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Demonstrator of the European virtual human twin simulation platform

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Building simulations for the Virtual Human Twin (VHT) is a challenging and complex task. In order to contemplate practical use of the VHT concept, we require an inclusive ecosystem of digital twins in healthcare, a federated cloud-based repository for gathering human digital twin resources such as models, data sets, algorithms and practices, along with a simulation platform to facilitate the transition towards personalised medicine.

These challenges are the focus of the EDITH EU-funded project [1], whose primary goal is to prepare the European roadmap for developing Virtual Human Twins. In the scope of preparing such a roadmap, we validated its key points by building a prototype implementation of the simulation platform. We began by analysing the internal structure and functional requirements of typical applications simulating human physiology, developed by EDITH partners. This formed the basis for a demonstrator of the execution subsystem of the VHT ecosystem: a software architecture that enables execution of computational models. An integrated versioning system enables collaborative editing and tagging of specific model versions that may be later selected to suit the researchers' needs. The platform also provides a straightforward way to display, download and analyse simulation results. The functionality of the demonstrator was successfully validated with a set of typical VHT modules on ACC Cyfronet HPC resources.

The demonstrator utilises standardised solutions to implement the simulation environment, such as Git repositories to store and version the simulation source code, S3 to store patient data, along with simulation outputs, Dataverse/Zenodo integration to utilise published datasets (or to create new ones), along with HPC to run complex and time-consuming workflows. The environment enables development of algorithms, models and simulations that can make personalised medicine easier, and, as a result, increase the effectiveness and timeliness of medical treatment. Our research has resulted in a demonstrator which can run VHT modules on HPC resources, and which may be integrated with model and data repositories. We consider this the first step towards elaborating the whole VHT ecosystem [2].

In the scope of this presentation we will show the main building blocks of the demonstrator, and discuss how they help build the VHTs and enact the corresponding methodology, ensuring that simulations follow the 3R principles (Repeatability, Replicability and Reproducibility). We will also address the obstacles and challenges posed by existing HPC infrastructures that need to be overcome to simplify the integration of platform similar to the demonstrator with large-scale computational resources.

References

1. EDITH –European Virtual Digital Twin, EU Project, Digital Europe, https://www.edith-csa.eu/

2. Peter Coveney, Roger Highfield: Virtual You. How Building Your Digital Twin will Revolutionize Medicine and Change Your Life, Princeton University Press, 2023

Topic

Needs and solutions in scientific computing: Digital Twins

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