Title: Intelligent games for assessing cognitive, social, and physical capabilities of elderly and children

Submitters & Research team
Students of DKE Honours Programme Research Path:
Bujnarowski, Kamil (Student DKE) k.bujnarowski@student.maastrichtuniversity.nl;
Calsius, Frederik (Student DKE) f.calsius@student.maastrichtuniversity.nl;
Dàvila Mateu, Marta (Student DKE) d.marta@student.maastrichtuniversity.nl;
Gaßner, Martin (Student DKE) m.gassner@student.maastrichtuniversity.nl
Meyers, Marion (Student DKE) marion.meyers@student.maastrichtuniversity.nl;
Negura, Albert (Student DKE) a.negura@student.maastrichtuniversity.nl;
Ritter, Hermann (Student DKE) hermann.ritter@student.maastrichtuniversity.nl;
Yared, Ryan (Student DKE) r.yared@student.maastrichtuniversity.nl
Researchers Maastricht University:
Christopher, Seethu (DKE) seethu.christopher@maastrichtuniversity.nl
Dahl, Lucas (DKE) lucas.dahl@maastrichtuniversity.nl
Corresponding author: Möckel, Rico (DKE) www.linkedin.com/in/rico-mockel
rico.mockel@maastrichtuniversity.nl
Tumanov, Kirill (DKE) k.tumanov@maastrichtuniversity.nl
Weiss, Gerhard (DKE) https://www.linkedin.com/in/weissg/   gerhard.weiss@maastrichtuniversity.nl
Urlings, Corrie (SBE) c.urlings@maastrichtuniversity.nl
Borghans, Lex (SBE) https://www.linkedin.com/in/borghans/   lex.borghans@maastrichtuniversity.nl
Coppens, Karien (SBE) https://www.linkedin.com/in/kariencoppens/   k.coppens@maastrichtuniversity.nl
Hamers, Huub (Engineer at PSYCHOLOGY) h.hamers@maastrichtuniversity.nl
Hurks, Petra (PSYCHOLOGY) https://www.linkedin.com/in/petra-hurks-675b324/
pm.hurks@maastrichtuniversity.nl
Goanta, Catalina (LAW) https://www.linkedin.com/in/catalina-goanta-b9898017/
catalina.goanta@maastrichtuniversity.nl

Theme: improving health care and well-being

An executive summary In the project we study the additive value of combining algorithms from data science and AI with robotics to assess the well-being in humans, and more specifically elderly and children. At the moment the number of instruments available for especially these target groups is limited and less ecologically valid. Assessments for elderly and children are difficult to apply, time consuming, and often lead to subjective results. In contrast, we evaluate the application of intelligent game devices like robotic dice, mazes, and board games for assessing cognitive, social, and physical capabilities. Monitoring these capabilities in elderly is important to detect possible deficits and to make informed decisions about required treatments. Monitoring these capabilities in children for instance in schools is important to ensure their healthy development. With the game devices we continuously obtain large amounts of data about the players that we process to infer their capabilities. We are a team of Honours students from the Department of Data Science and Knowledge Engineering and multidisciplinary researchers of four faculties of Maastricht University. Together we develop novel assessment tools and data science algorithms that are fun for elderly and children to use, and that free caregivers and teachers from tedious work.

The main objective and significance of the proposed research: (1) Avoiding high manual documentation load for caregivers and teachers while there is a lack of caregivers and teachers and the population keeps growing older. The proportion of people of working age in the EU-28 has been and keeps shrinking. The relative number of people estimated to be aged 65 or older and thus being retired or expected to be retired soon has been expanding by 2.4 % over the past 10 years. As a greater proportion of the post-war baby-boom generation reaches retirement in the coming years and due to the consistency of fewer births in the past year, professional projections predict that people aged 65 years or over will account for 29.1 % of the EU-28's population by 2080, compared with 19.2 % in 2016 leading to a continuously growing demand for more caregivers for elderly.

Already now there is a lack of available caregivers. At the same time, the demand for documentation and quality management increases and thus reduces the time caregivers can spend on the work they love: providing care for elderly and children. Instead, facilities for elderly and children report that caregivers must spend up to 50 % and more of their time for documentation and management tasks. This results in frustration for caregivers and high costs for the caregiving facilities, health insurances, and society.

Similarly as caregivers, also teachers at schools and kindergartens face the challenge that assessments of children and especially its documentation for instance in form of certificates is taking a lot of time – time that teachers would prefer spending instead on teaching. At the same time, schools in the Netherlands face a lack of teachers. In June 2017, a shortfall of some 900 primary school teachers has been reported with the prediction that these numbers will further be increasing in the future. The number of people qualifying as a primary school teacher has fallen from some 7,300 in 2005 to around 3,800 in 2015. So it becomes more and more crucial to unload teachers from tedious assessment and documentation work to spend their time more effectively – but also to make their work more attractive again.

