

# BioDynaMo: Biology Dynamics Modeller

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**BioDynaMo**  
BIOLOGY DYNAMICS MODELLER



**CERN**  
openlab

# Agent-Based Simulations

- **Agent-Based Modeling (ABM)** simulates interactions of autonomous entities (agents).
- Each **agent** operates independently and follows simple rules.
- **Local interactions** lead to **emergent behavior** (complex system-level effects).
- Used in **biology, medicine, epidemiology, neuroscience, economics, and more** (e.g. tumor progression, brain activity, and even economic trends).

# What is BioDynaMo?

- BioDynaMo is an **open-source, high-performance agent-based simulation platform**.
- Designed for **scalable and modular simulations** of biological, social, and physical systems.
- Supports **large-scale simulations**, handling **billions of agents efficiently**.
- Founded by **CERN** and **Newcastle University**.
- Available under the **Apache 2.0 license**

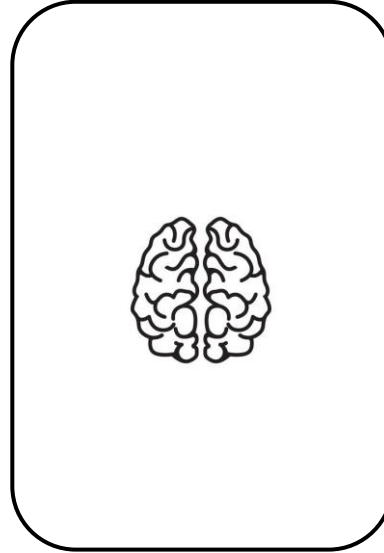
# Applications in Science & Engineering



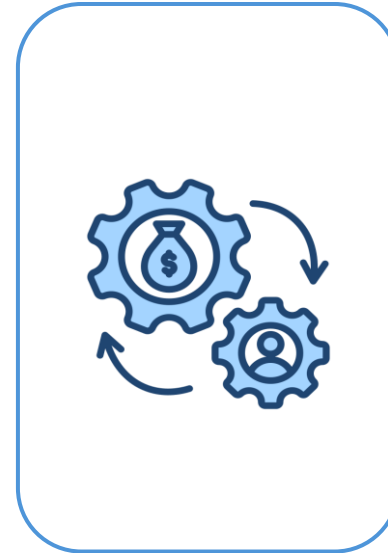
Biology and  
Medicine  
(tumor growth and  
drug interactions)



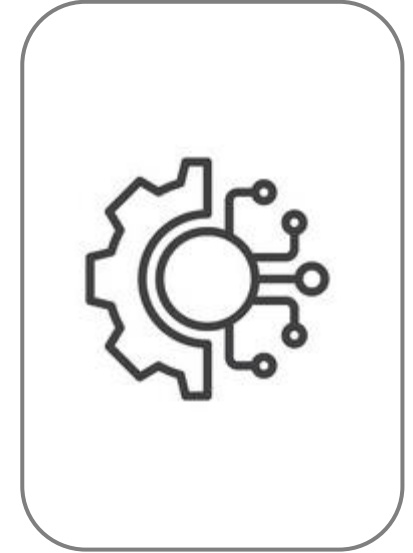
Epidemiology  
(disease spreads  
e.g. COVID-19)



Neuroscience  
(Neuron  
development  
and brain  
disorders)



