PhysiCell Training Apps Integration With Google Colab for Enhance Accessibility

Uziel Rivera-Lopez[1], Randy Heiland[2], Aneequa Sundus[3], Dr. Paul Macklin[2]
[1]Dept of Computer Science; Indiana University; Bloomington, IN [2]Dept of Intelligent Systems Engineering; Indiana University; Bloomington, IN
Contact: macklinp@iu.edu

Introduction

- Google Colab provides a cloud base platform by
  - Utilizing Jupyter notebooks for projects
  - Allows execution through a browser
  - Works great with simulations without local installations
- PhysiCell is an open-source cell simulator that is used to develop tissue-scale models in biology
  - Flexible and scalable for modeling cellular systems
  - Simulations require a local environment setup

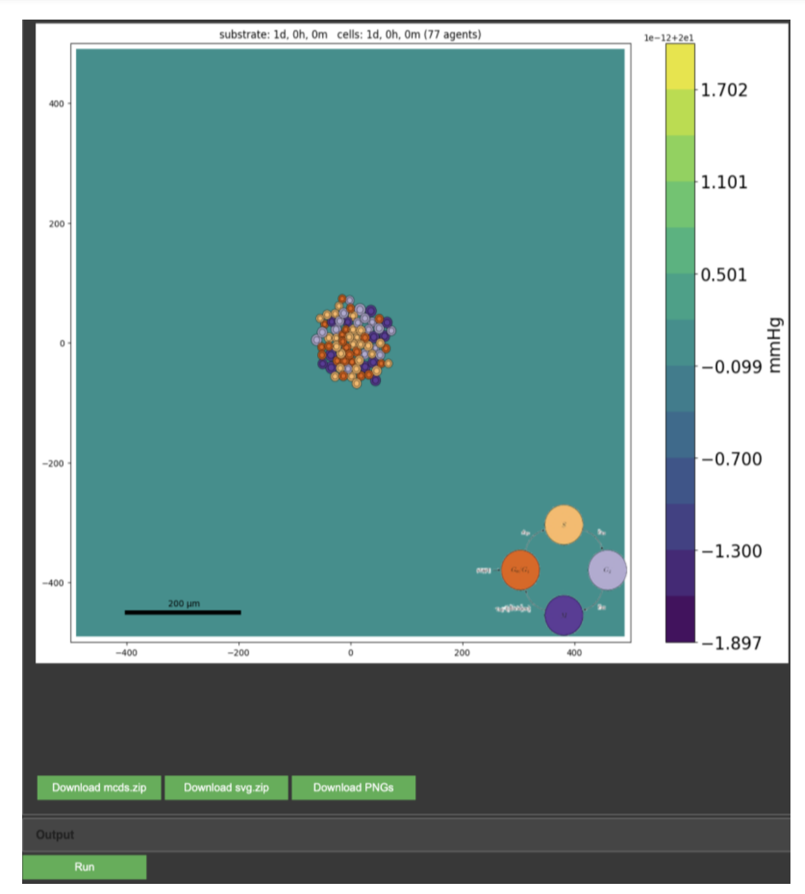
Objective

Our goal was to continue polishing, migrate, and fix and GUI issues. We also needed to speed up the process of loading the models, as well as add more export options and running times to the user.

