

Hence, the at least one AI-enabled data processing algorithm operated for the purpose of the present application may be any suitable data processing algorithm known in practice, such as but not limited to data processing algorithms based on (deep) reinforcement learning paradigms such as Q learning or Policy Gradient learning, or any supervised learning approach such as Support Vector Machines, Linear Discriminant Analysis, Artificial Neural Networks backpropagation learning, or unsupervised learning based of clustering or principal component analysis or other probabilistic methods.

Other mental states, such as agreement or satisfaction, can also be seen as an implicit judgement of perceived information, and may be utilized in a similar function.

The present method provides a tool to automatically acquire artificial intelligence by assessing a human's interpretation of a perceived event in a given context, in quasi real-time after the occurrence of that event. Such a tool provides for both continuous and event-related monitoring of the mental states of the human and allows an automized view in the subjective, situational observation and interpretation of a person and allows to make this information available for further processing, such as to transfer key aspects of the cognition and mindset of a human into a machine.

Building up on this, it is found that through interactive learning the artificial intelligence can home in on and converge to particular aspects of the human mindset, reflecting this person's strategies, interpretations, preferences, intelligence and moral values, for example. And the more data that become available from a person over time and in different contexts, the more history can be built-up, and a better match to that one person's intuitive intelligence is established, building up a profile/model of that human's subjective interpretations, that can be referred to as a cognitive copy.

A practical implementation of the present data processing method, implemented in an information processing device operating an AI-enabled data processing algorithm, comprises the steps of:

- obtaining, by the information processing device, sensed operational data originating from a context and human bio-signal data and human conduct data relating to human participation with this context;

- selecting, by the information processing device, based on at least one of the human bio-signal data and human conduct data, related operational data;

- allocating, by the information processing device, based on at least one of the human bio-signal data and human conduct data, a plurality of mental categories, a mental category comprising part of the selected operational data associated with at least one of the human bio-signal data and the human conduct data corresponding to that mental category;

- forming, by the information processing device, a collection of mental categories, wherein a collection of mental categories is at least one of a set of operational data associated with mental categories and a set of collections of mental categories;

- comparing, by the information processing device, a result of participating with the context by the human with a result of operating with the context by the at least one data processing algorithm enabling artificial intelligence based on the collection of mental categories formed;

- repeating, by the information processing device, the steps of allocating, forming and comparing until compared results match within predefined criteria, and

- acquiring, by the information processing device, based on matching results, artificial intelligence enabling the at least one data processing algorithm to process operational data originating from a context representing human participation with the context.

Those skilled in the art will appreciate that the information processing device may operate multiple data processing algorithms, such as but not limited to a data processing algorithm for performing the steps of obtaining, selecting, allocating and forming, and another separate data processing algorithm for performing the steps of comparing and acquiring.

Besides a single information processing device, parts of the processing of data according to the present method may be performed by multiple cooperating information processing devices, including so-called virtual machines, and information processing devices located at different geographic locations, which processing is deemed to be covered by the scope of the attached Claims.

Following the method presented, in case the information processing device operates multiple algorithms as indicated above, all such algorithms may be AI-enabled data processing algorithms.

In a second aspect, the present application comprises a data processing algorithm comprising artificial intelligence acquired in accordance with the data processing method disclosed in conjunction with the first aspect above. That is, a trained AI-enabled data processing algorithm.

In a third aspect, the present application provides a program product, comprising instructions stored on any of a transitory and a non-transitory medium readable by an information processing device, which instructions arranged to perform the method according to any of the facets disclosed above when these instructions are executed by an information processing device, including any of a computer and a computer application.

It is a further object of the present application to deploy a data processing algorithm comprising artificial intelligence obtained by the data processing method disclosed in accordance with any of the first, second and third aspects above.

Accordingly, a fourth aspect of the present application relates to a method of processing operational data originating from a context, the method performed by an information processing device operating a data processing algorithm comprising artificial intelligence acquired in accordance with any of the aspects disclosed above.

This fourth aspect of the present application relates to the actual use of a trained or learned AI-enabled data processing algorithm, by processing sensed operational data only and not requiring human bio-signal and human conduct data, while performing or handling a task, an operation or observation in a context based on the knowledge and skills of a human expert reflected in the artificial intelligence acquired by the AI-enabled data processing algorithm. That is, the operational data are processed representing human participation with the context.

Thus, in this aspect of the application, no human bio-signal data and/or human conduct data are required, although same may still be available, while the mental categories and collections of mental categories that have previously been formed continue to be used by the AI-enabled data processing algorithm, for example to provide internal representations of the operational data.

The artificial intelligence already acquired by the AI-enabled data processing algorithm may, in accordance with a further aspect of the present application, be modified by the information processing device based on operational data originating from the context.

For example, when operational data from the context indicate an error, conflict or other controversy in the performance of an operation or task, et cetera, by the information processing device operating the trained AI-enabled data processing algorithm, the artificial intelligence of the AI-enabled data processing algorithm may be corrected, updated, enhanced, or otherwise modified by the information processing device.

In a fifth aspect the present application provides a data processing system, comprising means arranged for performing the data processing method disclosed in conjunction with the first, second and third aspect above.

In general such a processing system includes at least one information processing device arranged for operating at least one AI-enabled data processing algorithm, equipment in data communication with the information processing device for sensing operational data originating from a context, human bio-signal data and human conduct data of a human participating in that context.

The present application provides a mechanism that assesses, correlates, outputs, or provides other products of human objective, subjective and intuitive intelligence, directly and automatically, optionally making use of but not explicitly requiring actions from a human participating in a given context. Using the methods outlined above, this allows aspects of human intelligence, such as used strategies, skills, categories, and logical reasoning, for example, to be learned by or otherwise transferred to an AI-enabled data processing algorithm - such as in the form of labels, weights, connections, neural network structure, model topology, functions, representations, meta parameters, decision trees, or descriptors - which can then reproduce such aspects autonomously, without requiring the participation of the human.

The use or involvement of bio-signals not only allows subconscious, intuitive, or otherwise automatic aspects of intelligence to be revealed and included, it also significantly improves ease of use and comfort to participate in an AI training context by a human user, but also avoids cognitive overload or any distraction from the ongoing context by possible complex to understand AI training or learning scenarios and instructions, for example.

The data input to the AI-enabled data processing algorithm is neither limited those data that can be consciously, explicitly generated by the human. The method presented may significantly speed up training and operation of an AI-enabled data processing algorithm compared to the training of AI-enabled data processing algorithms requiring explicit user actions, for example.

The present method, system, and program product results in what is called a Situationally Aware Mental Assessment for Neuroadaptive Artificial Intelligence, SAMANAI, tool that by which an AI-enabled data processing algorithm may acquire artificial intelligence from a human brain directly in contexts, environments or scenarios wherein the human participates, which contexts may comprise multiple sources of information, processes, tasks, events, etc.

This SAMANAI tool can be applied for increasing the learning rate of an AI-enabled data processing algorithm by integrating preprocessed evaluation of the human mind, with the effect that the learning will be quicker and less erroneous than using human input through AI training or learning scenarios and instructions button presses.

The SAMANAI tool can be applied to personalize any AI-enabled data processing algorithm, either a strong or weak AI, by assessing subjective and/or moral human values used in a given context environment and creating mental categories to be incorporated into the AI-enabled data processing algorithm, for future decision making in solving or completing a task, operation, or any type of handling based on these human values.

The SAMANAI tool enables context dependent valuations, interpretations, assertions, labelling, etc. by the AI-enabled data processing algorithm of operational data in contexts or environments, handling multiple, versatile, and non-predefined tasks.

As an untrained AI-enabled data processing algorithm is incapable of evaluating the world on its own, by definition, SAMANAI provides information to the learning process that would not be available otherwise.

The above-mentioned and other aspects of the present application are further illustrated in detail by means of the figures of the enclosed drawings.

Brief Description of the Figures

Figure 1 illustrates, schematically, a general set-up for practicing the present invention, both for training purposes and deployment in a real-life operational application.

Figure 2 shows a typical electrode placing of a passive brain-computer interface for registering brain activity signals based on electroencephalography, which can be used for operating the method according to the present application.

Figures 3 - 7 illustrate, schematically, an example based on the method according to the present application.

Figure 8 shows, in a graphical illustration, a comparison of the performance of the method according to the present application compared to prior art AI training methods, for the example illustrated of Figures 3 – 7.

Figure 9 illustrates, schematically, in a process type diagram, steps of an embodiment of the method according to the present application.

Detailed Description of the Figures

In Figure 1, reference numeral 10 schematically represents a particular context, illustrated by a dashed line, typically composed of a plurality of devices performing and handling multiple operations and producing operational data.

Non-limiting examples of such devices are audible alarms, illustrated by an alarm clock 11, sensing camera's such as a daylight camera 12 and/or a night vision Infra-Red, IR, camera 13, lighting devices 14, including flashing lights, temperature sensors or meters 15, traffic lights 16 and speedometers 17 in case of a driving vehicle context, for example, (virtual) buttons, keys or knobs 18 to be operated, audio equipment 19, message systems 20 presenting spoken, written or video messages, a display or displays 21, and one or more actuators represented by a motor 22.

Reference numeral 23 represents a software application, for example control software, simulation software, communication software, or so-called apps, also producing operational data.

Reference numeral 24 refers to at least one organism or living being, such as a person or persons, or an animal or animals acting in the context 10. In the light of the present application, the organism or living being forms part of the context 10 and acts performed by, and behavior observed from, such an organism or living being are treated as operational data originating from the context 10.

It is noted that operational data in the light of the present method also refers to environmental information, such as a weather forecast, schematically represented by reference numeral 25.

It will be appreciated that in practice a certain context may be comprised of more or less of the above mentioned devices or other devices, software, organisms or living beings like animals, for example. In practice, the devices 11-23 are also generally called objects, while organisms or living beings 24 are generally referred to as agents.

Reference numeral 30 refers to a human participant, such as a human expert, participating in or with the context 10. The manner and degree of participation or involvement of the human 30 may vary dependent on a respective context. In some scenarios the human 30 will only perceive actions and events occurring in a context 10 and has no control over the devices, for example, while in other scenarios the human 30 is also actively involved in the operations occurring in the context 10, such as pushing buttons 18, turning on lights 14, evoking alarms 11, etc.