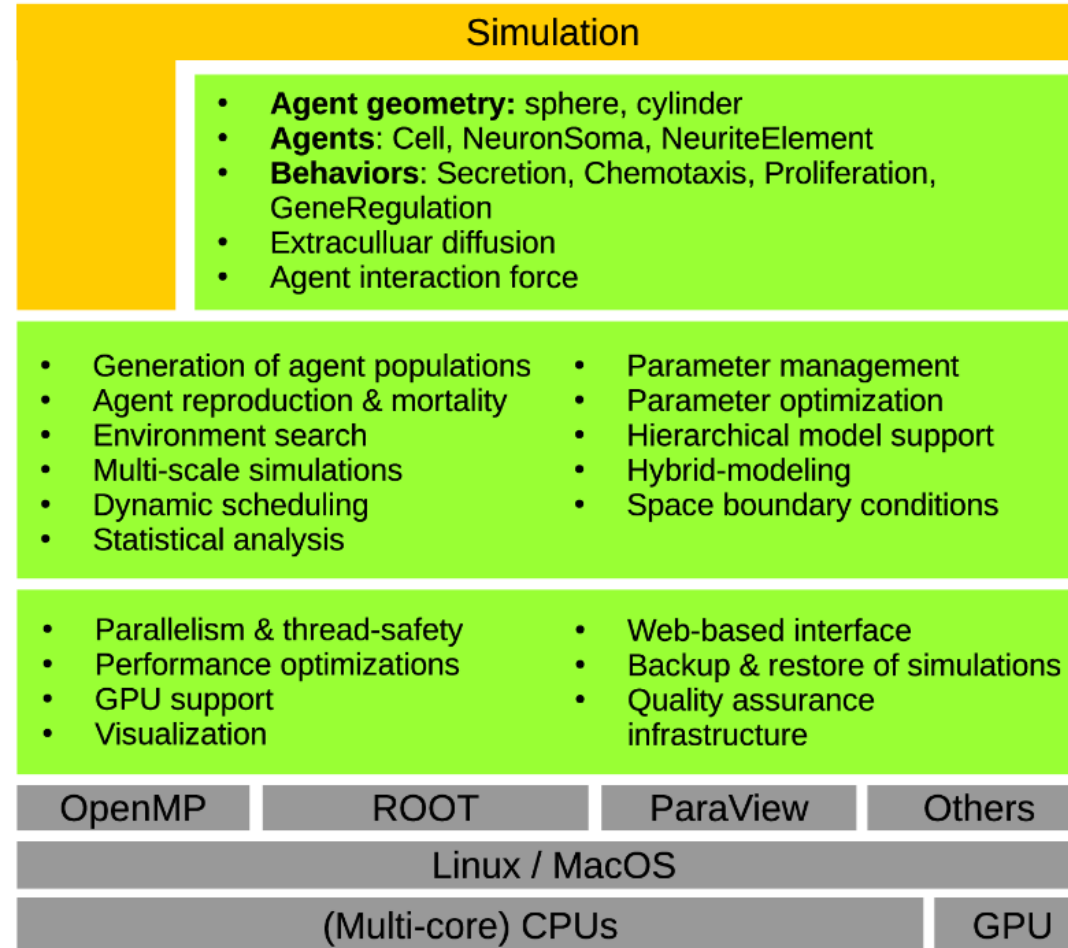
Social and  
Economics Systems  
(Market behavior  
analysis)



Physics and  
Engineering  
(Urban planning)

# BioDynaMo Features

- **Low-level features**  
*handle critical aspects of performance and usability*
- **High-level features**  
*commonly used across different agent-based modeling domains*
- **Model building blocks**  
*simplify the development of specific simulations, tailored for different scientific domains*



