

HYBRID MODELLING OF GLIOBLASTOMA EVOLUTION UNDER HYPOXIC CONDITIONS

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What is **GLIOBLASTOMA** ?

The most **aggressive** and **common** type of brain cancer. Its main hallmarks are the following:

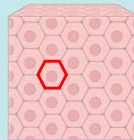


Hypoxic conditions **Lead to** Invasive behavior **Leads to** Extensive tumor infiltration

How can we **study it** ?

IN SILICO MODELS

AGENT BASED MODELS



Cells as individuals



Computationally more costly



As cells are considered as individuals, their interactions are taken into account

CONTINUUM MODELS

$$\frac{\partial u}{\partial t} + \frac{\partial^2 u}{\partial x^2} + s = 0$$

Diffusive term Source term

Cells as a population



Cell-cell or cell-environment interactions are ignored

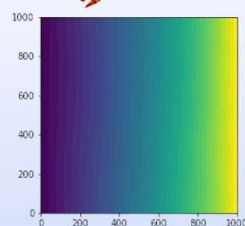


Large domains can be simulated

HYBRID MODELS

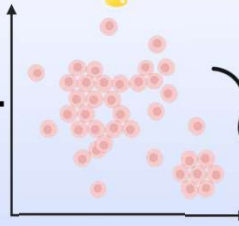
Our **HYBRID MODEL**:

We developed our own hybrid model combining a Python agent based model and a continuum model supported in FENICS.



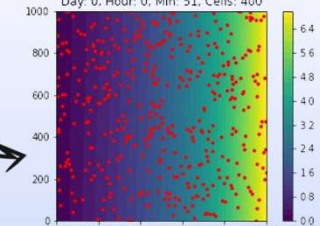
O₂: CONTINUUM MODEL

O₂ consumption and diffusion are modeled with a PDE and implemented in a finite element software (FENICS).



CELLS: AGENT BASED

The following cellular processes are modelled: proliferation, death, migration and O₂ consumption.



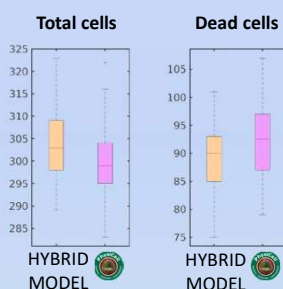
HYBRID MODEL

O₂ DYNAMICS IS FASTER:
 $\Delta t_{cells} > \Delta t_{O_2}$
TEMPORAL MULTISCALE

How can we **verify it** ?

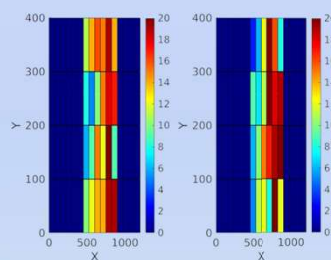
The model was verified carrying out the same simulation in Physicell and comparing some metrics

Student's t-test:



With this test we verify cellular **proliferation** and **death**.

χ^2 test



With this test we verify cellular **migration**.

The number of cells along the domain is showed.

TAKE HOME MESSAGE

Hybrid models **combine** the agent and continuum models **advantages**

BUT

computational cost is still quite high, so further **improvements** need to be made, such as including **multiscale in space**.