Agent-Based Modeling of Biological Systems — Hands-on

Learn how to represent cells, pathogens, immune players and other biological entities as agents that interact in space and time. This module introduces agent based modeling concepts, rule design, spatial environments and analysis of emergent behaviors, with practical workflows using accessible agent based modeling toolchains.

Agent-Based Modeling of Biological Systems

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Session Index

Session 1

Fee: Rs 8800 Apply Now

Agent-Based Modeling Foundations

What is agent based modeling and when to use it in biology

bottom up vs top down models **emergent behavior concepts** **examples from infection and tissue dynamics**

ABM building blocks and basic terminology

agents, states and attributes **time steps and schedules** **grids, neighborhoods and lattices**

Toolchain overview for agent based modeling workflows

concepts from visual model builders | Python based ABM frameworks preview | notebook driven simulation runs

Session 2

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Agents, Rules & Micro-Environments

Designing biological agents and state variables

cells, pathogens and immune players | health, activation and phenotype states | lifecycles and fate rules

Interaction rules and local update logic

movement and chemotaxis style ideas | contact based interactions | probabilistic events and stochasticity

Spatial micro environments and fields (concept level)

2 D and 3 D grid layouts | diffusive fields and gradients | boundary conditions and sources sinks

Session 3

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Implementing & Analyzing ABM Simulations

Implementing agent based models in a code framework

model classes and step functions | random seeds and reproducible runs | basic performance considerations

Collecting outputs and summary measures from simulations

population counts and time series | spatial distributions and heatmaps | distributions and variability across runs

Visualisation and analysis of emergent behavior patterns

R / Python plots for ABM outputs | simple dashboards or animation exports | interpreting qualitative and quantitative patterns

Session 4

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Mini Capstone: Biological Agent-Based Scenario

Design an agent based model for a chosen biological scenario

Theory + Practical

Run experiments and explore parameter and rule changes

scenario comparison runs | sensitivity style sweeps | qualitative behavior classification

Deliverables: simulation notebook, figures & short ABM report

R or Python based ABM notebook | plots or animations of system behavior | PDF/HTML summary of design and findings