*Simulation*

*BioDynaMo's model building blocks*

*BioDynaMo's high-level features*

*BioDynaMo's low-level features*

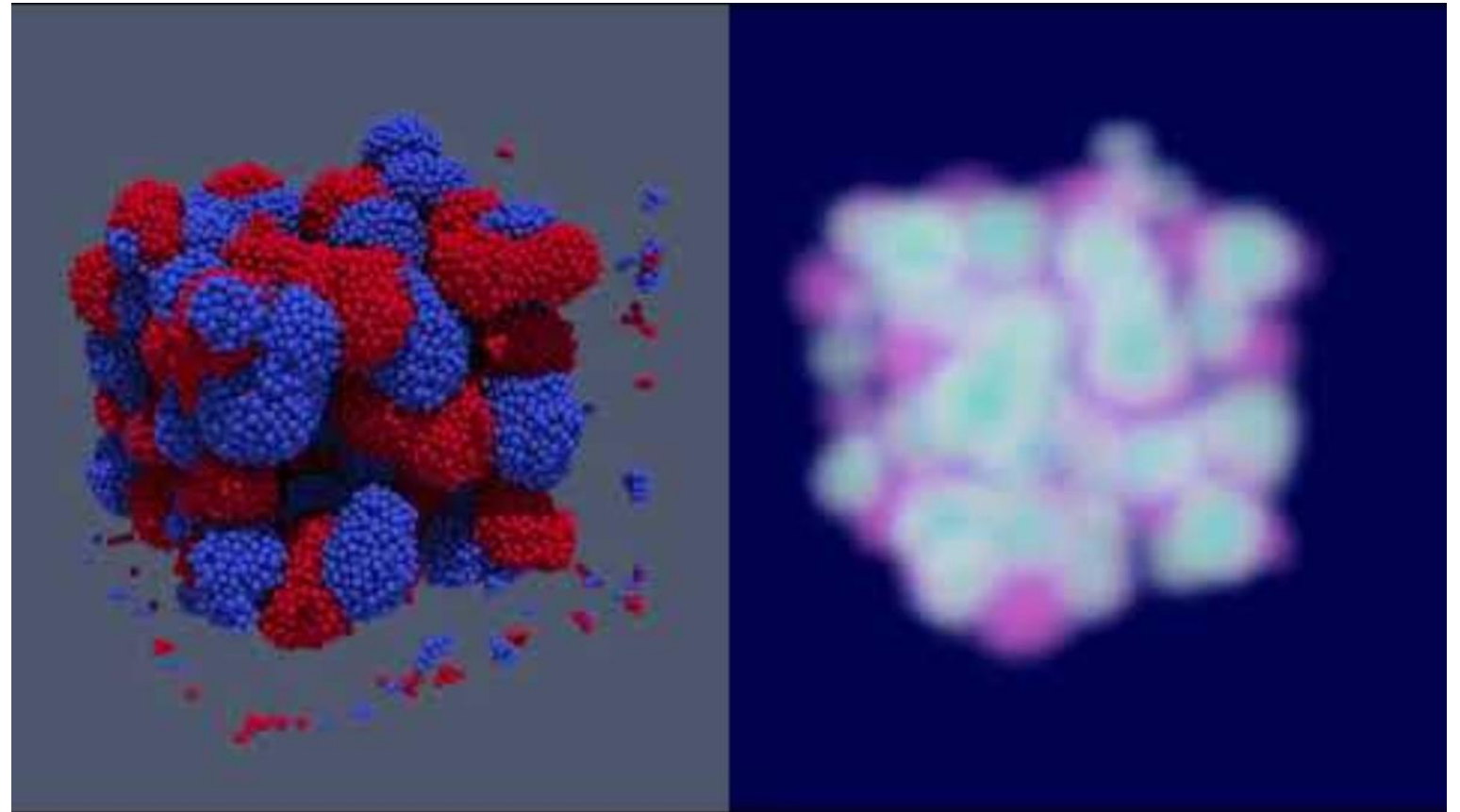
*Libraries*

*Operating System*

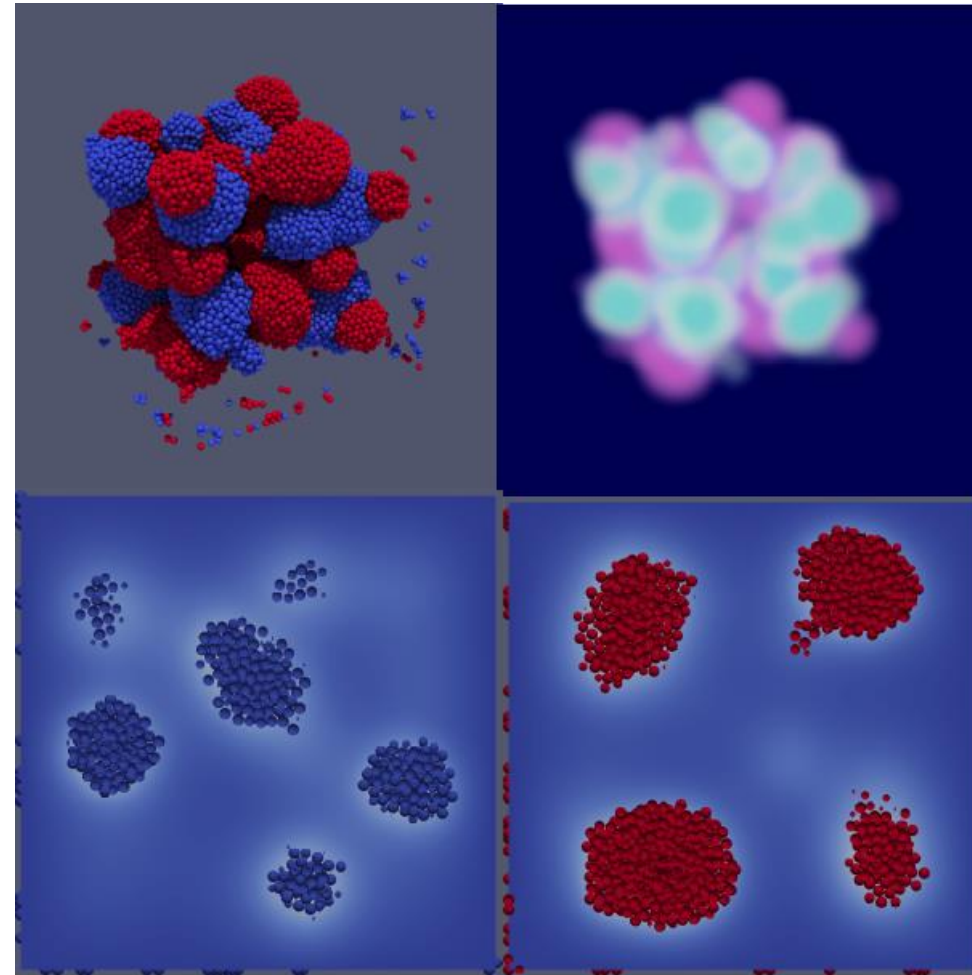
*Hardware*

# Example: Cell Clustering Model

- **Cells as agents** – spherical, two types (red & blue)
- **Two behaviors:**
  - **Secretion** – cells release substances into the environment
  - **Chemotaxis** – cells move toward higher concentrations
- **Initial state:** Random distribution in 3D space
- **Result:** Cells are organized in clusters