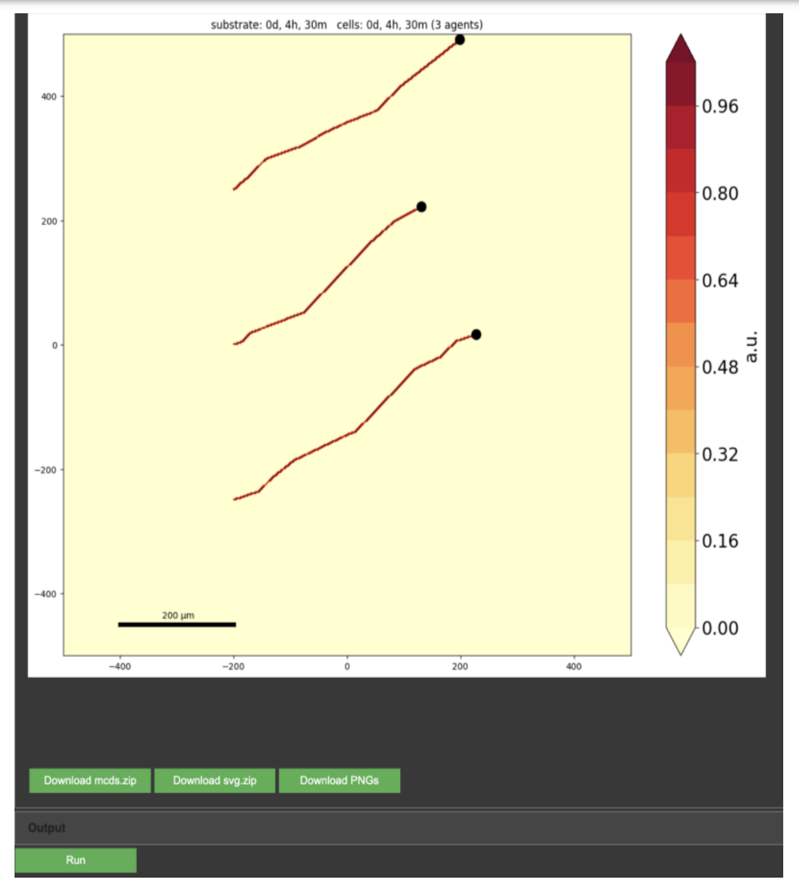
Methods

- **Environment Setup**
  PhysiCell Training applications were used and adapted to Colab. The Github link was used to import the notebook, for a seamless experience.
- **Programming and Compilation**:
  Pre-compiling the executable file to ensure a speed up, adding functionality to download PNGs, adding a separate window to show model running time, and integrate all this with the current GUI
- **Testing and Validation**
  Each application was tested within the Colab environment to verify functionality and model usability. Outputs were used as validation to confirm a successful updates.

