App for clock drawing test will help to detect dementia in future

The clock drawing test has been used for several decades as a simple and effective means of diagnosing disruptions to spatial orientation and dementias. Scientists at the Pattern Recognition Lab at the Department of Computer Science at Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) fed AI neural networks with data from 2500 tests to teach them how to assess these results independently. The research findings have been published in the journal Scientific Reports. The same group also plan to launch open source software that could make diagnosing dementia much easier for medical and neuropsychological specialists.

Clock drawing test provides more certainty

More and more people are being diagnosed with dementia and safe and simple methods of diagnosis are decisive to ensuring patients receive treatment as early as possible. Doctors across the world use the clock drawing test to diagnose dementia. This method is standardised and simple. The patient is given a piece of paper with a circle on it and is asked to draw the numbers on a clock on it, so as to subsequently enter the time of day, for example ten past eleven.

Conclusions can be drawn on the extent of disruption to normal brain function, depending on how much the drawing deviates from the correct answer. The medical specialist conducting the test gives a score similar to school grades between 1 and 6. One point is given for a perfect answer, three points means the clock has not been drawn correctly where perhaps there is one hand missing but the visual and spatial presentation are still acceptable. The clocks drawn by the patient become less accurate the higher the score, for example the gaps between the numbers are irregular, they are in the wrong order, the patient has only drawn a few numbers, they are outside the circle or there are just a few scribbles. Scores of three points or more are a sign to physicians that the patient has a relevant cognitive disorder, which is often dementia.

Prof. Dr. med. Markus Weih, who is a specialist in neurology and psychiatry, was previously Head of the Memory Clinic at the Department of Psychiatry and Psychotherapy at Universitätsklinikum Erlangen, is an author and has written several scientific publications. He currently works at the Medic Center in Nuremberg and is an external member of the Chair of Neurology at FAU where he teaches. He collected 2500 clock drawing tests from 1315 of his patients in his practice over the course of three or four years.

Prof. Andreas Maier from the Pattern Recognition Lab at FAU trained artificial neural networks to evaluate these drawings and support medical and psychology experts in practical applications. Prof. Weih scanned the clock drawings and test results and sent the information to the lab.

Training neural networks
At the lab, the team led by Prof. Maier began to digitalise the data. For his Master’s thesis, Harb Alnasser Alabdalarhim took on the task of training the deep neural networks of the high-performance computing facility with the clock drawings. In a short space of time, the neural networks learned to assign the correct diagnosis to the drawings. ‘In over 96 percent of the cases, the neural networks correctly assign the diagnosis as to whether it is a non-pathological or pathological diagnosis,’ explains Prof. Maier. ‘The assigned levels of dementia were correct in over 98 percent of the cases, which is a very good result.’ The processes are not new, as the way in which the connections in deep networks are learned is well known, although the learning algorithms differ considerably from those in the human brain.

At the Pattern Recognition Lab, researchers regularly feed x-ray images or CT images and MRI scans into the artificial networks so that the images can be used in diagnostics. ‘Our clock test, on the other hand, uses drawings and not images,’ says Prof. Maier. The large volume of data provided by Prof. Weih from his practice was a stroke of luck. After over 1000 training iterations, the artificial neural networks generated very precise results.

A simple but effective test

The researchers hope that a user-friendly app will be able to support medical staff in diagnosing dementia worldwide in future. ‘Of course, the staff carrying out the diagnosis must be familiar with the clock drawing test and use it in a standardised manner,’ emphasises Prof. Maier. ‘But they can use the app after the test to take a photo of it and receive an instant assessment.’ A second opinion can be requested from a doctor if any uncertainty arises regarding the assessment. The increases the reliability of diagnoses and improves the grading and categorisation of cases of dementia. The latter is of particular interest to clinical research.

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