

SimCells

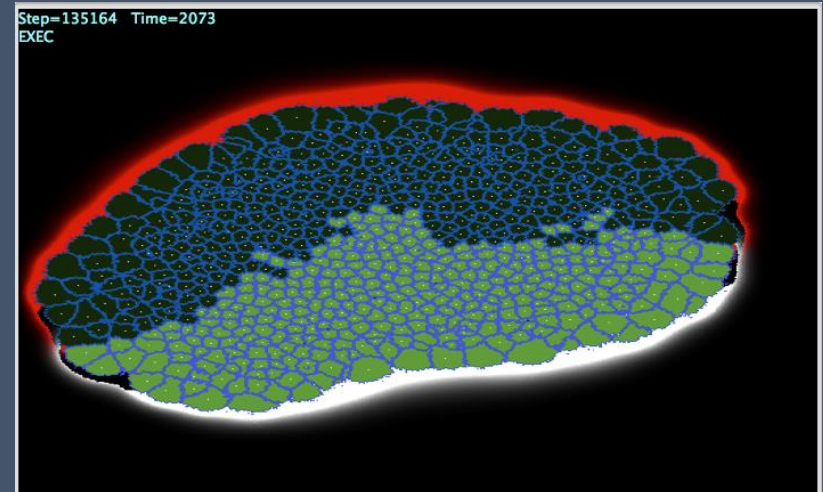
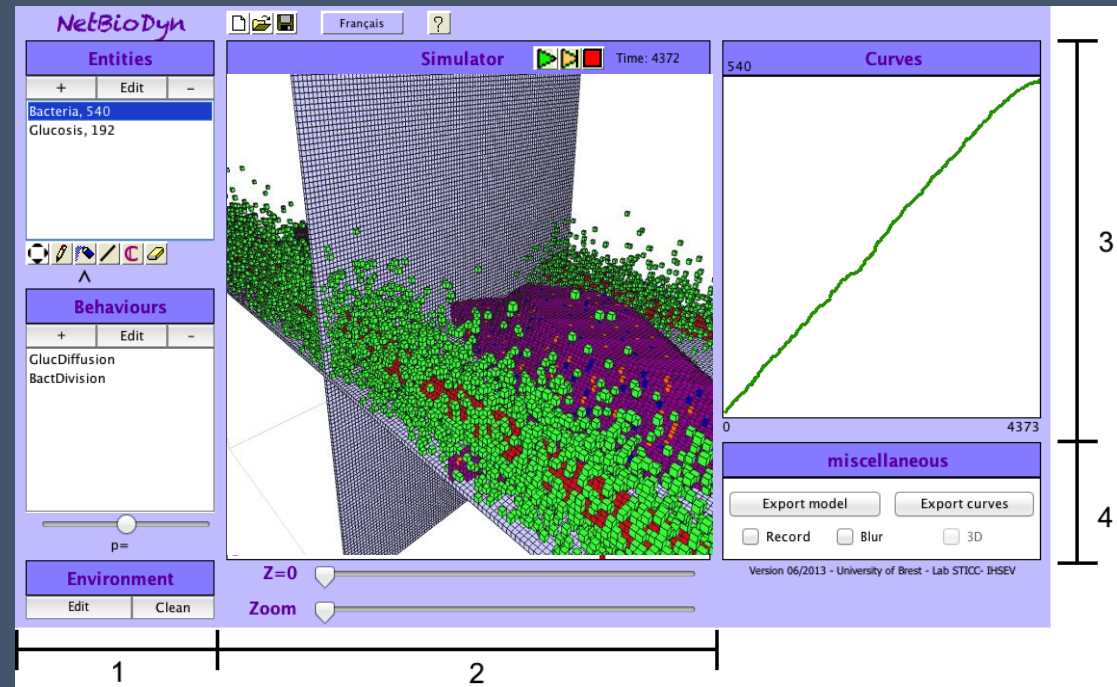
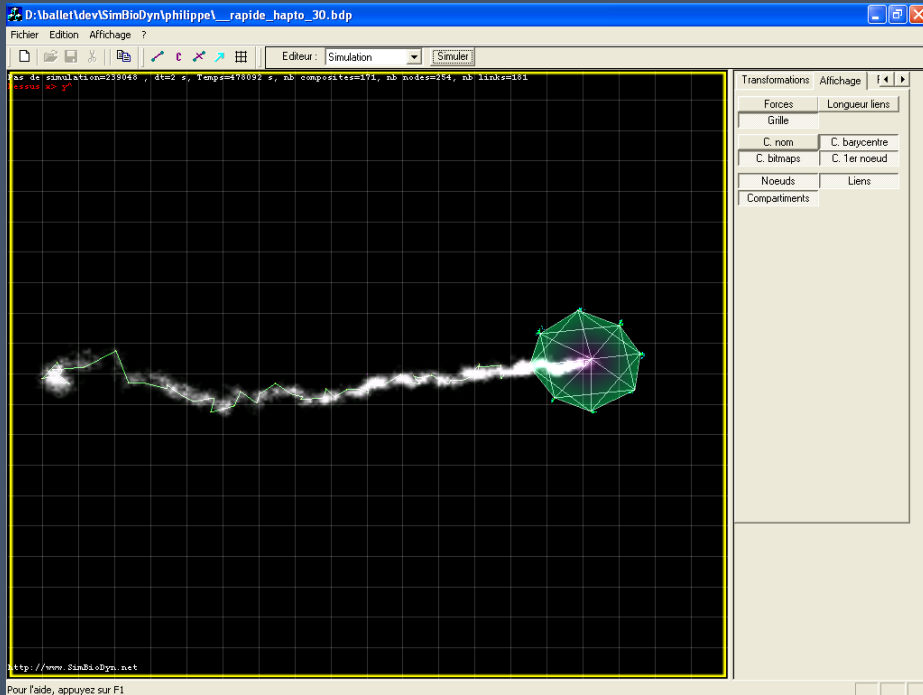
<http://virtulab.univ-brest.fr>

