DISCOVERABLE, REPRODUCIBLE, AND REUSABLE BIOSIMULATION MODELS

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COMPUTATIONAL MODELS OF THE HEART, ARGUABLY THE MOST ADVANCED ORGAN MODEL, HAVE EVOLVED SUBSTANTIALLY SINCE DENIS NOBLE PUBLISHED HIS ORIGINAL 1962 MODIFICATION OF THE HODGKIN & HUXLEY EQUATIONS APPLICABLE TO PURKINJE FIBRE ACTION AND PACEMAKER POTENTIALS. AS AVAILABLE COMPUTATIONAL POWER HAS GROWN THE RANGE OF CARDIAC PHYSIOLOGY AND ANATOMY ABLE TO BE REPRESENTED BY THE MATHEMATICAL MODELS AND NUMERICAL SIMULATIONS HAS RAPIDLY INCREASED, TO THE POINT WHERE WE ARE NOW ABLE TO MAKE USE OF MULTISCALE AND MULTIPHYSICS CARDIAC MODELS IN SCIENTIFIC INVESTIGATIONS. SIMILARLY, DETAILED BIOSIMULATION MODELS FOR OTHER ORGAN SYSTEMS HAVE EVOLVED COVERING AN EQUALLY WIDE RANGE OF SPATIAL AND TEMPORAL SCALES AS WELL AS THE REQUIRED TYPES OF PHYSICS. OFTEN SUCH MODELS ARE PARAMETERISED FOR A GIVEN SCENARIO, INCLUDING DETAILS SUCH AS A SPECIFIC ENVIRONMENT OR SPECIES. THE VIRTUAL PHYSIOLOGICAL RAT PROJECT (WWW.VIRTUALRAT.ORG), FOR EXAMPLE, PROVIDED A PLATFORM FOR THE CONSISTENT PARAMETERISATION OF A RANGE OF BIOSIMULATION MODELS FOR ONE OF THE MOST COMMON LABORATORY ANIMALS.

WHILE RECENT BIOSIMULATION MODELS CAN BE VERY DETAILED BIOPHYSICALLY AND ANATOMICALLY, SCIENTISTS FACE MANY CHALLENGES WHEN ATTEMPTING TO REPRODUCE THE RESULTS OF A GIVEN STUDY – OFTEN AS THE FIRST EXPLORATION STEP IN A DESIRE TO REUSE AN EXISTING MODEL. FOR INSTANCE, CARDIAC CELLULAR MODELS CONSISTING OF LARGE SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS ARE FREQUENTLY IMPOSSIBLE TO IMPLEMENT FROM THE PUBLISHED PAPER ALONE. TO ADDRESS THIS PROBLEM, THE PHYSIOME AND VIRTUAL PHYSIOLOGICAL HUMAN COMMUNITIES HAVE DEVELOPED STANDARDS FOR ENCODING MODEL AND SIMULATION DESCRIPTIONS WHICH ENABLE SCIENTISTS TO ARCHIVE AND EXCHANGE THEIR MODELS IN A REPRODUCIBLE MANNER.

THE ENCODED MODEL AND SIMULATIONS ALONE, HOWEVER, ARE OFTEN NOT SUFFICIENT TO ENABLE SCIENTISTS TO DISCOVER SUITABLE EXISTING MODELS OR TO COMPREHEND A MODEL ONCE IT IS DISCOVERED TO ENABLE REUSE. HERE WE WILL PRESENT RECENT DEVELOPMENTS AIMED AT IMPROVING THE DISCOVERABILITY AND REUSABILITY OF CARDIAC MODELS. FUTURE WORK TO ENCOURAGE SCIENTISTS TO MAKE USE OF THESE DEVELOPMENTS WILL ALSO BE PRESENTED.