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Editorial

Artificial Intelligence (AI) in cloud integrated, open access pathology publications: perspectives on 2020.

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Abstract

Goal: To describe, maintain and further develop the communication network of medical sciences www.diagnosticpathology.eu that publishes electronically submitted peer reviewed medical articles and fully takes advantage of its electronic environment, and to give the reader the opportunity to view digitized whole slide images (virtual slides, VS), to measure image objects, and to annotate images and text.

Background: The unique open access, peer reviewed journal www.diagnosticpathology.eu is embedded in a communication environment of different cloud components. The components include several distributed servers and databank systems such as access to article integrated VS, data storage, or scientific data banks (atlas of fine granulate and natural and synthetic fiber hazards).

Implementation specificities: Theoretical considerations on specific substantial differences between the physical real world and its virtual transformations guide the implementation. The differences include, for example, the minimum number of mandatory space dimensions, of their essential (ir)-reversibility of objects, structures, and functions as well as the relationship of image features to the observation time.

The implemented system focuses on communication issues in tissue – based science only. Its volunteers allow disregard any predominantly financial impact such as financial profit. Artificial intelligence (AI) is used to maintain its sustainability, connectivity, distribution, measurement and discussion of medical images, especially microscopic slides.

2019 Data: The journal and its concurrent operation of interactive communication demonstrate the advantage of AI in open access publication. VS are ready to be screened and annotated by any reader worldwide. QR codes provide DOI registration and upload of oral presentations by the auditorium. Interactive publication permits the release of a distinct continuous article chain. Annotations of VS images can be transferred in public or private databanks. The reader is invited to check his impression of marker scores by own automated measurements.

Perspectives: Applications of AI in tissue – based diagnosis, communication and implementation are not limited to deep learning, quality assurance or so-called diagnosis assistants. AI is on the way to significantly modify medical diagnostics and treatment. These modifications will, in

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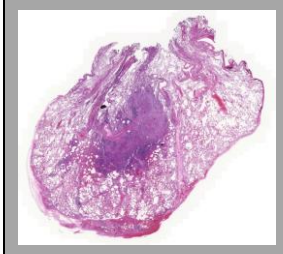
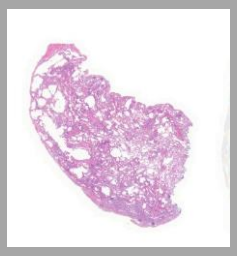
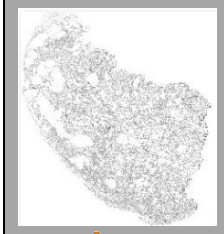
addition, modify our understanding of disease and life. www.diagnosticpathology.eu is one of the pathfinders and pioneers in this unavoidable process.

Keywords: Artificial Intelligence, Open Access Journal, Virtual Slide, Deep Learning, Tissue – based Diagnosis.

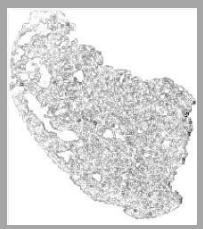
Virtual Slides:



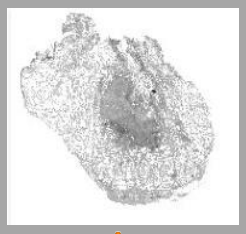




fibrosis_norm.avi



fibrosis_gradn.avi



tuberculosis_norm.avi

tuberculosis_gradn.avi

The exemplarily included virtual slides and AVI Videos are published in
http://dx.doi.org/10.17629/www.diagnosticpathology.eu-2018-4:269

Introduction

Application of Artificial Intelligence (AI) is continuously entering the world of digital pathology (1-5). Neuronal networks are available in the internet for free, and so– called deep learning systems might be used to assist the pathologist in routine diagnosis already (1, 6-8)} .

The common definition says that **Artificial intelligence** (**AI**) is the simulation of human **intelligence** processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction (quality assurance). A more elaborate definition characterizes AI as “a system’s ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation” (9). See also: (10-12).

Tissue - based diagnosis includes all medical diagnoses that are derived from investigations of human tissue. These include micro - and macromolecules, cellular compartments, function units, organs, and bodies (6, 13-15).

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Obviously, digitalization of mages, electronic signals and sounds is mandatory to analyse and classify released features and to apply AI automation.

Systems which use AI in tissue – based diagnosis have to recognize specific tissue areas. They display with or without relationship to the patients' history, and are prerequisite to classify image features (objects, structures, textures), and to derive functions from recognized structures/objects (7, 15, 16).

The recognized image features predominantly serve to automatically derive clinically applicable diagnosis classes, such as 'classic' (HE), prognosis associated, potential treatment associated (predictive) or risk associated diagnosis (probability of futurity) (17-21).

In this editorial we describe and try to forecast the degree and specific algorithms which are ready or likely to be implemented in both, daily routine and research tissue – based diagnosis (surgical pathology).

Theory

Each AI algorithm possesses a goal, which should be reached. In surgical pathology, frequently the goal addresses information content of microscopic images and its relationship to history, present stage or development of the patient's disease.