Curved arrows 31, 32 schematically represent the human participation. Arrow 31 illustrates the perception of the context 10 by the human 30 and arrow 32 illustrates active interaction of the human 30 with the context 10, i.e. the human 30 is in charge with and/or controls tasks, processes and operations that occur in the context 10 and/or need to be accomplished.

Events, changes, adaptations, modifications etc. that happen in or in relation with the context 10, although not particularly focused on, may nevertheless attract attention, arousal or may otherwise be noticed 31 by the human 10, consciously or subconsciously.

Reference numeral 50 refers to an information processing device, typically including a computer, a computing device, a virtual machine, a server, or a plurality of cooperatively operating computers, computing devices, virtual machines, or servers, either operating stand-alone or on-site and/or in a cloud computing environment possibly at different geographic locations (not specifically illustrated).

The information processing device 50 operates at least one data processing algorithm 51 enabling artificial intelligence, hereinafter also referred to as an AI-enabled data processing algorithm, and is arranged for processing a plurality of operational or contextual data acquired from the devices, objects, environment, organisms and/or living beings 11 – 25 operating in the context 10.

Acquisition of operational data from the context 10 is illustrated by a curved arrow 58. Operational data for controlling, by the information processing device 50, of one or more of the devices operating in the context 10 is illustrated by a curved arrow 59.

Those skilled in the art will appreciate that the devices, objects, environment, organisms and/or living beings 11 – 25, when operating in the context 10, are in data communication with the information processing device 50, either via an individual or shared wired, wireless or cloud or internet data communication connection, for example operating an Internet-of-Things, IoT, a WiFi, a Bluetooth™ or any other present or future data communication protocol.

Bio-signals 33 of the human 30 participating with or in the context 10, including but not limited to electrical and non-electrical time-varying signals comprising any of human body bio-signals and measurements of human physiological structure and function, may be obtained from commercially available sensors or sensing devices 35, operatively connected to or directed at the human 30, as represented by curved arrow 36.

Reference numeral 35 generally represents bio-signal sensors or devices for use with the present application, and include direct and indirect measurements of electro cardiac activity, body temperature, eye movements, pupillometric, hemodynamic, electromyographic, electrodermal, oculomotor, respiratory, salivary, gastrointestinal, and genital activity.

The term indirect measurements here also refers to derivate measures of bio-signals, including physiological parameters such as heart rate variability, gaze, peak amplitudes, power in specific frequency bands, and signal rise and recovery times, for example.

The bio-signal sensors 35 are in data communication with the information processing device 50, as illustrated by curved arrow 46. The data communication 46 and/or the connection 36 to the human 30 may operate either via an individual or shared wired, wireless or cloud or internet data communication connection, for example operating an Internet-of-Things, IoT, a WiFi, a Bluetooth™ or any other present or future data communication protocol.

Brain waves and other measures of brain activity are also bio-signals for the purpose of the present application. Brain activity signals 33 of the human 30 participating with or in the context 10 may be provided by Brain-Computer Interface, BCI, in particular a passive Brain-Computer Interface, pBCI. In the embodiment shown, a pBCI is illustrated in two parts that are in data communication with each other, illustrated by a curved arrow 45 representing brain activity data of the human 30.

That is, a hardware part 37 for registering brain activity signals 33 of the human 30, such as a plurality of electrodes attached to the human head in the case of an electroencephalogram, EEG, and a software part 54 running on the information processing device 50 and operating one or a plurality of classifiers for processing the raw brain activity signals received from the hardware part 37 of the pBCI. Commercially available pBCI software 54 for use with the present method is known as BCILAB and OpenViBE, for example.

It is noted that the human bio-signal data communicated 46 to the information processing device 50 may likewise be processed by one or a plurality of classifiers arranged for processing the bio-signal data 46 received from the bio-signal sensors 35, and also using commercially available software operated by the information processing device 50.

Electroencephalography is a well-known electrophysiological monitoring method to record electrical activity on the scalp representing the activity of the surface layer of the brain underneath. It is typically non-invasive, with the electrodes placed along the scalp.

Figure 2 shows a typical electrode placing of the hardware part 37 of a pBCI for registering brain activity signals based on EEG and used for operating the present invention. The Hardware part 37 comprises several electrodes which are depicted as numbered small circles, such as circles 65, 66.

Instead of or in addition to recording brain activity data 45 by EEG or intracranial EEG, other recording techniques suitable for the purpose of the present invention are Magnetoencephalography, MEG, a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, functional Near-InfraRed Spectroscopy, fNIRS, that is a functional neuroimaging technique based on brain hemodynamics, functional Magnetic Resonance Imaging, fMRI, that measures brain activity by detecting changes associated with blood flow, or ElectroCorticoGraphy, ECoG, a type of electrophysiological monitoring that uses electrodes placed directly on an exposed surface of the brain, i.e. not on the scalp, to record electrical brain activity.

By the above-mentioned techniques, pBCI data are provided based on implicit or passive human participation, different from explicit or active, i.e. voluntary, intentional, conscious, human interaction with the context 10.

Measurements of the physiological state of the human 30 can be continuously monitored from the brain activity signals 33, for example by the pBCI 37, or a separate pBCI (not shown), as well as from measurement data provided by sensors and devices 35 attached or operatively connected to the human 30. In practice, prior to registering bio-signal data, a calibration procedure may have to be applied.

Human conduct data may be monitored or sensed by a number of commercially available sensors operatively connected with and/or aimed at the human participant 30, i.e. worn by or aimed at the human participant, as illustrated by curved arrow 47. Reference numeral 38 refers to a body motion sensor and reference numeral 39 refers to eye-tracking equipment. Other examples of human conduct data sensors or device for sensing human conduct data include but are not limited to input modalities comprising a keyboard, push buttons, switches, touch screen, mouse, joystick, electronic pencil/stylus, laser pointer, motion controller, game controller, microphones, cameras, thermal imagers, motion capture devices, pressure sensors, gyroscopes or other equipment for signaling a selection or decision for example.

Data communication of the human conduct sensors 38, 39 with the information processing device 50 is schematically illustrated by curved arrow 48. The data communication 48 and/or the connection 47 to the human 30 may operate either via an individual or shared wired, wireless or cloud or internet data communication connection, for example operating an Internet-of-Things, IoT, a WiFi, a Bluetooth™ or any other present or future data communication protocol.

It will be appreciated that the bio-signal sensors and human conduct sensors shown in Figure 1 and discussed above are just examples of suitable sensors and any other or future bio-signal sensor and/or human conduct sensor may be applied with the present invention.

Those skilled in the art will appreciate that the information processing device 50 may operate plural AI-enabled data processing algorithms 51 and/or plural algorithms for data sensing of sensors 35, 36, 37, 38, 39 and input/output of operational data 58, 59, processing and pre-processing in real-time or quasi real-time, and time-synchronization, in particular in a time critical context. That is, processing of at least one of human bio-signal data, operational data, and human conduct data for acquiring artificial intelligence input for the AI-enabled data processing algorithm 51, i.e. the part 52 thereof, from associating related operational data, human bio-signal data and human conduct data.

As well as for adapting aspects of the context 10, such as controlling the alarms 11, lighting 14, audio equipment 19, actuator(s) 22, etc. or purposely inducing or evoking probes and to evoke a response from the human 30, such as to evoke at least one mental category or a collection of mental categories, i.e. for the purpose of interactive learning, as explained in the Summary part above. In figure 1, such algorithms are collectively referred to by refence numeral 53.

For completeness's sake, reference numeral 55 represents a database or data repository or any other type of memory devices for storing data acquired and processed by the information processing device 50, such as is generally known. The database may be fully or partly located externally from the information processing device 50, for example remote in a cloud computing environment or data center, and/or be fully or partly located internally with the information processing device 50.

The database 55 may contain files, lists, libraries, or any other assembly of information for use in the processing of data according to the present invention, in particular data pertaining to mental categories and/or collections of mental categories, as generally designated by block 56. As disclosed in the Summary part above, the more data that become available from a person over time and in different contexts, the more history can build up a profile/model of that human's interpretations, knowledge, et cetera that can be referred to as a cognitive copy, which may be stored in the database 55.

When the information processing device 50 operates multiple algorithms 53 as described above, potentially all such algorithms may be adapted based on the data processing performed in accordance with the present method, inclusive adaptation of multiple operated AI-enabled data processing algorithms 51, and data storage 55 and respective contexts.

Operational data 58, 59 may comprise physical data produced by or for the control of physical devices, equipment, sensors, etc. in the context 10, such as technological device states like device input states, device output states, device operational states, device game states, computer aided design states, computer simulated design states, computer peripheral device states, computer-controlled machinery states and respective state changes, and acts performed by and behavior observed from an organism or living being, as well as so-called virtual operational data originating from the context 10. The latter are data relating to, for example, the software program or software application 23 operating in the context 10, and/or data received from the camera's 12, 13, for example, or any other sensor operating in the context 10.

Referring to the Summary part above, the present invention provides for a continuous and event-related monitoring of the human mindset and mental states of the human and allows an automatic view into the knowledge, intelligence, moral values, subjective and situational interpretations as well as human advise about tasks, processes, devices, and information perceived by the human.

In Figure 1, the human mindset, intelligence, strategies, skills, logic, values, subjectivity, objectivity and mental states, et cetera, are very schematically illustrated by the brain cloud 34.

Although a single human 30 is referred to in Figure 1, those skilled in the art will appreciate that the set-up presented is feasible for more than one human participating in or with the context 10, such as a group of people, by simply replicating any or all of the sensors 35, 37, 38, and using processing software adapted accordingly, for example. Schematically indicated by the further human 49.

It is noted that the human 49 may be located at the same or a different geographical location compared to the human 30. In the latter case, the human 49 may participate in the context 10 in that same is replicated or is otherwise partly or completely virtually made available to the human 49 or a group of humans 49.

The present application also comprises a program product comprising instructions stored on any of a transitory and a non-transitory medium 60 readable and executable by an information processing device 50.

The application further provides a data processing algorithm comprising artificial intelligence acquired in accordance with the present method disclosed above, generally referred to by reference numeral 61. The trained data processing algorithm 61 may be stored on any of a transitory and a non-transitory medium 60 readable and executable by an information processing device, as illustratively shown in Figure 1.