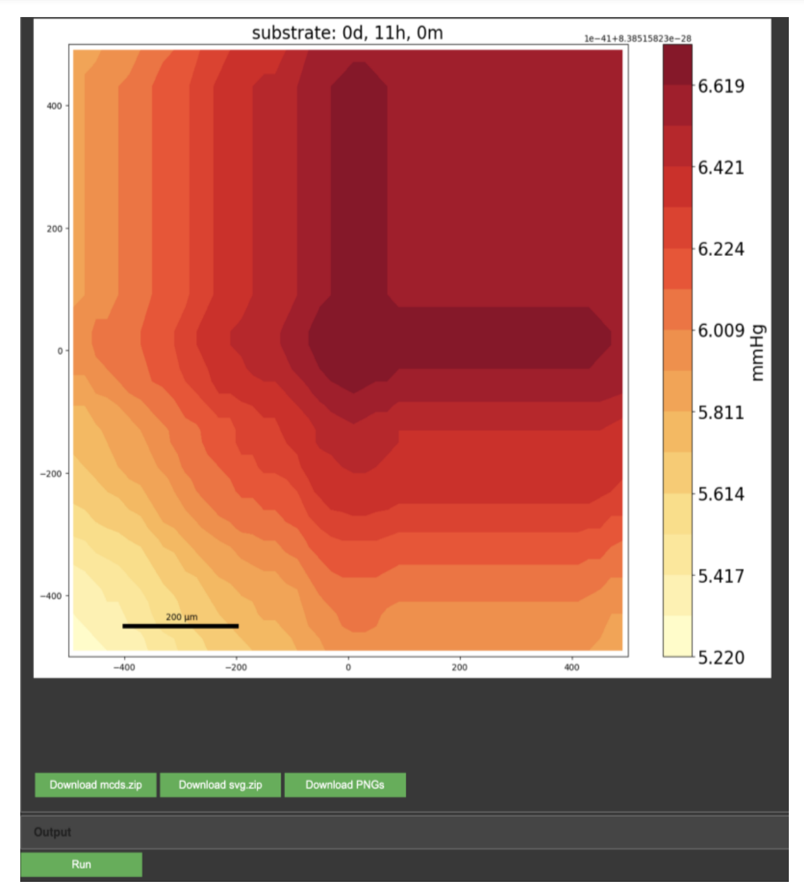
Results



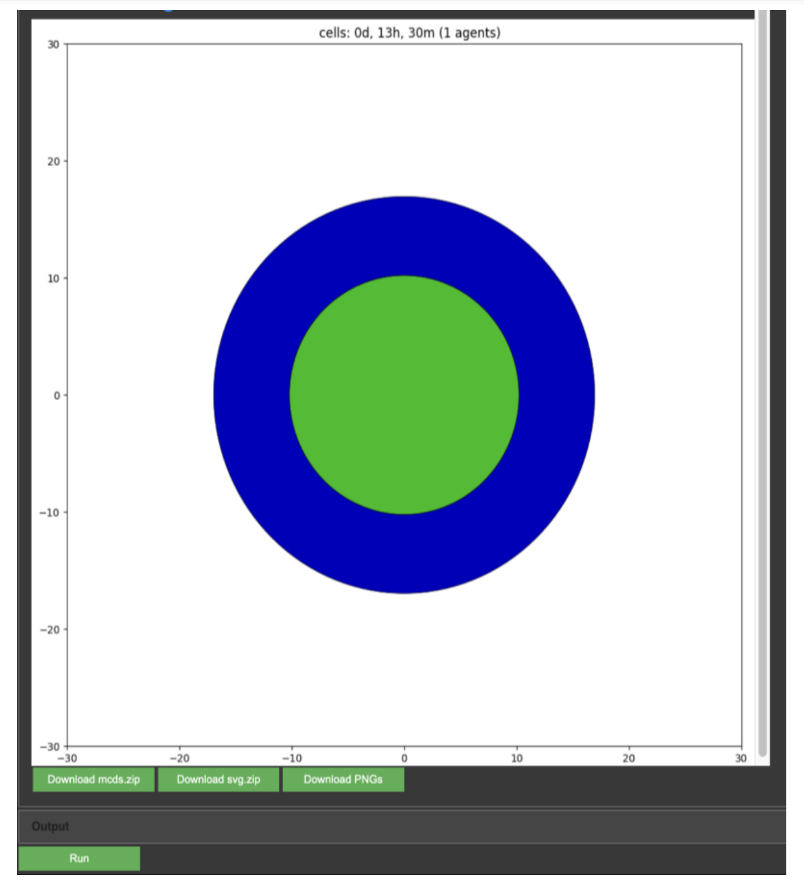
Cell Cycle
- Output displays cycle growth over a period
- PNG output option and pre-complied added
- Runtime reduction from 7 to 3 mins



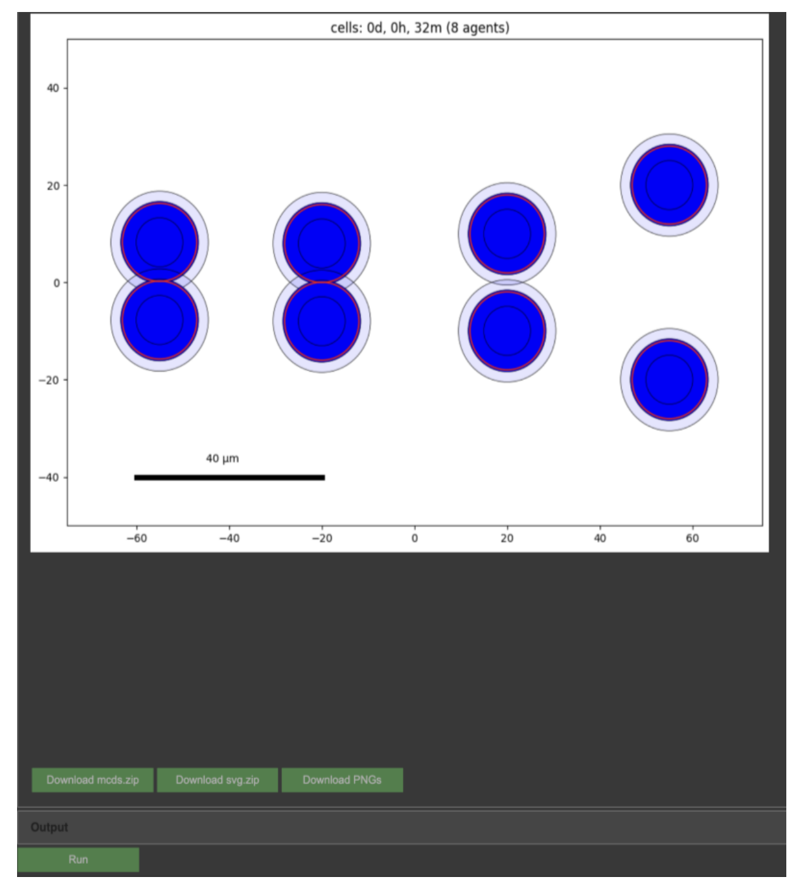
Cell Motility
- Output displays a cell's movement within a simulated environment
- PNG output option and pre-complied added
- Runtime reduction from 7 to 3 mins