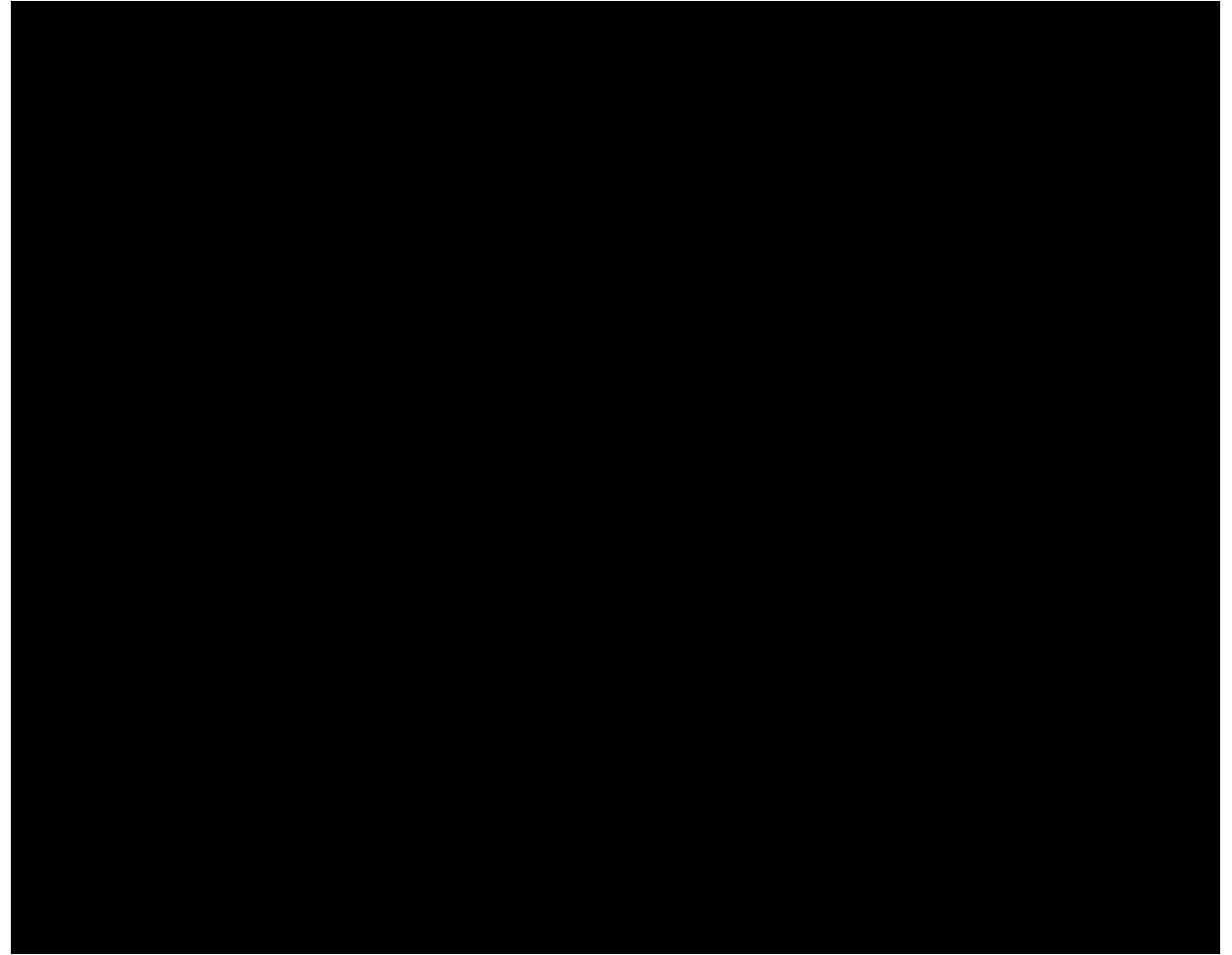


# Example: Cell Clustering Result



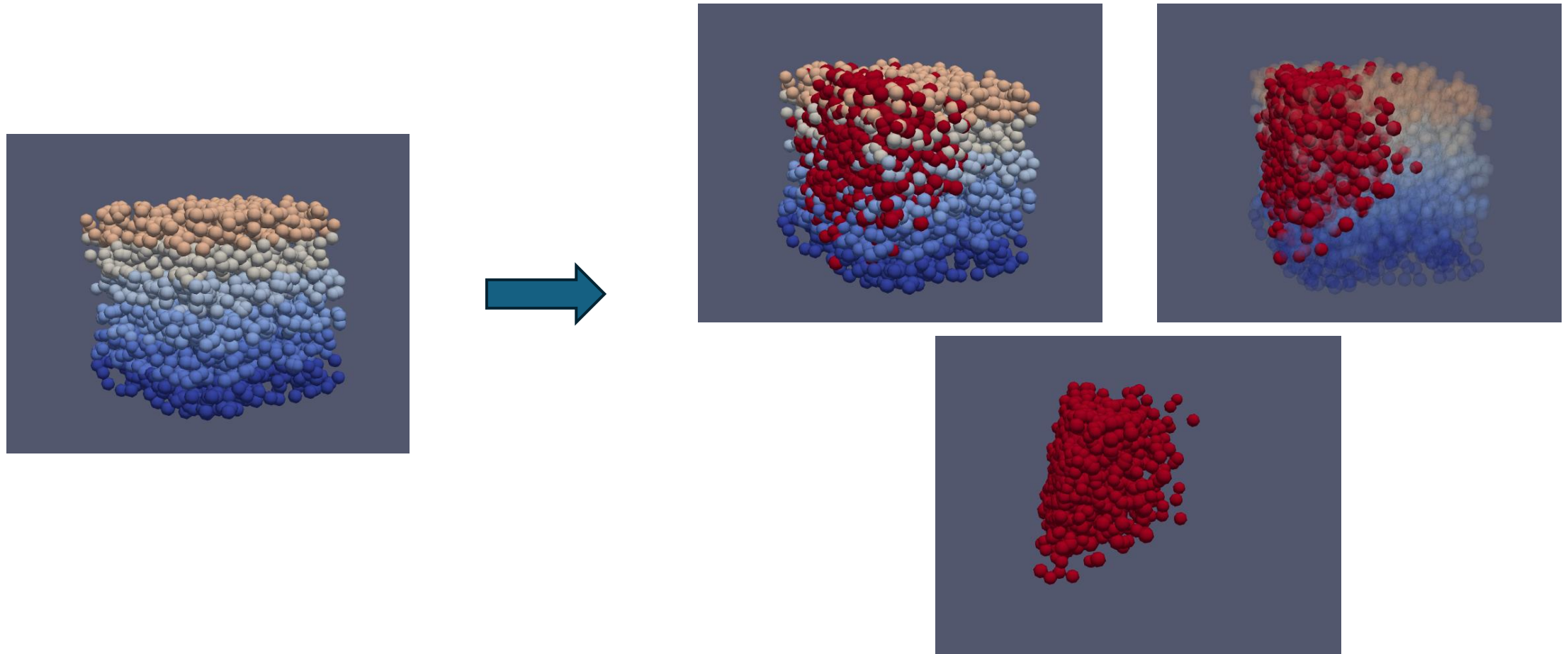
# Example: Tumor Growth Model

- **Simulates tumor growth** in a structured environment.
- **Initial state:** Layered cells, different tissue regions.
- **Tumor cells emerge** and begin expanding.





