PerMedCoE

HPC/Exascale
Centre of
Excellence in
Personalised
Medicine

Personalising the prognosis and treatment of cancer: three scenarios reveal how the biomedical community can benefit from cell-level simulations in HPC environments

The European Centre of Excellence for Personalised Medicine (PerMedCoE) exploits HPC/Exascale infrastructure by facilitating access to the tools and methodologies needed for a deeper understanding of cancer and for recommending appropriate treatment.

15 March 2023.- By optimising cell-level simulation tools, PerMedCoE provides an alternative to the current methods for the analysis of genomic and other individual-level biomedical data. PerMedCoE simulations aim to use these data to conduct experiments in areas such as cancer drug treatments and analysis of cancer-related genomic data.

Alfonso Valencia, ICREA Professor, Life Science Director at the Barcelona Supercomputing Center and PerMedCoE coordinator, highlights:

> *In its two years of existence the centre has made substantial progress in the optimisation of cell-level simulations and their integration in HPC environments. These tools and workflows, now openly available to the community, open new avenues for understanding cancer cell biology, which may help in the optimisation of personalised treatments in the long run.*
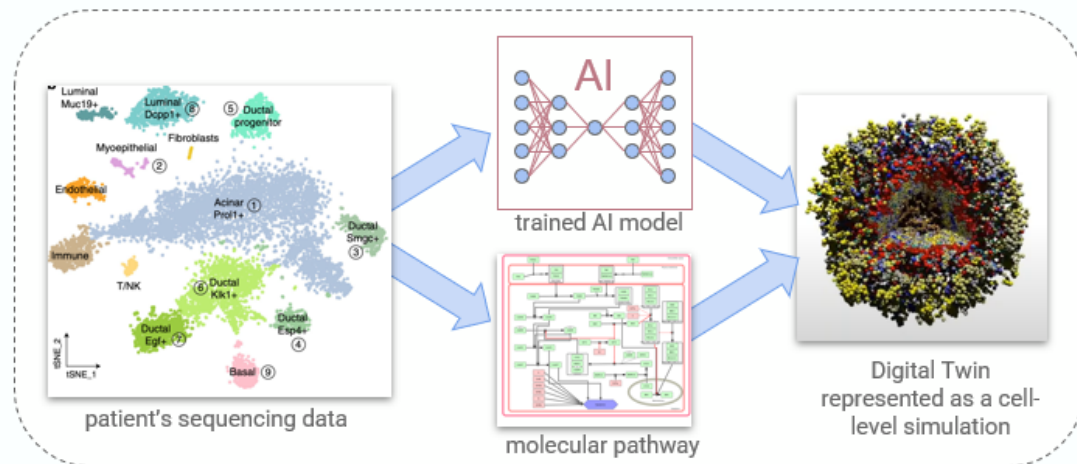

Figure 1:Training AI models with massive amounts of experimental and clinical data will revolutionise molecular biology and medicine, providing new insights and novel methodologies for improving disease prognosis and treatment. Credit: This composite image was generated using materials from Paul Macklin (digital twin image), the COVID19 Disease Map community (molecular pathway image), and the BSC.

Through three practical cancer-centred scenarios, PerMedCoE combines core simulation tools (MaBoSS, CellNOpt, COBREXA, CARNIVAL and PhysiCell) in computational workflows that are executed in HPC facilities.

Drug synergies of cell lines in cancer treatments

To identify the consequences of different drug synergies used in cancer treatments, PerMedCoE HPC-ready cell-level simulation software models combine interactions between targeted cancer therapies. The project has proposed effective drug combinations for gastric, colon and prostate cancers using MaBoSS, CellNOpt and COBREXA to simulate thousands of cell lines and to enable the browsing and clustering of data so that patterns can be identified. Capturing patient heterogeneity allows for next-generation modelling to further personalise drug treatments. A workflow for the prediction of personalised targeted drug combinations, focusing on early cancer metastasis on colon cancer, was developed and successfully run on the Barcelona Supercomputing Center's MareNostrum 4 supercomputer.

Cancer diagnosis based on omics information Through three practical cancer-centred scenarios, PerMedCoE combines core simulation tools (MaBoSS, CellNOpt, COBREXA, CARNIVAL and PhysiCell) in computational workflows that are executed in HPC facilities.

In this use case, cell-level simulation tools are used to identify the different clinical course of individual patients based on molecular and clinical information. An ongoing analysis examines the case of 551 patients suffering from Chronic Lymphocytic Leukaemia at Hospital Clinic in Barcelona, Spain. The tools MaBoSS, COBREXA and PhysiBoSS produce metabolic models based on omics information and knowledge from the literature. They help to predict clinical outcomes and test different initial personal conditions and potential interventions.

Tumour evolution based on single-cell omics and imaging

PerMedCoE tools have been used to model tumour evolution by using HPC simulations to help answer questions such as 'What would have happened if the tumour had not been removed from the patient?' This approach deepens our understanding of tumour evolution and provides opportunities for finding personalised treatments in the case of a relapse. Unlike classical mathematical approaches, the use of HPC allows for the simulations of billions of cells incorporating genetic and environmental perturbations and paves the way to simulate real-sized tumours, a step towards testing drugs and treatments in digital twins (virtual models designed to reflect a physical object).

As a HPC Centre of Excellence, PerMedCoE provides a holistic approach including technical and training support, high-quality training materials, demos based on the use cases, a free open-source software repository, and customised workflows. Furthermore, PerMedCoE works to attract the community of method developers around a common tool benchmarking activity.

About PerMedCoE

PerMedCoE is the HPC/Exascale Centre of Excellence for Personalised Medicine in Europe and aims to provide an efficient and sustainable entry point to the HPC/Exascale-upgraded methodology to translate omics information into actionable models of cellular functions of medical relevance. Coordinated by the Barcelona Supercomputing Center (BSC), this CoE has been awarded €5 million in funding from the European Commission and will run from 1 October 2020 to 30 September 2023. A range of 12 world-class academic and industry partners from across Europe participate in this CoE: Barcelona Supercomputing Center, CSC – IT Center for Science, University of Luxembourg, Institut Curie, University Hospital Heidelberg, Atos Spain, KTH Royal Institute of Technology, European Molecular Biology Laboratory-outstation European Bioinformatics Institute, Centre for Genomic Regulation, Max Delbrück Center for Molecular Medicine, the University of Ljubljana and ELEM Biotech.

Further information:

www.permedcoe.eu

@PerMedCoE

#PerMedCoE

Press contact: Janine Gehrig, Senior Science Dissemination Officer, janine.gehrig@bsc.es