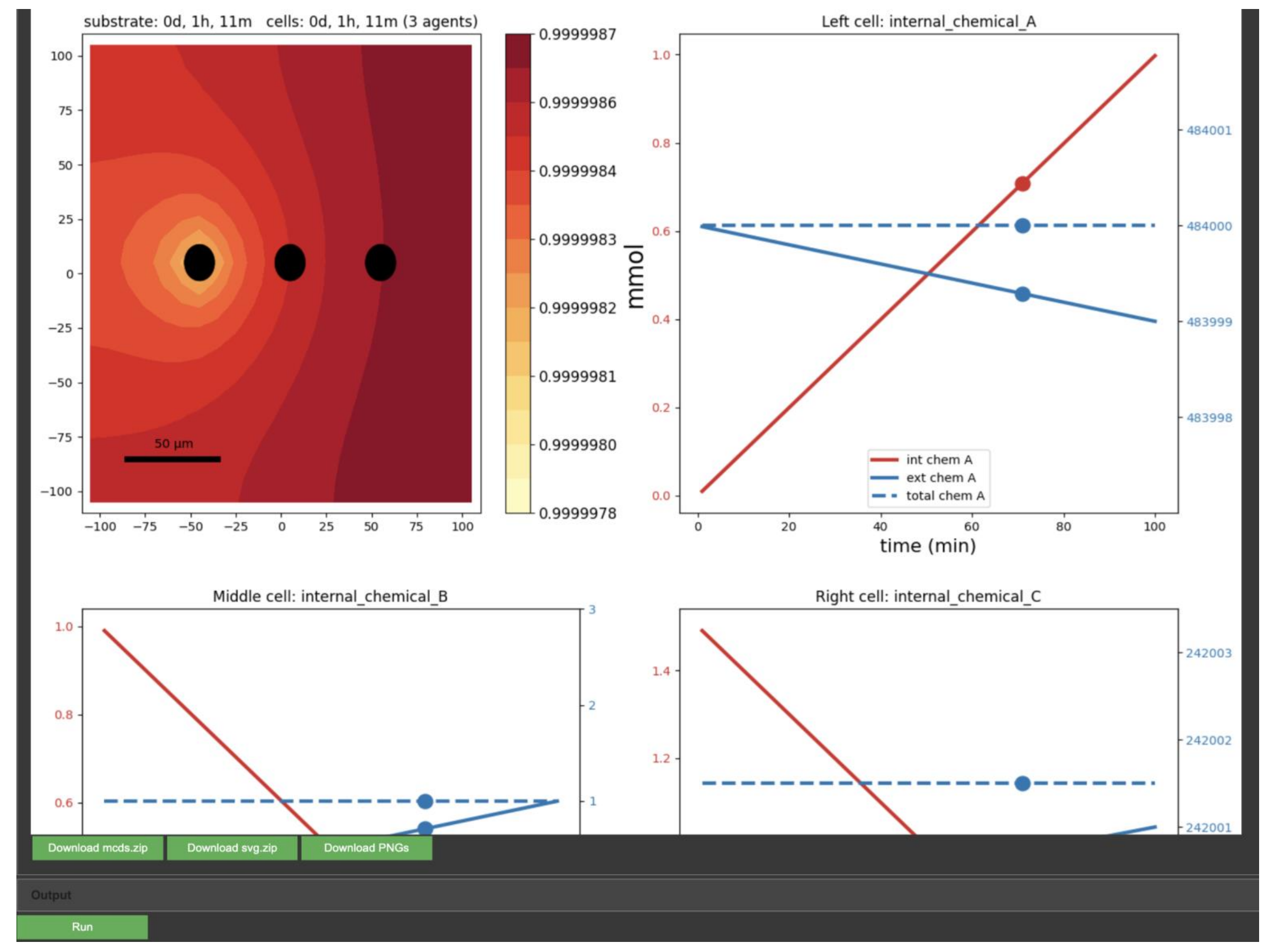
Cell Microenvironment
- Simulates distribution of oxygen and nutrients in the cell environment
- PNG output option and pre-complied added
- Runtime reduction from 7 to 2 mins