As will be appreciated, for an actual deployment of the trained AI-enabled data processing algorithm 61, participation of the human 30, 49 and hence the human bio-signal and human conduct data sensors 35, 37, 38, 39 are not required. The trained AI-enabled data processing algorithm may operate, handle, perform and complete an operation or task in a context 10 from obtaining operational data 58 as discussed above.

However, for improving, updating, enhancing or otherwise training or learning an already trained AI-enabled data processing algorithm the set-up discussed above may be used in a same manner as disclosed, provided that the AI-enabled data processing algorithm 51 is an already (partly) trained AI-enabled data processing algorithm.

As will be appreciated, in accordance with the present application, in addition to and/or in combination with the artificial intelligence acquired from human participation, the information processing device may also acquire or modify artificial intelligence of the AI-enabled data processing algorithm from operational data sensed from the context, i.e. originated from the context, in both training and deployment of an already trained AI-enabled data processing algorithm.

For example, when operational data from the context indicate an error, conflict or other controversy in the performance of an operation or task, et cetera, by the information processing device, the artificial intelligence of the AI-enabled data processing algorithm may be corrected, updated, enhanced, or otherwise modified by the information processing device. That is, even when no human takes part in the deployment of a trained AI-enabled data processing algorithm.

As an example, the present application may be used to acquire artificial intelligence in the context of automotive applications. Current and future fully or partially autonomously driving vehicles, e.g. "self-driving cars", may be equipped with any number of sensors to perceive objects, facts, quantities, properties, and other aspects and elements present in a context 10, both inside and outside of the vehicle.

For example, cameras, lidar, radar, sonar, thermometers, inertial measurement units, GPS, as well as virtual data provided using e.g. maps or other location-based databases may provide the vehicle's data processing algorithms, operated by the information processing device 50, with large quantities of operational data 58 concerning the vehicle's internal and external environment.

A human occupant 30 may be present in this vehicle, either actively controlling the vehicle, or as a passenger, for example. Alternatively, the human 30, or a second human 49 in case the human 30 controls the vehicle directly, may be present at a different geographic location with the vehicle's captured operational data 58 being relayed to them in an appropriate manner, as disclosed above.

At either location, additional sensors 38, 39 may capture human conduct data 48 inside the vehicle, such human conduct data 48 may, for example, consist of looking, braking, acceleration, and steering behaviors, whereas at an external location, human conduct data 48 may represent focus on the explicit identification, or labelling, of contextual elements, the approval or disapproval of certain behaviors of, for example, a human 30 controlling the vehicle, or the labelling of temporal sequences, as well as looking, for example.

The human or humans in question will simultaneously be equipped with bio-sensors, such as EEG 37 and heart rate sensors 35, to capture their bio-signal data. As such, this set-up provides for the simultaneous acquisition of operational data 58 from a context, human bio-signal data 46, and human conduct data 48.

Because of the presence of bio-signal sensors, all of the operational data can be associated, by the information processing device 50, with corresponding bio-signal data. Based on these bio-signal data - by the information processing device 50 - mental categories can be formed that represent various patterns present in the bio-signal data, such as patterns representing various mental states, or patterns representing various responses to specific parts of operational data. As such, each part of operational data is associated with at least one mental category. This association provides additional information concerning each part of operational data that could not have been obtained from the operational data alone, but relies on the availability and joint processing of at least the operational data and the human bio-signal data, imparting at least part of a human interpretation to the data and thus to the AI-enabled data processing algorithm using this data.

Once mental categories have been formed and sufficiently representative operational data has been collected, an AI-enabled data processing algorithm learns to interpret the operational data in terms of these mental categories directly, no longer needing the human bio-signal data. This approach thus provides a method to represent operational data based on mental categories, initially formed based on human bio-signal data, enabling an AI-enabled data processing algorithm to use this same representation during deployment.

Furthermore, in the setup described above, it will be possible for an algorithm operated by the information processing device 50 to select specific parts of the operational data based on their associations with, or information obtained from, the other data sources.

For example, when based on human conduct data 48, only operational data parts may be selected that, for example, correspond to gaze fixations, were gathered less than five seconds before specific human actions were performed, or were explicitly identified by a human in the course of labelling.

These selected operational data parts may additionally be represented in a collection of mental categories along with the corresponding conduct data that informed the selection, as well as the associated mental categories.

Similarly, selections of operational data may also be performed based on their associated mental states. For example, only operational data parts leading up to mental "error" states may be selected, or data parts comprising mental "high workload" states, or data parts following the identification of "fatigue". This allows a selection to be made by the information processing device of operational data parts that are difficult to identify based on operational properties, but can be easily and uniquely identified by a human.

For example, data parts can be selected, and collections of mental categories can be formed that are associated with mental categories representing perceived risk. When combined with additional AI generation steps, this approach provides a method to teach an AI-enabled data processing algorithm to recognize operational data representing risk.

The mental categories defined in this way can, using a supervised training machine learning paradigm, be used to teach an AI-enabled data processing algorithm to predict a risk measure associated with the operational data, for example. The training paradigm is minimizing the mismatch between the model prediction of the mental categories and the true categories defined above. In this way an AI-enabled data processing algorithm can be trained that is able to provide more meaningful labels that include a risk measure, for example.

This new labelling dimension represents a new interpretation of the operational data which involves the internal logic of a human brain and can be used in a larger AI system that is built with the purpose of autonomously steering a vehicle. Usually the goal for the latter AI is to achieve a performance that is better than the average human driver in terms of driving safety.

As another example, a predetermined mental category may be used to represent any number of aversive psychological states. Collections of mental categories can then be formed of operational data leading up to, or comprising, those psychological states. Based on these collections of mental categories, an AI-enabled data processing algorithm that is already capable of safe driving, for example an AI-enabled data processing algorithm achieved using the method according to the present application, may be further adapted, using a reinforcement learning training paradigm, to specifically avoid operational situations that lead to aversive psychological states, or conversely, to promote operational situations that lead to positive psychological states.

Among other things, this approach would allow an AI-enabled data processing algorithm to be adapted to the mental experiences of a specific human driver. Additionally, this approach may be used to add reactive driving functionality such as for instance "emergency braking" to an autonomous AI pilot by teaching this AI pilot to take evasive actions based on the metal category or risk associated with the currently analyzed operational data.

Figures 3, 4, 5, 6 and 7 illustrate an example to further clarify the method according to the present application. With reference to Figure 1, in this example, a human individual 30 has to perform a task that is comprised by elements displayed at the display 21. In the sense of the present application, these elements represent operational data 58.

Human bio-signal data from the human individual 30, obtained by the information processing device 50, comprise brain activity signals, recorded by a pBCI 37, 45, 54 as illustrated and disclosed above in conjunction with Figure 1 and Figure 2. Human conduct data of the individual 30 are obtained by the information processing device 50 from eye tracking data 48, using eye tracking equipment 39. That is, through the eye tracking equipment 39 the information processing device 50 is informed at which part of the operational data 58 momentarily displayed at the display 21 the human 30 is looking at, i.e. task-relevant behavior of the human 30.

With reference to Figure 3, in this example, a grid 70 of 25 elements 71 is displayed at the display 21 and visible to the human 30. Each element 71 consists of a written character surrounded by either a circle or a square. That is, an element 71 has two dimensions, i.e. it is either a circle 72 or a square 73 as a first dimension, and one of a written character b, d, p or q as a second dimension.

The task to be performed by the human 30 is to look at the elements 71 and to decide for the grid 70 as a whole whether or not this is a good or a bad grid or display, or a type one or a type two grid or display, for example. That is, the human 30 has to perform a decision making task, classifying the grid 70 as belonging to a first or a second different class.

The human 30 is given or may come up with a specific way or rule to classify the grid 70, as schematically illustrated in Figure 4. For example, if the grid 70 contains more b's in a circle than q's in a square, as indicated in Figure 4 top part, it is a "good" or type one grid 70 or display, otherwise it is a "bad" or type two grid 70 or display, respectively indicated by a thumb-up symbol 74 or a thumb-down symbol 75.

This rule is completely arbitrary and can be turned around, for example, as indicated in Figure 4 middle part, i.e. if there are fewer b's in circle than q's in a square, it is a good or type one grid 70, i.e. thumb-up 74, and otherwise it is a bad or type two grid 70, i.e. thumb-down 75.

Another rule may be, for example, if there is an equal number of b's in a circle and q's in a square, as shown in Figure 4 bottom part, it is a good or type one grid 70, i.e. thumb-up 74, and otherwise it is a bad or type two grid 70, i.e. thumb-down 75.

The rule can be made even more complicated, such as if there are more b's in a circle than q's in a square and if there are fewer than five b's and at least two q's it is a good or type one grid and otherwise it is a bad or type two grid. (Not shown).

Important is that the information processing device 50 operating the at least one AI-enabled data processing algorithm 51 is not informed about the decision rule applied by the human 30. That is, the human 30 has some strategy to perform the task but the information processing device 50 does not know this strategy.

Using known or traditional learning or training techniques for training an AI-enabled data processing algorithm, such as but not limited to a machine learning algorithm based on reinforcement learning allowing to acquire artificial intelligence from trial and error, or using deep reinforcement learning, the AI-enabled data processing algorithm can be taught the applicable decision rule and to perform the task by giving the raw data to the algorithm, as illustrated in Figure 5.

That is, the AI-enabled data processing algorithm is informed about all the elements 71 in the grid 70, along with the final decision made for each grid 70, for example by the person 'telling' the information processing device, i.e. the AI-enabled data processing algorithm, for each grid, whether it is a good or bad grid 70 or a type one or type two grid 70, for example.

For example, the top part of Figure 5 representing a grid 70 comprising 25 elements 71 (not all shown in the figure) is classified by the human 30 as a bad or type two grid, i.e. thumb-down 75. The middle part of Figure 5 representing a grid 70 comprising 25 elements 71 (not all shown in the figure) is likewise classified by the human 30 as a bad or type two grid, i.e. thumb-down 75. The bottom part of Figure 5 representing a grid 70 comprising 25 elements 71 (not all shown in the figure) is classified by the human 30 as a good or type one grid, i.e. thumb-up 74, et cetera.