# Example: Tumor Growth Result

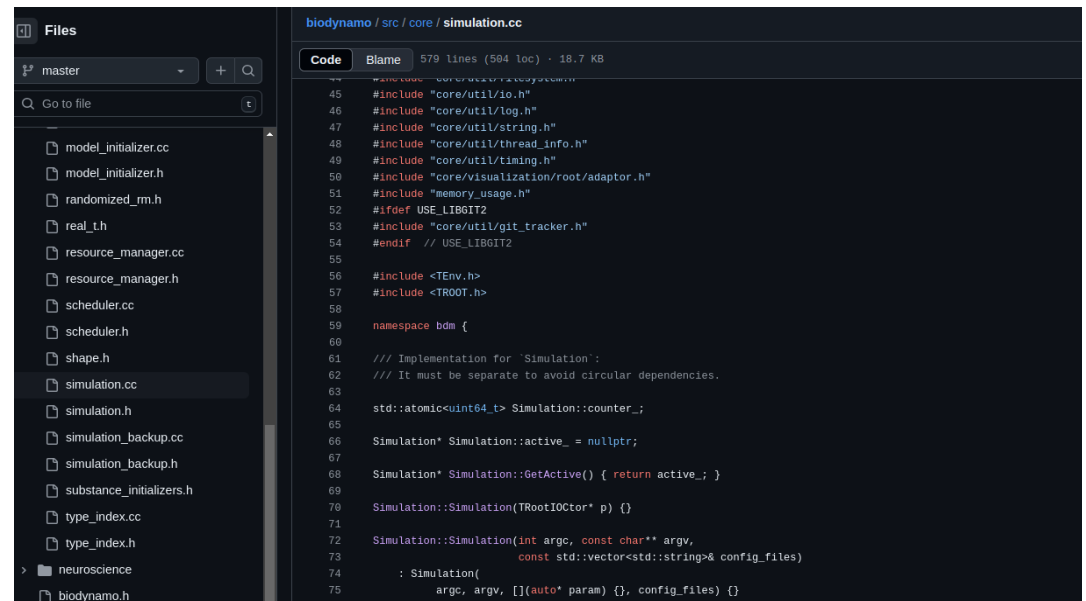
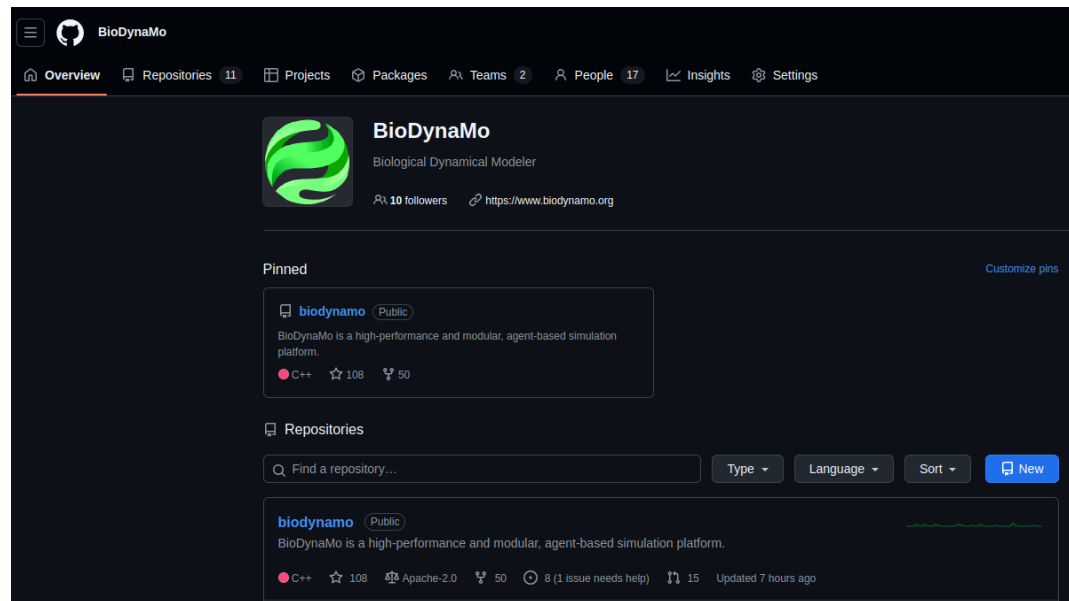


# BioDynaMo Members



# BioDynaMo Community

- **GitHub project:** <https://github.com/BioDynaMo/biodynamo>
- **Contributions welcome** – open-source collaboration.



# Conclusion

- BioDynaMo is a powerful, scalable agent-based simulation platform.
- It supports applications in medicine, biology, engineering, and more.
- Open-source and free to use.
- Encouraging researchers and developers to get involved.

# Thank you!

# References and Extra Information

- Breitwieser et al. 2021, <https://doi.org/10.1093/bioinformatics/btab649>
- Breitwieser et al. 2023, <https://doi.org/10.1145/3572848.3577480>
- BioDynaMo web site: <https://www.biodynomo.org>
- GitHub: <https://github.com/BioDynaMo>
- Tumor Concept: <https://www.biodynomo.org/user-guide/from-installation-to-1st-steps>