(2) Avoiding stressful testing for elderly and children in artificial test environments. Making assessments more objective and less dependent on experimentalist. The execution of psychological and physical tests is typically stressful both for elderly and children when being assessed. To avoid uncontrollable influences, elderly and children often are typically being separated from their natural

environment. Still the test results are not objective and have the risk of being depended on the skills of the experimentalist. Continuous testing becomes difficult because of time constraints, is often too expensive, and there is a risk that elderly or children are not tested at all for deficits that are not already sufficiently expressed with the risk that treatments come too late.

The research plan: **Our proposed solution: intelligent game devices for automated assessments to reduce documentation load of caregivers and teachers**

To reduce the amount of required documentation load, our research focusses on providing technologies that allow for automated assessments of cognitive, social, and physical capabilities of elderly and children in natural environments. For this, elderly and children play games with game devices specifically developed by us for this application. These game devices are equipped with intelligent sensor technology. While they play, intelligent algorithms developed by us automatically assess the elderly's and children's capabilities based on the sensor outputs and provide part of the necessary documentation for caregivers, teachers, doctors, and nurses. As a result the amount of documentation, that caregivers and teachers have to provide, is reduced. For the development and testing of our technologies, we work closely together with schools, kindergartens, and facilities for elderly in the Netherlands and Germany where we test elderly and children and obtain feedback on the usability of our device from caregivers and teachers. We perform acceptability, psychological, and physical test. So far two physical assessment devices, an intelligent dice and an intelligent maze, have been developed. In addition research and developments have been performed for data analysis. First test data has been obtained. In 2018 we plan to obtain more data through user studies with our partners. To prove the value of our developments we compare the outputs of our assessments against standard psychological and physical tests and questionnaires. We develop statistical models as well as parametric models that we train with machine learning methods to predict the output of the standard tests with our automatic game assessments. Colleagues from the law faculty research about liability aspects of our game devices and the application of artificial intelligence for elderly and children from two main perspectives: 1. The relationship between the algorithms used by the game devices and the duty of care affiliated with relevant care-givers (e.g. Should the use of algorithms lead to an obligation on means or an obligation of result, etc.); 2. The privacy aspect of data collection (e.g. Which privacy standards apply and how can they be met, etc.).

The innovation in the proposed research The project aims at innovation at a variety of disciplines: (1) The development of novel algorithms from data science and artificial intelligence that animate elderly and children to play and process the sensor outputs of our game devices to correctly predict the cognitive, social, and physical capabilities of elderly and children. (2) The development of novel physical game devices that are fun for elderly and children and facilitate professional assessments of cognitive, social, and physical capabilities. (3) The development of novel psychological, cognitive, and biophysical models that describe the cognitive, social, and physical capabilities of elderly and children. (4) The exploration of the legal aspects of such novel assessment devices.

The anticipated results along with short and long term benefits

Benefits for elderly and children (1) By playing games continuously, it is possible to obtain objective data on the capabilities of elderly and children continuously, over a long time, and more often per day than it would be possible if caregivers or teachers had to provide the information through observation. As a result, there is higher quality and more objective data to support a better choice of treatment or therapy. The need for treatments or therapies can be detected earlier. Unnecessary treatments can be avoided. The quality of life for elderly and children can be improved. (2) Elderly and children have fun using our games and do not realize that they are being tested. In contrast to normal artificial standardized tests our games cause less stress for elderly and children – leading to more realistic higher quality assessments in natural environments.

Benefits for caregivers and teachers (1) Through the application of automated assessments, caregivers and teachers get unloaded of paper work and can focus again on the work they like to perform: providing care and education. This leads to happier caregivers and teachers, and possibly better performance of these caregivers and teachers. (2) Caregivers and teachers also gain time since elderly and children can have fun playing the games together without the necessity of a continuous supervision by a caregiver or teacher.

Benefits for caregiving facilities, schools, health insurances, and ministry of education (1) Caregiving facilities and schools imposing less documentation load are more attractive employers and gain an advantage on the job market. (2) Continuous and objective quality assessments allow for better quality control through the management. (3) Caregivers and teachers having more time for elderly and children leads to a higher efficiency and lower costs for the facilities, health insurance, and the ministry of education. (4) Earlier and better detection of required treatments reduces costs in caregiving facilities and for health insurances. (5) By providing objective, long-term data, health insurances obtain better information about the effectiveness of the applied therapies and treatments.

Benefits for society (1) By making the jobs of caregivers and teachers more attractive and efficient, shortage of caregivers and teachers can be reduced. (2) Increasing the efficiency of caregivers and teachers effectively helps to fight their shortage in caregiving facilities and schools. (3) Under the impression of an aging population more efficient caregiving contributes to a reduction of economic load faced by the society. (4) More objective assessments of elderly and children lead to fairer assessments.