With the above sequence repeated many times, for example up to thousand or more times, eventually the AI-enabled data processing algorithm will be able to infer the decision rule and perform the task according to the decision rule applied by the human 30.

In accordance with the method of the present application, different from the traditional or known manners of AI learning or training, the artificial intelligence for the AI-enabled data processing algorithm is acquired by the information processing device 50 using sensed bio-signal data and human conduct data, i.e. in this example the brain activity data from the pBCI 37, 45, 54 and the eye tracking equipment 39, respectively.

That is, as shown in Figure 6, based on the sensed human conduct data and the human bio-signal data, while looking by the human 30 at the grid 70, the information processing device 50 may detect a pattern in the bio-signal data that some elements 71 of the grid elicit different brain activity than all the other elements of the grid. For example, the elements 76, 77, 78 and 79 indicated in the grid 70 of Figure 6 elicit a different brain activity than all the other elements 70.

In this example, the pBCI 37, 45, 50 operates a number of classifiers to distinguish different brain activity in the brain 33 of the human 30. For this example it is not known or important what type of brain activity the classifiers operate at, only that same are different. With reference to Figure 6, the elements 77 and 78, for example, may elicit a different brain activity than the elements 76 and 79.

Based on the above, in accordance with the present application, mental categories may be associated with the elements 70 in the grid of Figure 6. That is, the elements 76, 77, 78 and 79 appear grouped together in one mental category, while the other elements may constitute a different second, non-overlapping mental category, with these categories essentially reflecting the fact that elements 76, 77, 78, and 79 are relevant to performing the task, i.e. used by the human to make the decision, while the others may not be relevant. And, depending on the number of classifiers and their performance accuracy, the same or a further classifier may provide a basis for the q's in a square 76, 79 to be separated from the b's in a circle 77, 78 in yet further mental categories.

As such, in this example, there may be at least four mental categories associated with the various elements 71 appearing in a grid 70: a first mental category of "irrelevant" elements which the human does not use for a decision, a second mental category of "relevant" elements 76, 77, 78, 79 which the human does use to base a decision on, and a third and fourth mental category possibly hierarchically contained within the "relevant" category that further subdivide same into q-square 76, 79 and b-circle 77, 78, respectively.

These mental categories thus reflect the different meaning these elements have to the human 30 in solving the task, based on the decision rule applied. It is repeated that the decision rule applied by the human 30 is not known to the information processing device 50, is essentially arbitrary for the purpose of this example, and that the above designations referring to specific elements 76, 77, 78, and 79 as informing the decision are similarly arbitrary.

The mental categories may be named or labelled based on the type of human bio-signal data or human conduct data corresponding to a respective mental category.

Now having established different mental categories, same can be input into the AI-enabled data processing algorithm 51, such that the AI has more information and forming a different perspective than with the traditional AI learning illustrated above with reference to Figure 5.

Different from the set up disclosed with the example above, in which the mental categories are formed by the information processing device from the related operational, human bio-signal data and human conduct data sensed, the information processing device may be informed beforehand of certain pre-determined mental categories, pre-determined bio-signal data and/or pre-determined human conduct data applicable to the performance of the task or operation, for example. In the case of a pBCI, for example, classifiers pointing to a particular mental category may be known beforehand, or it may be known that a certain heart rate or variability in the heart rate may point to a certain mental category.

When a specific classifier or set of classifiers is known to be responsive to "relevant" elements, for example, a mental category based on the corresponding output of the respective classifier or classifiers may be predetermined. This as elucidated in the Summary part above.

When showing different grids 70 to the human 30, for example the grids as illustrated in Figure 5, the result of applying the method according to the present application is an additional representation of the data grids based on the above-mentioned first, second, third and fourth mental categories formed, indicated by reference numerals 80, 81, 82 and 83, respectively, as schematically illustrated in Figure 7.

Once the AI-enabled data processing algorithm has acquired artificial intelligence in accordance with the present method, i.e. after applying a number of different grids 70 and processing the related operational, bio-signal end human conduct data, when providing a new grid 70 to the trained data processing algorithm operated by an information processing device, same may translate the new grid, i.e. the features or elements of the real world, into mental categories and solve a new task based on the mental categories obtained. That is, sensing operational data from a real-world context and mapping same with certain mental categories or collections of mental categories, as disclosed in the Summary part above.

With the present method, an AI has been generated that can use a mental representation learned from a human expert in its own logic.

The present manner of mimicking, by an AI, a strategy based on mental categories learned from a human individual adheres to or connects excellently to the way the human brain considers people, objects and actions are related and reflect what kind of learning may be going on in the brain.

Figure 8 shows, in a graphical illustration 85, based on simulated data, the difference between traditional training of an AI-enabled data processing algorithm just from the raw data, i.e. the graph 86, compared to acquiring AI in accordance with the present method, illustrated by graph 87. In the graphical illustration 85, the number of grids or training samples 70 provided are set along the horizontal axis, and the performance provided by the trained AI is indicated along the vertical axis, in a number ranging from 0, i.e. no performance, to 1, i.e. excellent performance.

As can be clearly seen form Figure 8, the method according to the present application performs already from the start significantly better than the prior art methods, i.e. even with a relative low number of grids or training samples.

Figure 9 illustrates, in a process type diagram, steps of an embodiment of the method according to the present application, implemented in an information processing device 100 operating two AI-enabled data processing algorithms, indicated by reference numerals 101 and 102, respectively.

In a first step 103, sensed operational data originating from a context and human bio-signal data and human conduct data relating to human participation with this context are obtained by the information processing device 100.

In a second step 104, a first or initial training is performed, starting with a process for selection 105 of operational data of interest, based on at least one of the human bio-signal data and human conduct data related to this operational data.

To the thus selected operational data and corresponding bio-signal and human conduct data, indicated as a whole by reference numeral 106, the first AI-enabled data processing algorithm 101 allocates 107 a plurality of mental categories 108. A mental category comprising part of the selected operational data associated with at least one of the human bio-signal data and the human conduct data corresponding to that mental category.

The allocation step 107 may comprise several intermediate steps like sorting, grouping, and performing a mental assessment of the data, for example, not shown.

The mental categories 108 are inputted as data 109 at the second AI-enabled data processing algorithm 102, by which one or more collections of mental categories 110 is or are formed. A collection of mental categories comprises at least one of a set of operational data associated with mental categories and a set of collections of mental categories. The collections of mental categories 110 formed describe the operational data as provided from the human participating in the context, i.e. a human performing a task with the context, for example.

After this first or initializing step 104, in which the first and second AI-enabled data processing algorithms 101, 102 are initialized, based on the sensed data 103, a training or analysis step 114 is performed by the first AI-enabled data processing algorithm 101. In this second training 114, from the sensed data 103, operational data and corresponding bio-signal and human conduct data 116 are selected 115, and the thus selected data 116 are processed by the AI-enabled data processing algorithm 101.

This results in mental categories 118 that are inputted 119 at the now initialized second AI-enabled data processing algorithm 102, by which one or more collections of mental categories 120 is or are formed. Based on the input data 119 and the collections mental categories 120, the second AI-enabled data processing algorithm 102 processes a result 122 as if the information processing device 100 operated with the context in performing a task, operation or other handling with the context.

The result 122 is now compared 123, 124 with a result 125 directly obtained from the human participation in the context, performing the same task, operating or handling with the context as the information processing device 100 leading to result 122.

Based on this comparison, the above steps of allocating, forming and comparing may be repeated 126, i.e. result "no" of the comparing step, until the compared decisions match within predefined criteria 124, i.e. result "yes" of the comparing step.

In the repeating step 126 several processing steps may be performed at the mental categories 108 and/or at the algorithm forming them 107, based on the result of the comparing step 123, 124, as illustrated in block 126. For example, the creation of new mental categories, strategies, et cetera, and comparison with the previous mental categories, as schematically illustrated in block 126.

Eventually, the resulting mental categories and training of the first and second AI-enabled data processing algorithms 101, 102 results in artificial intelligence 127 enabling the information processing device 100 to process operational data originating from a context representing human participation with the context.

The order of the above steps may be interchanged, and steps may be executed in parallel, for example.

For an expert, further modifications and adjustments are conceivable based on the above-described embodiments, which further modifications and adjustments are all considered to be encompassed by the enclosed claims.

Conclusies

1. Werkwijze voor het verwerken van data, uitgevoerd door een informatieverwerkingsinrichting waarop tenminste één dataverwerkingsalgoritme werkzaam is dat kunstmatige intelligentie verschaft, welke werkwijze omvat het waarnemen van operationele data afkomstig van een context en menselijke bio-signaaldata en menselijke gedragsdata met betrekking tot menselijke participatie in deze context, waarin de kunstmatige intelligentie door de informatieverwerkingsinrichting wordt verworven uit het associëren van gerelateerde operationele data, menselijke bio-signaaldata en menselijke gedragsdata.

2. Werkwijze volgens conclusie 1, waarin een selectie van de gerelateerde operationele data, menselijke bio-signaaldata en menselijke gedragsdata door de informatieverwerkingsinrichting wordt geassocieerd, welke selectie wordt gebaseerd op ten minste één van de waargenomen operationele data, menselijke bio-signaaldata en menselijke gedragsdata.

3. Werkwijze volgens conclusie 1 of 2, waarin de kunstmatige intelligentie door de informatieverwerkingsinrichting wordt verworven op basis van ten minste één mentale categorie, waarin een mentale categorie een gedeelte van de operationele data omvat dat is geassocieerd met ten minste één van de menselijke bio-signaaldata en de menselijke gedragsdata die met de betreffende mentale categorie corresponderen.

4. Werkwijze volgens conclusie 3, waarin de ten minste ene mentale categorie ten minste één vooraf bepaalde mentale categorie omvat.

5. Werkwijze volgens conclusie 3 of 4, waarin de ten minste ene mentale categorie ten minste één mentale categorie omvat die door de informatieverwerkingsinrichting wordt gevormd op basis van ten minste één van de menselijke bio-signaaldata en menselijke gedragsdata en hiermee gerelateerde operationele data.