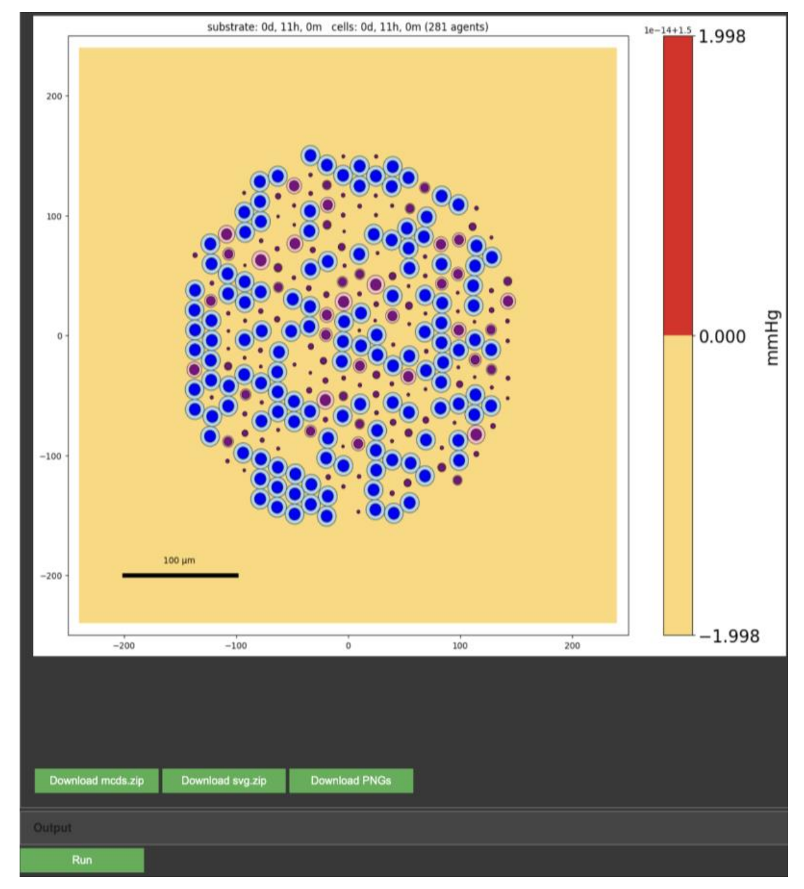
Cell Volume
- Cells undergo growth cycles based on volume parameters
- PNG output option and pre-complied added
- Runtime reduction from 6 to 2 mins



Cell Mechanics
- Simulation displays physical interactions such as adhesion and repulsion
- PNG output option and pre-complied added
- Runtime reduction from 5 to 3 mins



Cell Secretion
- Cell secretion model displays diffusion of chemical signals
- PNG output option and pre-complied added
- Runtime reduction from 9 to 3 mins



Cell Death
- Model displays cell death processes including apoptosis and necrosis
- PNG output option and pre-complied added
- Runtime reduction from 7 to 3 mins

Discussion and Future Work

- Fixed some of the UI elements
- Speed up the process of PNG downloads for some apps
- Possible enabling Animations tab for specific apps

(Link takes you to PhysiCell Training Apps)

References

- Aneequa Sundus, et al. "PhysiCell Training Apps: A Case Study for Creating Interactive Training Materials for Scientific Software Packages." BioRxiv (Cold Spring Harbor Laboratory), 28 June 2022, https://doi.org/10.1101/2022.06.24.497566. Accessed 8 Dec. 2024.
- Heiland, Randy, et al. "PhysiCell Studio: A Graphical Tool to Make Agent-Based Modeling More Accessible." BioRxiv (Cold Spring Harbor Laboratory), 27 Oct. 2023, https://doi.org/10.1101/2023.10.24.563727. Accessed 12 Dec. 2024.
- Ghaffarizadeh, Ahmadreza, et al. "PhysiCell: An Open Source Physics-Based Cell Simulator for 3-D Multicellular Systems." PLOS Computational Biology, vol. 14, no. 2, 23 Feb. 2018, p. e1005991, www.ncbi.nlm.nih.gov/pmc/articles/PMC5841829/, https://doi.org/10.1371/journal.pcbi.1005991. Accessed 17 July 2022.
- Computational work was performed using Google Colaboratory (Google LLC).

Acknowledgements

- I would like to Thank the Luddy Undergraduate Research program for organizing this program.
- Thank you, Dr. Macklin for allowing me to be part of your lab, and thank you Aneequa Sundus for helping me through this semester.

LUDDY
SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING

Math Cancer Lab
Undergraduate Research – Spring 2025