In principle, AI algorithms consist of two different compartments, namely 1) detection and structuration of image parameters (statistical space, coordinates) and 2) classification of parameter (coordinate) data.

Recognition of image parameters and feature extraction should start with image standardization, quality assurance, and pixel / feature relationship (7). Object and structure – based parameters as well as features require either 'constant' image preparation and acquisition or re-adjustment of input data (16, 19, 20, 22). It is followed by multivariate statistical analysis (7, 20, 23-25). The result undergoes a classification procedure, which generally results in binary classes (cancer (yes – no), surgical treatment (yes – no), adjuvant cytostatic therapy (yes – no), etc.

Neural networks usually combine both procedures and to not permit an insight into the statistical significance of an individual input parameter and its data.

The general principle of neuronal networks, i.e. to modify the 'response' of each node according to the individual expression of its input features generates a dynamic system with broad variation of individual node reactions (4, 26-29).

Therefore, it does not make sense to focus on an 'activation' or 'depression' reaction of an individual node or on its associated input parameters. A neural network acts similar to a 'black box' that is connected with multiple inputs and is able to release a surprisingly reliable output (30-33).

Similar reliable and confident results are obtained by multivariate statistical analysis with inbound feedback mechanisms, which step by step 'add' 'test data' to 'training data' and accordingly 'readjust' themselves (15, 24, 30-34).

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The advantages and disadvantages of neural networks and multivariate feedback systems are:

Neural networks are a combination of feature extraction and classification. They are easy to handle and require a homogenous and standardized quite large input cohort consisting of numerous parameters and features. They are commercially available and 'ready to use'.

Multivariate feedback analysis and classification systems consist of an image analysis system and a separated feature classification system. The amount of mandatory input data depends upon the feature classification algorithm and the classification arrangement (straight forward, feedback, hybrid) and chosen method (hierarchic, parallel, dynamic, etc.).

They usually require a small training set, because they select the most significant selective parameters by themselves, and reorder the training input parameters according to the classification result of each individual case (15, 24, 30-34). They are not commercially available to our knowledge; however, they might be interactively constructed by combining commercially available statistical packages.

Applications

Conventional microscopic diagnostics needs a (random or whole slide) screening at low magnification in order to detect areas of human tissue, abnormal human tissue, non-human biological tissue or external non-biological material.

The non – normal specimen areas might be small in comparison to the contemporary displayed normal tissue. The automated detection of these so–called regions of interest (ROI) requires a sensitive sampling algorithm, which can be considered the 'lowest AI degree' in virtual microscopy (6, 35-37). Several vendors offer ROI notification; some of them are already embedded in digital slide scanner programs.

The acquired images might be viewed by the pathologist without (interactive virtual microscopy) or with modifications (assisted virtual microscopy) (34, 36, 38).

The proposed or already implemented digital assistants include automated ROI screen presentation, online measurement assistants (especially for immnunohistochemically stained slides), scoring assistants, quality assurance assistants and diagnosis assistants. These AI components have already been described in numerous publications. Most of them are commercially available. Some of them can be applied in open access platforms.

The 'final AI degree' will be a fully automated diagnosis system with or without final control by man (15). The implementation of neural networks in such systems is already entering the scene of routine tissue–based diagnosis (15). Self–learning systems like Watson master already multiple and highly different tasks. It is relatively easy to embed them in a tissue–based diagnosis environment (39-41). The different levels of AI complexity are shown in figure 1. (15, 42).