6. Werkwijze volgens conclusie 5, waarin de ten minste ene mentale categorie door de informatieverwerkingsinrichting wordt gevormd op basis van ten minste één van vooraf bepaalde menselijke bio-signaaldata en vooraf bepaalde menselijke gedragsdata.

7. Werkwijze volgens een van de conclusies 3 - 6, waarin de kunstmatige intelligentie wordt verworven op basis van een verzameling van mentale categorieën, waarin een verzameling van mentale categorieën ten minste één is van een set van operationele data geassocieerd met mentale categorieën en een set van verzamelingen van mentale categorieën.

8. Werkwijze volgens conclusie 7, waarin de kunstmatige intelligentie wordt verworven op basis van een verzameling van mentale categorieën en corresponderende menselijke gedragsdata.

9. Werkwijze volgens conclusie 7 of 8, waarin het verwerven van de kunstmatige intelligentie omvat het verrijken van labels op basis van ten minste één van een mentale categorie en een verzameling van mentale categorieën.

10. Werkwijze volgens een van de voorgaande conclusies, waarin operationele data door de informatieverwerkingsinrichting teweeg worden gebracht.

11. Werkwijze volgens conclusie 10, afhankelijk van conclusie 3, waarin operationele data door de informatieverwerkingsinrichting teweeg worden gebracht om ten minste één mentale categorie voort te brengen.

12. Werkwijze volgens conclusie 10, afhankelijk van conclusie 7, waarin operationele data door de informatieverwerkingsinrichting teweeg worden veroorzaakt om ten minste één verzameling van mentale categorieën voort te brengen.

13. Werkwijze volgens een van de voorgaande conclusies, waarin de menselijke bio-signaaldata worden waargenomen door ten minste één sensor die werkzaam is verbonden met de menselijke participant, welke menselijke bio-signaaldata een omvatten van menselijke bio-signalen en metingen van menselijke fysiologische structuur en functie, waaronder begrepen maar niet beperkt tot ten minste één van directe en indirecte metingen van elektrocardiologische activiteit, lichaamstemperatuur, oogbewegingen, pupillometrische, hemodynamische, elektromyografische, elektrodermale, oculomotorische, respiratoire, speeksel-, gastro-intestinale, genitale en hersenactiviteit, en de menselijk gedragsdata een omvatten van menselijke uitdrukkingen, communicatie en

fysieke activiteit waargenomen door ten minste één sensor die werkzaam is verbonden met de menselijke participant, waaronder begrepen maar niet beperkt tot invoermodaliteiten omvattende een toetsenbord, drukknoppen, schakelaars, aanraakscherm, muis, joystick, elektronisch pen/stylus, laserpointer, bewegingsstuurorgaan, spelstuurorgaan, microfoons, camera's, warmtebeeld-camera's, inrichtingen voor bewegingsregistratie, druksensoren en gyroscopen.

14. Werkwijze volgens conclusie 13, waarin menselijke hersenactiviteitsdata door ten minste één hersen-computerinterface worden verwerkt, in het bijzonder ten minste één passieve hersen-computerinterface werkzaam met ten minste één classificator die op de menselijke hersenactiviteit reageert.

15. Werkwijze volgens een van de voorgaande conclusies, waarin de operationele data ten minste één omvatten van fysieke data en virtuele data afkomstig van de context.

16. Werkwijze volgens een van de voorgaande conclusies, waarin de operationele data, de menselijke bio-signaaldata en de menselijke gedragsdata data omvatten welke zijn waargenomen van ten minste één individu of een groep van individuen.

17. Werkwijze volgens een van de voorgaande conclusies, omvattende de stappen van het:

- verkrijgen, door de informatieverwerkingsinrichting, van waargenomen operationele data afkomstig van een context en menselijke bio-signaaldata en menselijke gedragsdata gerelateerd aan menselijke participatie in de context;
- selecteren, door de informatieverwerkingsinrichting, op basis van ten minste één van de menselijke bio-signaaldata en menselijke gedragsdata, van gerelateerde operationele data;
- toewijzen, door de informatieverwerkingsinrichting, op basis van ten minste één van de menselijke bio-signaaldata en menselijke gedragsdata, van een veelheid mentale categorieën, waarin een mentale categorie een gedeelte omvat van de geselecteerde operationele data geassocieerd met ten minste één van de menselijke bio-signaaldata en de menselijke gedragsdata corresponderend met de betreffende mentale categorie;
- vormen, door de informatieverwerkingsinrichting, van een verzameling van mentale categorieën, waarin een verzameling van mentale categorieën ten minste één is

van een set van operationele data geassocieerd met mentale categorieën en een set van verzamelingen van mentale categorieën;

- vergelijken, door de informatieverwerkingsinrichting, van een resultaat van menselijk participatie in de context met een resultaat van het in de context werkzaam zijn door het tenminste ene dataverwerkingsalgoritme dat kunstmatige intelligentie verschaft op basis van de gevormde verzameling van mentale categorieën;

- herhalen, door de informatieverwerkingsinrichting, van de stappen van het toewijzen, vormen en vergelijken totdat de vergeleken resultaten binnen vooraf gedefinieerde criteria overeenkomen, en

- verwerven, door de informatieverwerkingsinrichting, op basis van overeenkomende resultaten, van kunstmatige intelligentie welke het tenminste ene dataverwerkingsalgoritme in staat stelt operationele data afkomstig van een context te verwerken, aldus menselijke participatie in de context representerend.

18. Werkwijze volgens conclusie 17, waarin de stappen van het selecteren, toewijzen en vormen en de stappen van produceren en vergelijken door afzonderlijke, op de informatieverwerkingsinrichting werkzame, dataverwerkingsalgoritmen worden uitgevoerd.

19. Dataverwerkingsalgoritme omvattende kunstmatige intelligentie verworven in overeenstemming met de werkwijze volgens een van de voorgaande conclusies.

20. Programmaproduct, omvattende instructies opgeslagen op een van een door een informatieverwerkingsinrichting leesbaar vluchtig en niet-vluchtig medium, welke instructies zijn ingericht voor het uitvoeren van de werkwijze volgens een van de conclusies 1 – 19, wanneer deze instructies worden uitgevoerd door een informatieverwerkingsinrichting, waaronder begrepen een van een computer en een computerapplicatie.

21. Werkwijze voor het verwerken van operationele data afkomstig van een context, welke werkwijze wordt uitgevoerd door een informatieverwerkingsinrichting waarop een dataverwerkingsalgoritme werkzaam is omvattende kunstmatige intelligentie verworven in overeenstemming met een van de voorgaande conclusies.

22. Werkwijze volgens conclusie 21, waarin de kunstmatige intelligentie van het dataverwerkingsalgoritme door de informatieverwerkingsinrichting op basis van operationele data afkomstig van de context wordt gemodificeerd.

23. Dataverwerkingssysteem, omvattende middelen ingericht voor het uitvoeren van de werkwijze voor het verwerken van data volgens een van de conclusies 1 - 22.

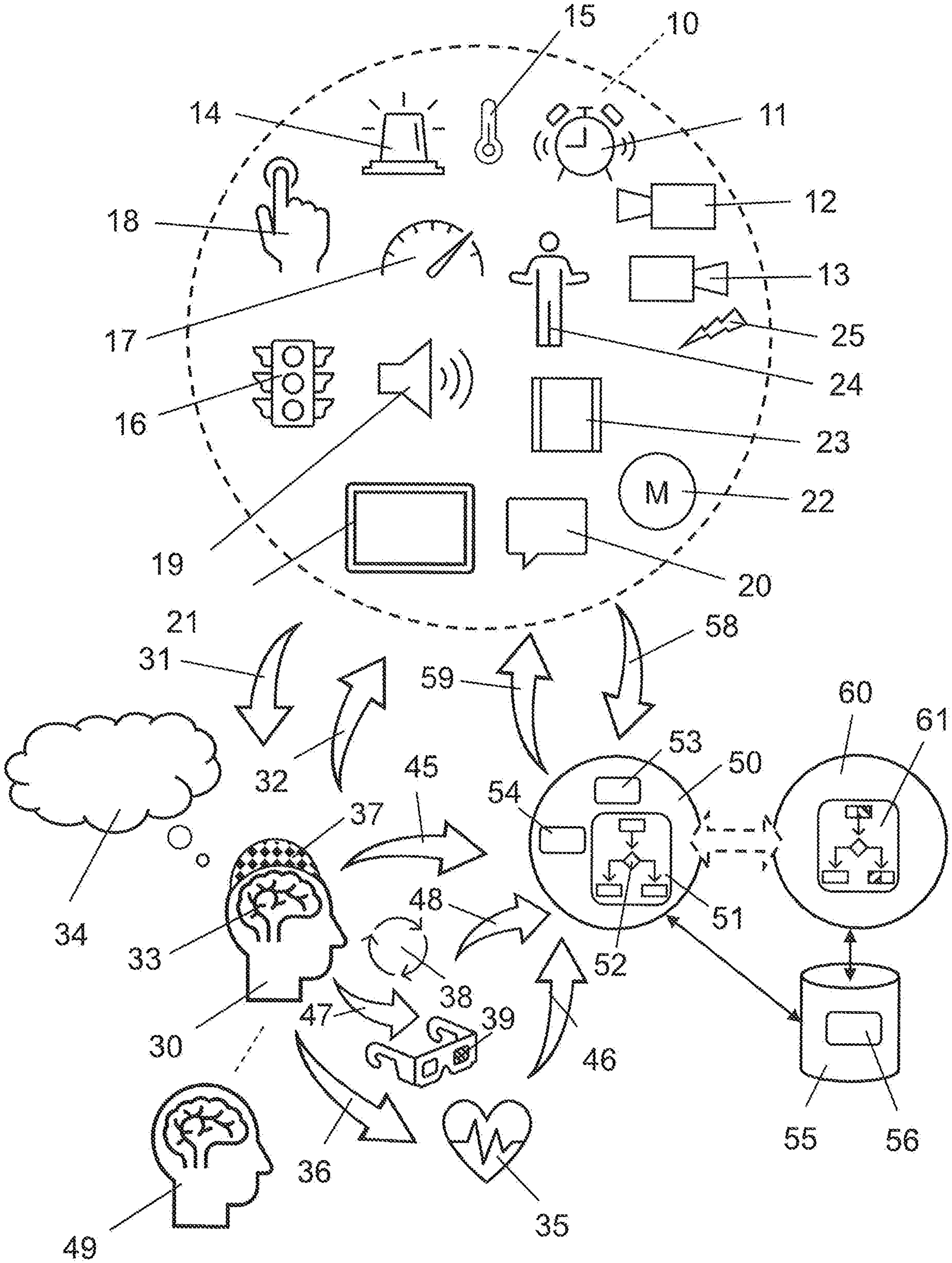
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Fig. 1

