

## Plan for Sharing Software

The proposed study will result in a wide range of computer code, analysis scripts, and computational models. Most importantly, the activities will end up with multiple *in silico* representations of the knee joint. These virtual representations will expand the capabilities of finite element analysis software by providing solutions to explore knee joint biomechanics, which may be considered similar to a plug-in. It is very likely that a number of analysis scripts will be developed; to parse experimental data, to automate model generation, and to post-process simulation results. To facilitate collaborative work and to track community involvement, new features and/or interface will be implemented to SimTk (<https://simtk.org>), collaboration website of Simbios, NIH Center for Biomedical Computing at Stanford. FEBio (<http://www.febio.org>) code will also be updated to reflect the requirements of nonlinear mechanical simulations of the knee joint. The team will also develop a web gateway to XSEDE (<http://www.xsede.org>), Extreme Science and Engineering Discovery Environment, or to an alternative high performance computing environment to enable simulations of joint mechanics on the cloud. All coding, analysis, modeling and simulation will be supported by open and freely accessible software, when possible.

All models will be distributed for free, using Creative Commons Attribution-ShareAlike 3.0 Unported (CC BY-SA 3.0) license, see <http://creativecommons.org/licenses/by-sa/3.0/>. This license allows anyone to share (to copy, distribute, transmit the work), to remix (to adapt the work), and to make commercial use of the work under the following conditions: i) attribution – one must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work); ii) share alike – if one alters, transforms, or builds upon this work, one may distribute the resulting work only under the same or similar license to this one. We anticipate that this licensing scheme will provide utmost dissemination and promote open science. We should emphasize that this license does not restrict any type of use, academic or commercial. If, this licensing scheme is found not to be desirable by users and developers during the course of the project, the research team (as the potential copyright holders), will consider different licensing, e.g., a more liberal Creative Commons Attribution 3.0 Unported (CC BY 3.0), <http://creativecommons.org/licenses/by/3.0/>, or the MIT license, <http://www.opensource.org/licenses/MIT>. It is also possible that we may adapt dual-licensing.

All analysis scripts will initially be distributed using the GNU General Public License, <http://www.gnu.org/licenses/gpl.html>, or the MIT license, depending on the licensing conditions of any re-used code. SimTk is accessible to public and any new features will be available to other investigators immediately, as has been done before in a similar manner by the Stanford University. FEBio is open source and freely accessible for research purposes and any new features will be available to other FEBio users following the release schedule of the software. It should be noted that both SimTk and FEBio has been shared as part of funding from the National Institutes of Health. Any code written as part of the web-based gateway to conduct simulations will be disseminated with GNU Public License or MIT license, depending on the licensing conditions of any re-used code. This dissemination will likely facilitate other interested users of XSEDE or high-performance computing to develop gateways for user-friendly access to computing resources.

Along with code, scripts, and models, any related documentation will be disseminated on the project site, provided by SimTk. Our research group has a good track record of dissemination as described above. We have already implemented similar model and code sharing procedures in our past and current projects: Efficient Methods for Multidomain Biomechanical Simulations (R01EB006735, see <https://simtk.org/home/multidomain>), and Predicting Cell Deformation from Body Level Mechanical Loads (R01EB009643, see <https://simtk.org/home/j2c>). For almost two years, we have been openly developing and disseminating a knee joint model, Open Knee: A Three-Dimensional Finite Element Representation of the Knee Joint, see <https://simtk.org/home/openknee>.

This proposal promotes free and open science, any model and script will be developed in a public manner, where any registered user of SimTk will have read access to work in progress (from the beginning). As we have done before (see above), release versions of stable code and models will be disseminated using the framework of SimTk to any registered user of the site. It should be noted that registration to SimTk is free and available to anyone; it is simply designed to be evaluate user and developer statistics and facilitate communication. Any interested party will also be invited to discuss potential contribution venues, to enable community-involvement. The proposed plan for sharing software is designed to promote open science and it will enable others (academic or commercial) to continue the work, if the developing team abandons the project, or to branch it into different scientific directions. Please also refer to Research Strategy for detailed description of dissemination strategy implementing open science. Also check Data Sharing Plan for more information on sharing experimental data.