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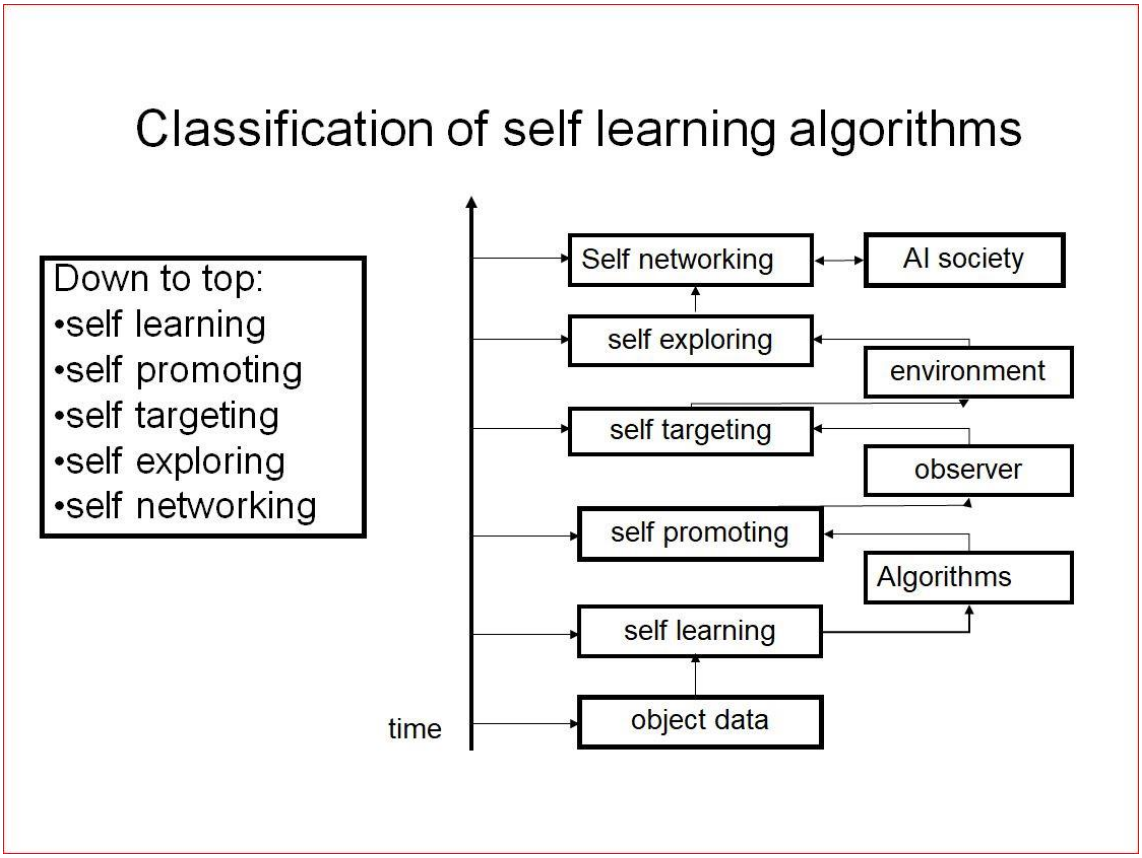

Figure 1: Proposed order of self-learning algorithms. Self-learning (neural networks) form the lowest level of the chain. The calculated output data of each level serve for input data into the system at the next level. All self-automated systems work in the same manner (network configuration be application of neighbourhood conditions and feedback mechanisms. (Scheme provided by: Gortler, [42].

Interestingly, each level addresses an associated degree of intelligence, the highest level an automated generation of research goals or 'own ideas' (15).

The situation can be visualized the best by using graph theory calculations in combination with symmetry approaches. Such mathematical method is also suitable to answer questions such as: 'Should the pathologist trust human diagnosis or automated AI derived diagnosis in case of conflict?'

The result 'correct diagnosis' cannot be assured by any algorithm that is limited to the 'final diagnosis layer'. The answer of the 'gold standard question' must be derived from external lower or upper layers, whose constellation will ascertain the most accurate answer. As a consecutive, human diagnosis will not automatically remain the 'gold standard'.

AI and www.diagnosticpathology.eu

The peer reviewed open access journal www.diagnosticpathology.eu is run by volunteers only. It is, therefore, mainly a non - profit journal and addresses research and development of

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scientific communication in pathology and medicine. Cloud embedded publication of virtual slides in connection with open or private annotations, interactive publication, contemporary publication of text, sound and movements demonstrate some of the unique algorithms of the journal. All of them are expressions of AI and permit the application of scientific perceptions which can only be presented in an electronic environment.

Oral distribution of research frequently occurs in scientific conferences, sessions or meetings. The presented message is often lost sometimes already after a couple of days.

Application of AI assists to 'always be able to read/hear again the message'. www.diagnosticpathology.eu offers implementation of a QR code in the presentation, its link to and storage in an 'eternal' databank. This technique offers a practical and easy to handle distribution of the presented data without any heavy work of the author.

We are aware, that our engagement covers only partly the authors' needs to become promoted by publications in conventional journals which provide a high citation index (CI). The reason of such a promotion is simple the ongoing commercialization of research and science. All high rated CI journals are owned by predominant and therefore profit oriented publication companies, which check in detail the profit percentiles of each of their journals.

Questions such as 'What is the goal of research or progress in pathology' are unknown, not answered, or disregarded because they obstruct the financial goal.

Christmas time is close which is again commercially overwhelmed despite its very different origin. The power of a young child grew to immense influence on human behavior and interactions despite its birth under miserable conditions.

Christmas and any birth strongly call for communication with nature in its own, non- policy and non–business oriented language. They ask for a peaceful, merciful, future oriented and educated world.

Having the idea of Christmas in mind, we especially thank Dr. Stephan Borkenfeld, Dr. Lech Banach MD, Dr. Manfred Dietel, MD, Dr. Etienne Martin, MD, Dr. Mihaela Moscu, MD, Dr. Robert Ogilvie, PhD, Dr. Ronald S. Weinstein, MD for all their efforts and assistance to further develop our journal.

We welcome you, all our readers and interested colleagues to contact, support and collaborate with us via our technical director Stephan Borkenfeld (s.borkenfeld@web.de). We will do our very best to distribute your ideas, research and experience all over the world.

We wish you, all our readers, reviewers, and interested colleagues a Merry, Peaceful Christmas, and a Happy, Healthy, Prosperous and Enjoyable New Year.

Klaus Kayser Editor in Chief

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