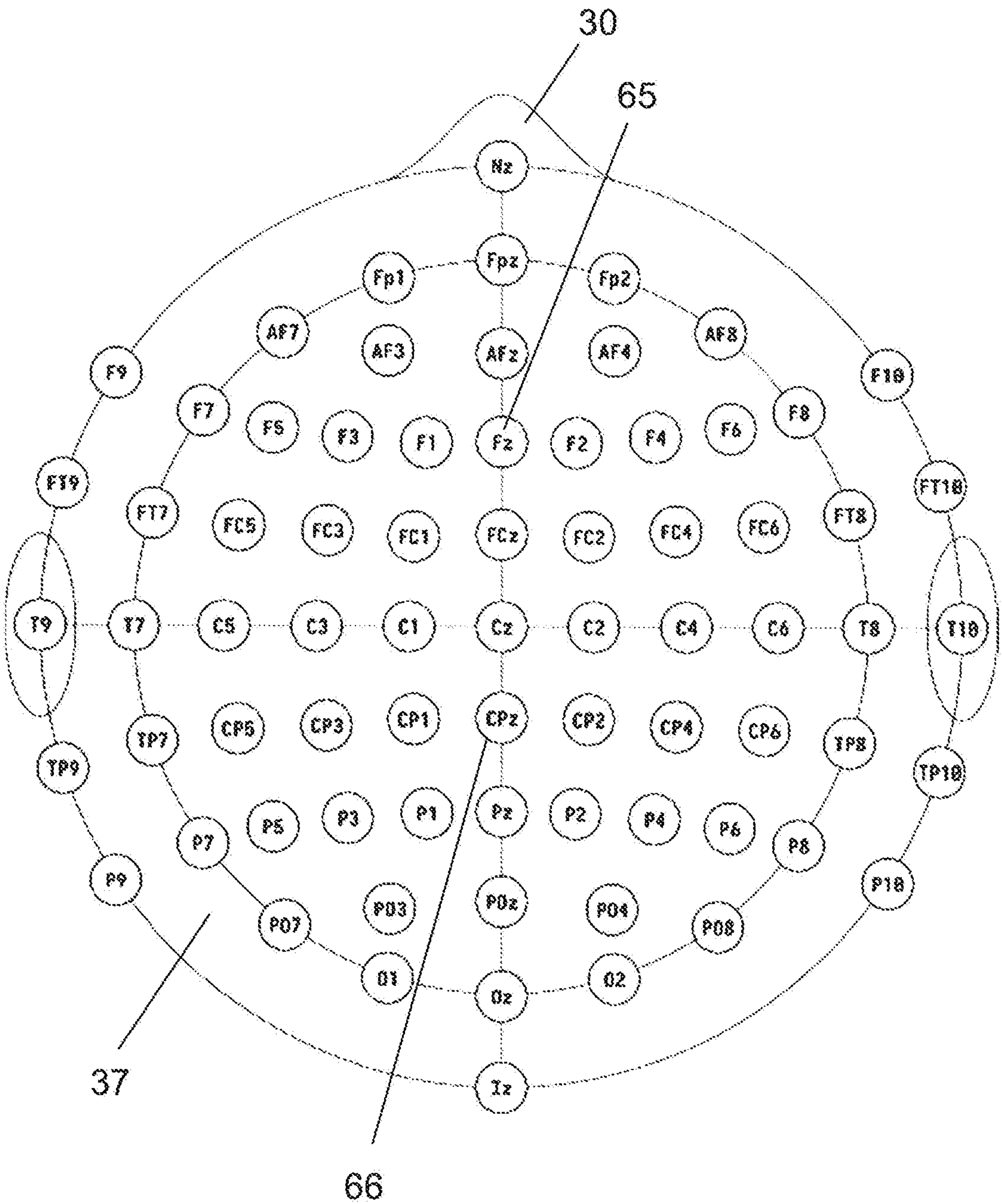
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Fig. 2

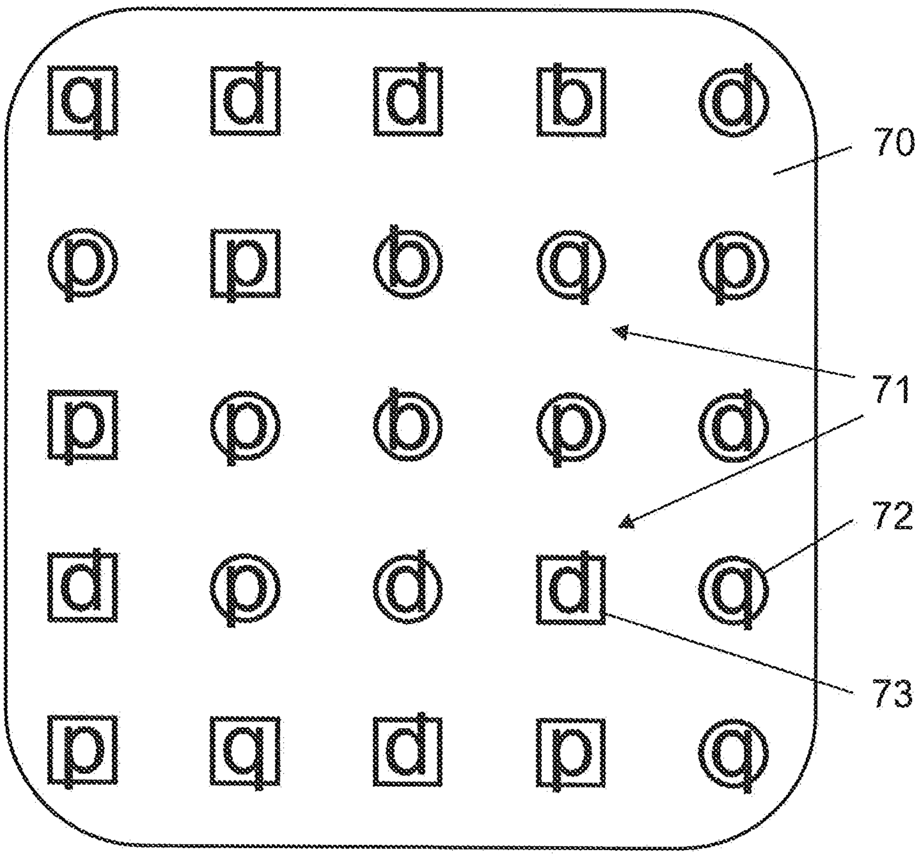


Fig. 3

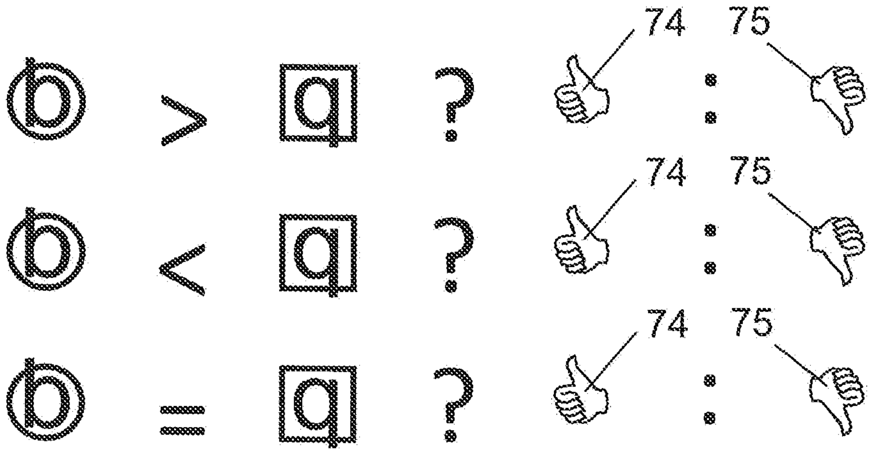
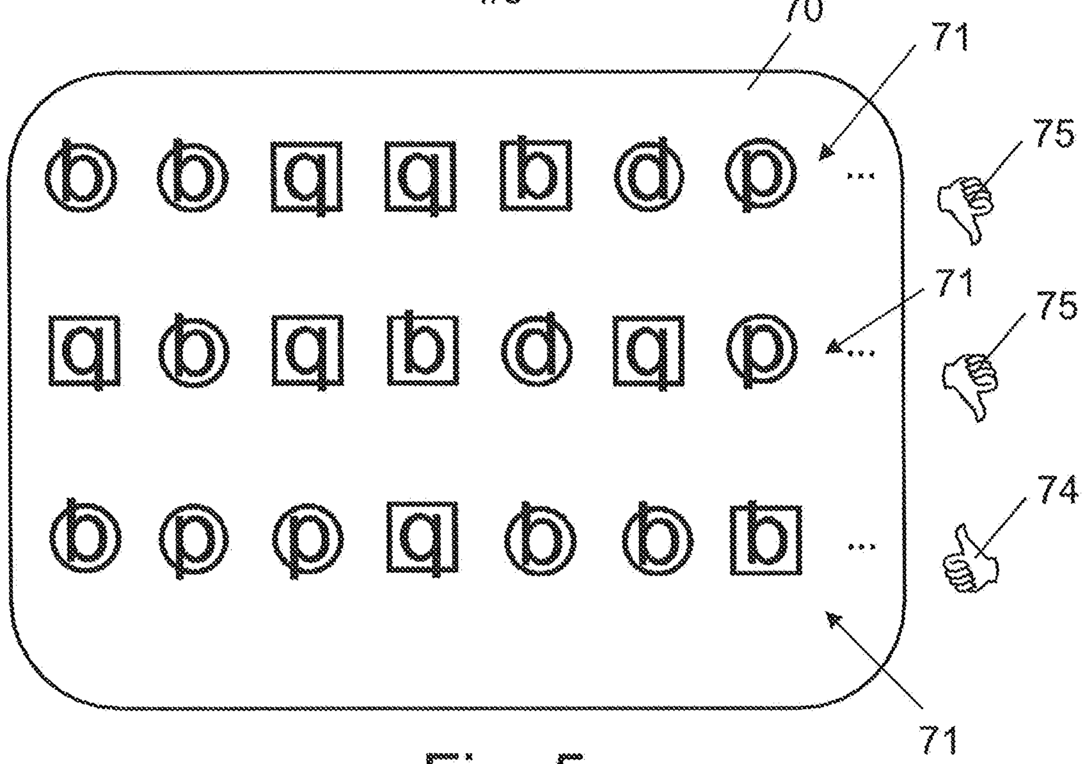


