openCARP: An Open Sustainable Framework for in-silico Cardiac Electrophysiology Research

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Introduction: Multi-scale computational models of cardiac electrophysiology are used to investigate complex phenomena such as cardiac arrhythmias, its therapies and the testing of drugs or medical devices. While a couple of software solutions exist, none fully meets the needs of the community. In particular, newcomers to the field often have to go through a very steep learning curve which could be facilitated by dedicated user interfaces, documentation, and training material.

Outcome: openCARP is an open cardiac electrophysiology simulator, released to the community to advance the computational cardiology field by making state-of-the-art simulations accessible. It aims to achieve this by supporting self-driven learning. To this end, an online platform is available containing educational video tutorials, user and developer-oriented documentation, detailed examples, and a question-and-answer system. The software is written in C++. We provide binary packages, a Docker container, and a CMake-based compilation workflow, making the installation process simple. The software can fully scale from desktop to high-performance computers. Nightly tests are run to ensure the consistency of the simulator based on predefined reference solutions, keeping a high standard of quality for all its components. openCARP interoperates with different input/output standard data formats. Additionally, sustainability is achieved through automated continuous integration to generate not only software packages, but also documentation and content for the community platform. Furthermore, carputils provides a user-friendly environment to create complex, multi-scale simulations that are shareable and reproducible.

Conclusion: In conclusion, openCARP is a tailored software solution for the scientific community in the cardiac electrophysiology field and contributes to increasing use and reproducibility of in-silico experiments.