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Sano Computational Medicine Seminars

Monday, 4 April 2022, 14:00-15:30 (CEST)

Join us via Zoom: https://seminar.sano.science/

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High-performance computational techniques to create the blood of the Digital Twin

Abstract

Blood is the single most important fluid in the human body. It has an important role in most healthy and pathologic processes. Yet many of its properties are poorly understood primarily due to its complex cellular nature. It is composed of a dense suspension of deformable cells and various proteins suspended in blood plasma.

To reduce complexity, blood is usually simulated as continuum fluid with empirical rheology curves. However, in recent years our understanding in connected physiologic processes and diseases has increased significantly. It has reached the point where more detailed description of blood is necessary to interface it with biological and biochemical processes. Good examples are demonstrated by the Virtual Physiological Human short movie on YouTube (https://youtu.be/1FvRSJ9W734) - look for anything blood related to see HemoCell in action. The dynamics, collision, and deformation of every red blood cell is resolved every microsecond by approximately 5000 equations.

I will introduce the computational challenges and solutions that allow an efficient simulation of these intricate details of blood and demonstrate how this solution can scale over a quarter million CPU cores. Finally, I will show a set of examples on how these novel large-scale simulations contribute to clinical and in vitro experimental research, leading to better understanding of the respective investigated pathologies.

Gabor Zavodszky is an assistant professor of multi-scale computing at the University of Amsterdam and assistant professor at the Budapest University of Technology. His research focuses on designing and developing detailed high-performance computational models targeting cardiovascular challenges, including thrombotic and diabetic diseases. He maintains active interdisciplinary collaborations with several clinical institutes and experimental labs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857533 and from the International Research Agendas Programme of the Foundation for Polish Science No MAB PLUS/2019/13.

European Funds Smart Growth · Republic of Poland · FNP Foundation for Polish Science · European Union European Regional Development Fund

across Europe. He is currently co-PI and work package leader in CompBioMed2 (H2020). He is coordinating the development of HemoCell (www.hemocell.eu), the open-source high-performance cellular blood flow simulation framework, that is being used by several research groups and is deployed in more than a dozen HPC centers around the World.

Recently, HemoCell has been successfully scaled up to 260.000 CPU cores. As a PI in the National Brain Research Program, he also developed medical device deployment simulations for endovascular aneurysm treatments which are currently being used as clinical decision making support tools in Hungary.

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