Fig. 4



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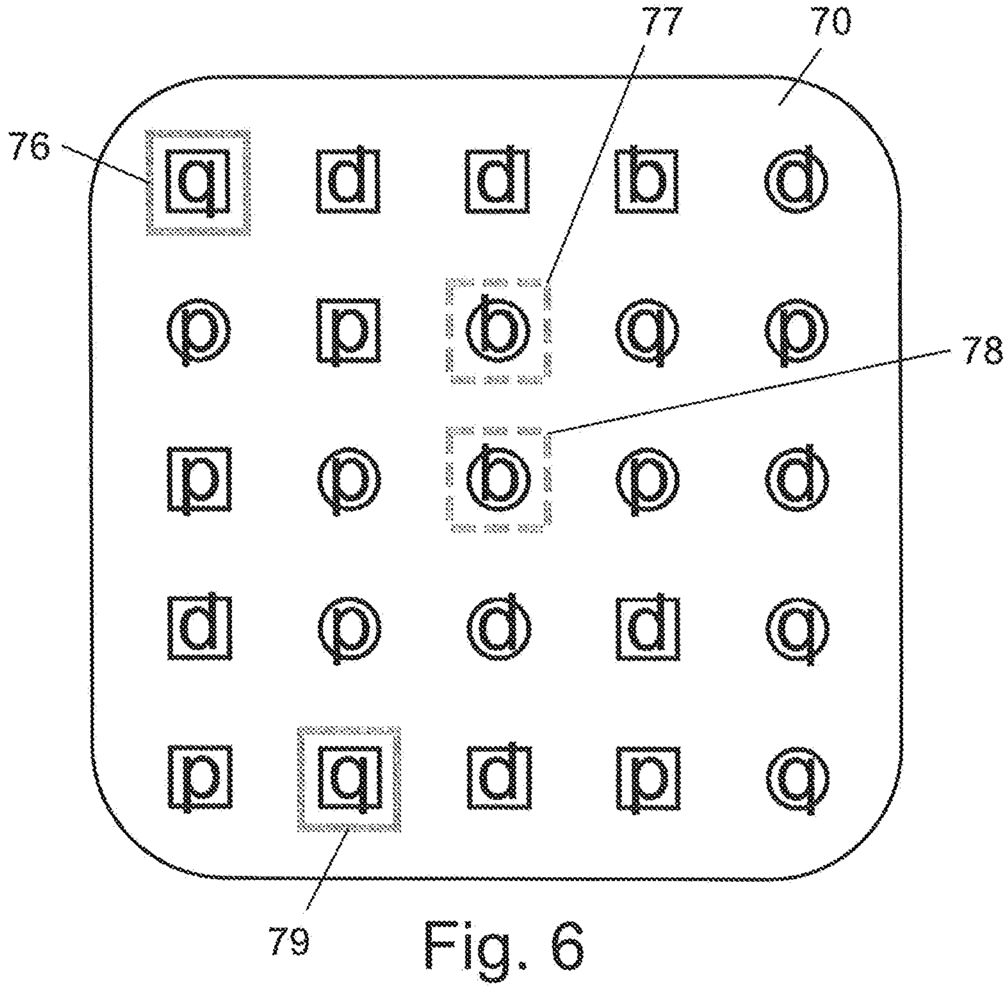
q b q b d q p ...
b p p q b b b ...

Fig. 5



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p p b p d
d p d d q
p q d p q

Fig. 6

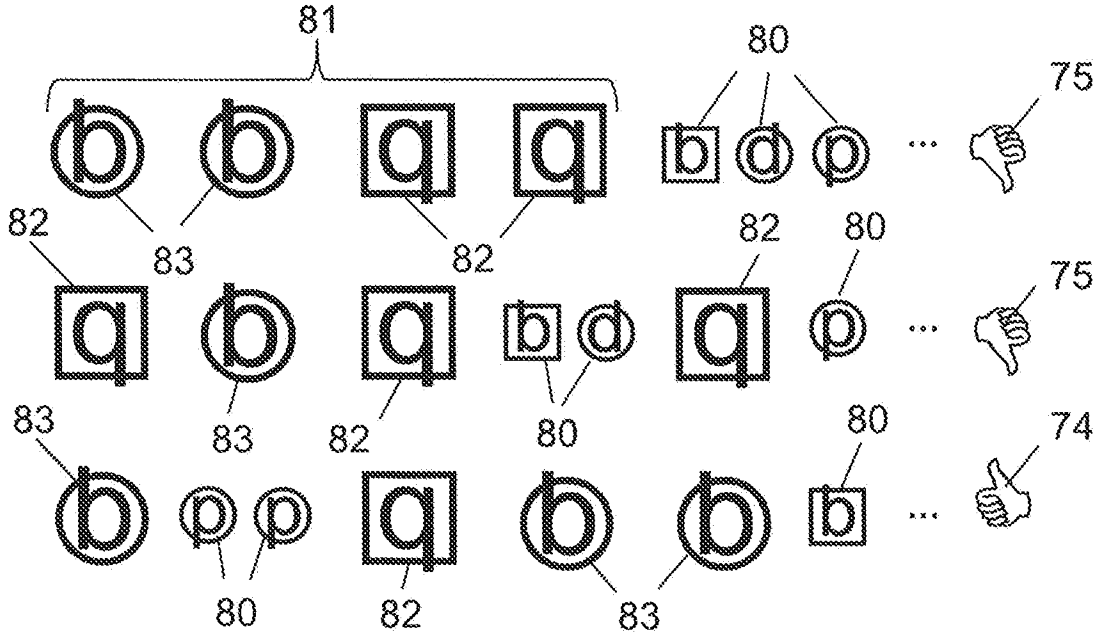

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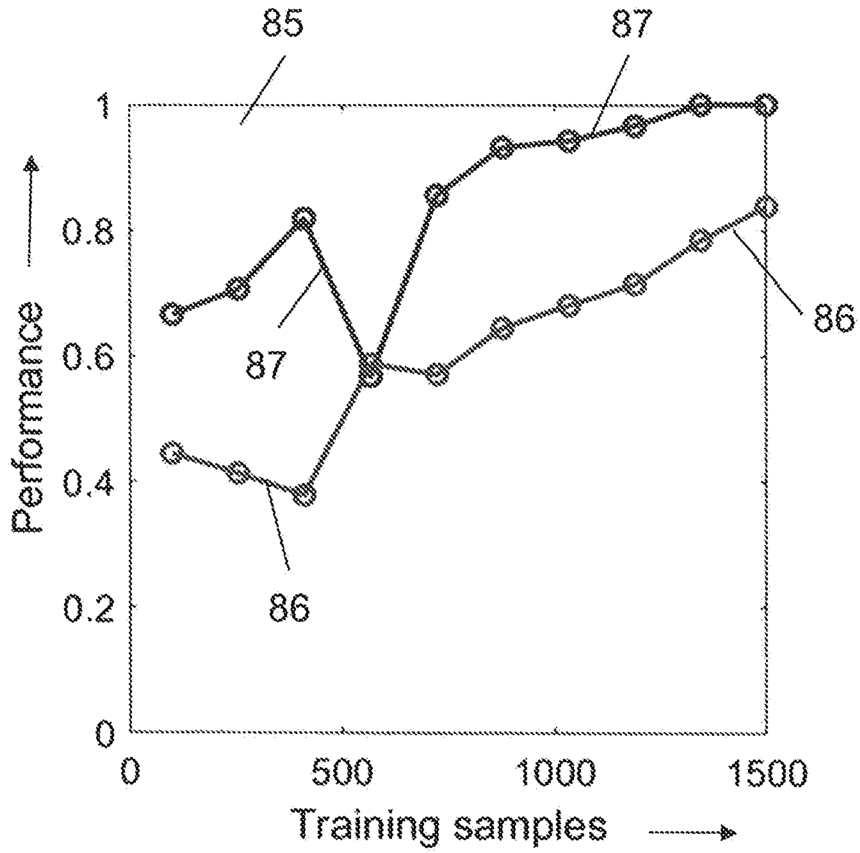
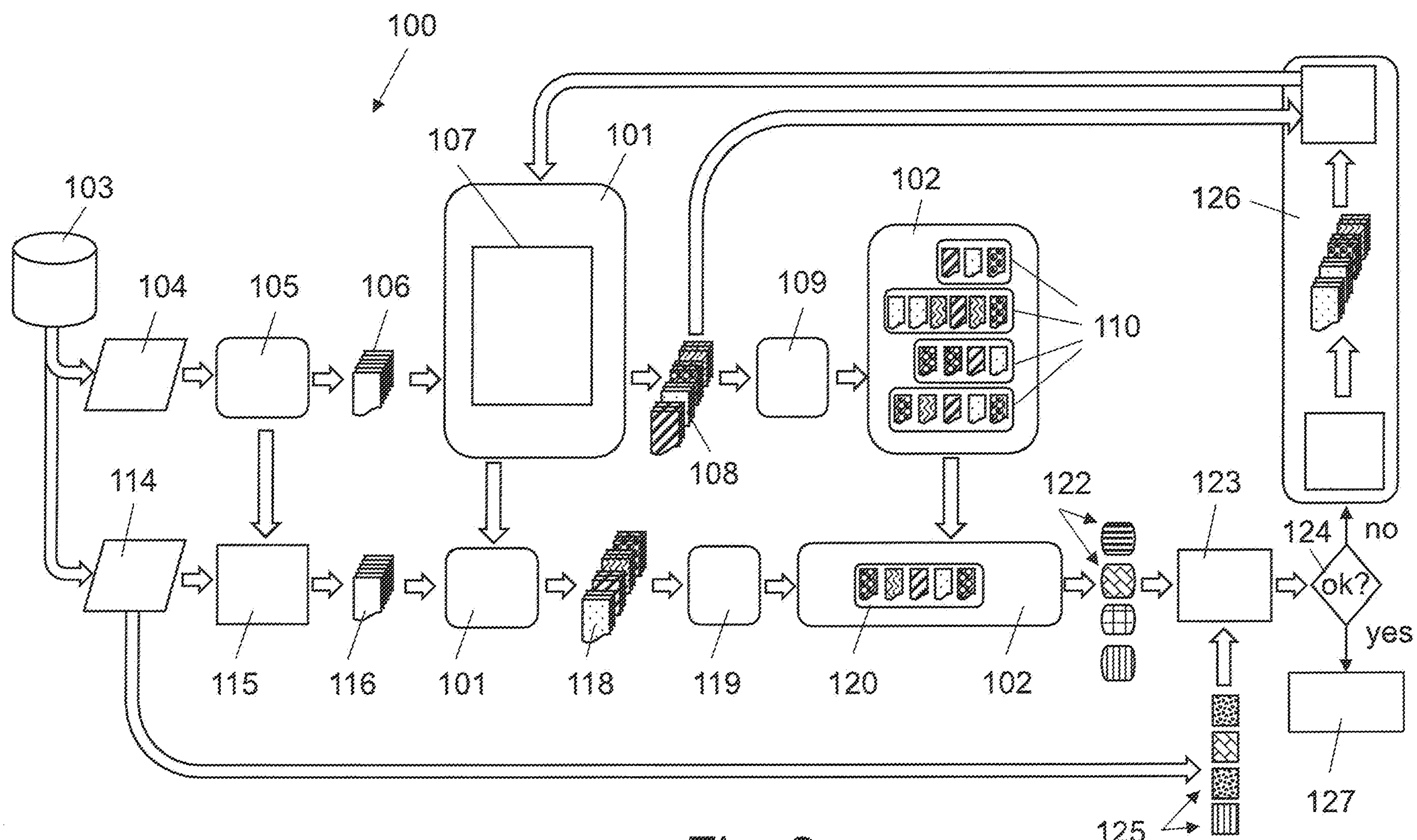
Fig. 7



85
87
Performance
0
0.2
0.4
0.6
0.8
1
0
500
1000
1500
Training samples
87
86
86

Fig. 8



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122
123
124
ok?
no
yes
125
126
127

Fig. 9

Rijksdienst voor Ondernemend Nederland

OCTROOIAANVRAAG NR.:

NO 142526
NL 1044409

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie(IPC)
X	US 2019/101985 A1 (SAJDA PAUL [US] ET AL) 4 april 2019 (2019-04-04) * samenvatting * * alinea [0005] * * alinea [0020] - alinea [0031] * * alinea [0057] - alinea [0066] * * figuur 9 * -----	1-20	INV. G06N20/00 G06F3/01 G06F3/02 G06F3/033 G06F3/041
X	EP 3 561 645 A1 (FUJITSU LTD [JP]) 30 oktober 2019 (2019-10-30) * samenvatting * * alinea [0004] * * alinea [0025] - alinea [0035] * * alinea [0049] - alinea [0055] * * figuren 2, 3 * -----	1-23	
X	EP 3 629 243 A1 (INTEL CORP [US]) 1 april 2020 (2020-04-01) * samenvatting * * alinea [0036] - alinea [0038] * * alinea [0062] - alinea [0063] * -----	1-23	

Onderzochte gebieden van de techniek
G06N G06F

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
's-Gravenhage	15 februari 2023	Papadakis, Georgios

[1] NDERLINCATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

EOB FORM 02.83 (P0414B)

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 142526
NL 1044409

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd;; de gegevens worden verstrekt voor informatiedoeleinden.

15-02-2023

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 2019101985 A1	04-04-2019	US 2019101985 A1	04-04-2019
		WO 2017177128 A1	12-10-2017
EP 3561645 A1	30-10-2019	EP 3561645 A1	30-10-2019
		JP 2019192207 A	31-10-2019
		US 2019332931 A1	31-10-2019
EP 3629243 A1	01-04-2020	CN 110969257 A	07-04-2020
		EP 3629243 A1	01-04-2020
		US 2019042894 A1	07-02-2019

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO142526	30.08.2022		NL1044409
CLASSIFICATIE INV. G06N20/00 G06F3/01 G06F3/02 G06F3/033 G06F3/041			
AANVRAGER Zander Laboratories B.V.			

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☒ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR
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Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1044409

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Deze motivering is opgesteld, met betrekking tot **nucleotide- en/of aminozuursequenties** die genoemd worden in de aanvraag, op basis van een sequentielijst die:

   a. ☐ is opgenomen in de aanvraag zoals deze oorspronkelijk is ingediend

   b. ☐ aangeleverd is na de indieningsdatum ten behoeve van het onderzoek

   ☐ en vergezeld ging van een verklaring dat de sequentielijst niet meer informatie bevat dan de aanvraag zoals deze oorspronkelijk is ingediend.

3. ☐ Deze motivering is opgesteld, met betrekking tot nucleotide- en/of aminozuursequenties die genoemd worden in de aanvraag, voor zover een zinvolle motivering gevormd kon worden zonder een sequentielijst die voldeed aan WIPO standaard ST.26.

4. Overige opmerkingen:

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies	
	Nee:	Conclusies	1-23
Inventiviteit	Ja:	Conclusies	
	Nee:	Conclusies	1-23
Industriële toepasbaarheid	Ja:	Conclusies	1-23
	Nee:	Conclusies	

2. Citaties en toelichting:

   Zie aparte bladzijde

Onderdeel VII Overige gebreken

De volgende gebreken in de vorm of inhoud van de aanvraag zijn opgemerkt:

Zie aparte bladzijde

Re Item V

Reference is made to the following documents:

D1 US 2019/101985 A1 (SAJDA PAUL [US] ET AL) 4 april 2019 (2019-04-04)

D2 EP 3 561 645 A1 (FUJITSU LTD [JP]) 30 oktober 2019 (2019-10-30)

D3 EP 3 629 243 A1 (INTEL CORP [US]) 1 april 2020 (2020-04-01)

1 Claim 19 corresponds to abstract mental act (Dataverwerkingsalgoritme) for which normally a search is nor required. However, the present Opinion and the accompanying Search Report is drawn interpreting said *Dataverwerkingsalgoritme* as being performed by an information processing apparatus see e.g. claims 20, 21.

2 The present application does not meet the criteria of patentability, because the subject-matter of claims 1, 19-21, 23 is not new.

2.1 D1 discloses a *werkwijze voor het verwerken van data, uitgevoerd door een informatieverwerkingsinrichting waarop tenminste één dataverwerkingsalgoritme werkzaam is dat kunstmatige intelligentie verschaft* ((§[0005]: self driving AI; §[0007]: computer implementation), *welke werkwijze omvat het waarnemen van operationele data afkomstig van een context* (figs 3, 5: data related to the driving environment) *en menselijke bio-signaaldata* (§§[0005], [0031]: biosignal data) *en menselijke gedragsdata met betrekking tot menselijke participatie in deze context* (§§[0025]-[0027]: user's driving behaviour data), *waarin de kunstmatige intelligentie door de informatieverwerkingsinrichting wordt verworven* (§§[0005], [0025]-[0027], [0031], figs 3, 5: improving the AI of the autonomous vehicle by reinforcement learning) *uit het associëren van gerelateerde operationele data* (figs 3, 5: data related to the driving environment are used to reinforce the AI), *menselijke bio-signaaldata* (§§[0005], [0031]: hBCI signals used for the reinforcement of the AI) *en menselijke gedragsdata* (§§[0025]-[0027]: user's driving performance data used to reinforce the driving AI).

Hence, D1 discloses all the features of claim 1.

2.2 Claims 19 (also see §1 above), 21: D1 discloses *[werkwijze voor het verwerken van operationele data afkomstig van een context, welke werkwijze wordt uitgevoerd door een informatieverwerkingsinrichting waarop] een dataverwerkingsalgoritme werkzaam is omvattende kunstmatige intelligentie verworven in overeenstemming met een van de voorgaande conclusies* (see the passages discusses in §2.1 above).

2.3 Claims 20, 23: The subject-matter of claims 20, 23, albeit in the form of a program product *(Programmaproduct)* or of a n apparatus *(Dataverwerkingssysteem)*, respectively, corresponds to that of claim 1. Therefore, the same arguments as in §2.1 above apply, mutatis mutandis.

Hence, D1 discloses all the features of claims 20, 23.

2.4 Moreover, both D2 (see §§[0004], [0025], [0034], [0049], [0050], [0054], [0055], figs 2, 3) and D3 (§§[0005], [0036]-[0038], [0062], [0063]) each taken alone, disclose all the features of claims 1, 19-21, 23.

3 Dependent claims 2-18 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty or inventive step, the reasons being as follows:

3.1 Claim 2: See the passages discussed in §§2.1 and 2.4 above, regarding observed data.

3.2 Claims 3-12, 17, 18: See D1 (§§[0020]-[0022], [0029], [0065], [0066], fig. 9: see the disclosure around the users cognitive and emotional states and the determination thereof).

3.3 Claims 13, 14, 16: See D1 (§§[0031], [0057]-[0059]), D2 (§§[0025], [0035], [0050]-[0052]), D3 (§§[0037], [0063], [0068]). It is noted that features following the expression *"[...] waaronder begrepen* <u>*maar niet beperkt tot ten minste*</u> *[...]"* until the end of the sentence including said expression, are not limiting the claimed subject-matter (optional).

3.4 Claims 15: See the passages discussed in §§2.1 and 2.4 above.

3.5 Claims 20: See §2.2 above.

<u>Re Item VII</u>

4 Furthermore, the following deficiencies are mentioned:

4.1 The relevant background art disclosed in D1-D3 is not mentioned in the description, nor are these documents identified therein.

4.2 The features of the claims are not provided with reference signs placed in parentheses.