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Previously...



SimCells = Multicellular Simulator

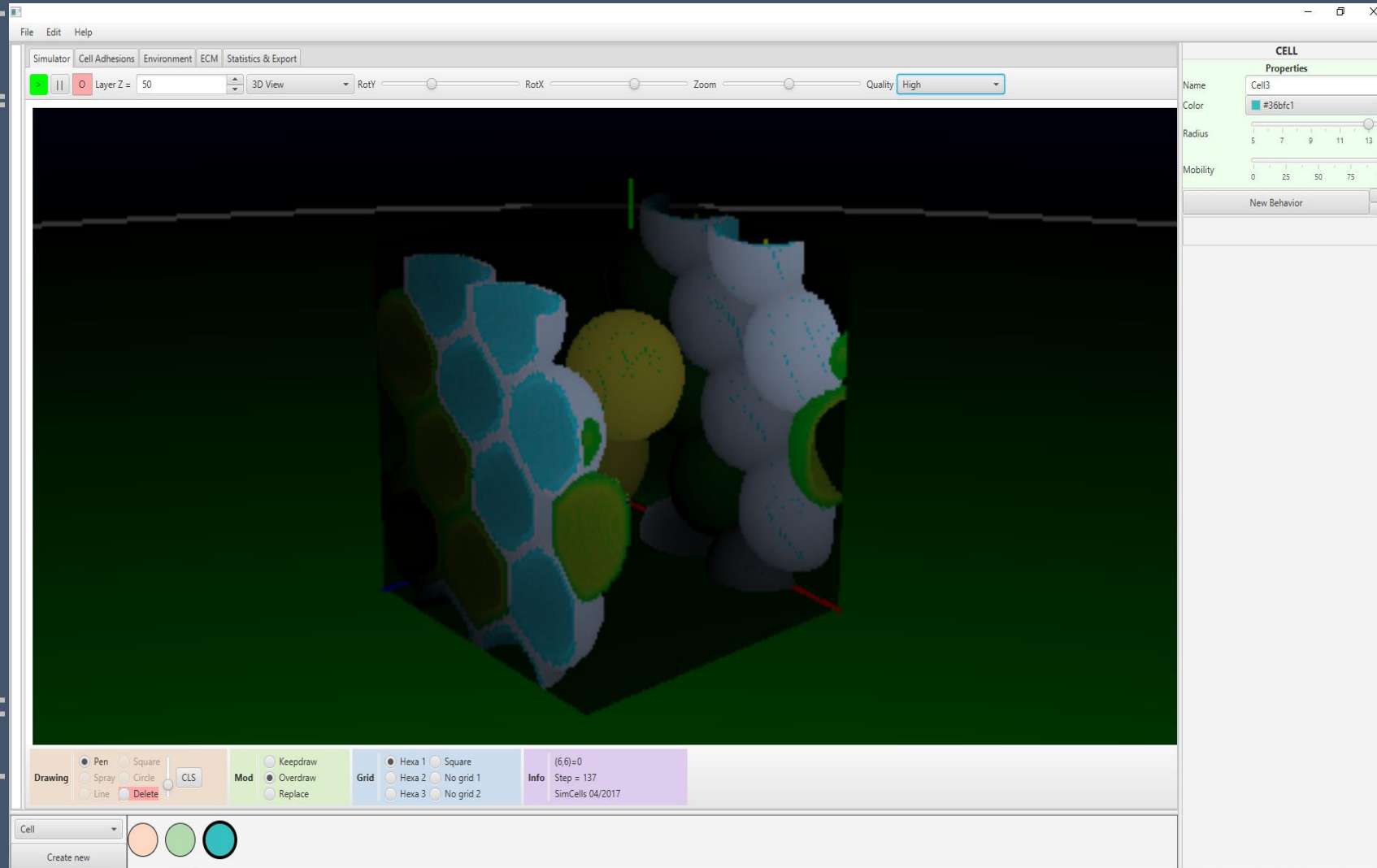
agent based => virtual laboratory bench

Controls
simulation+view

3D scene

Scene design

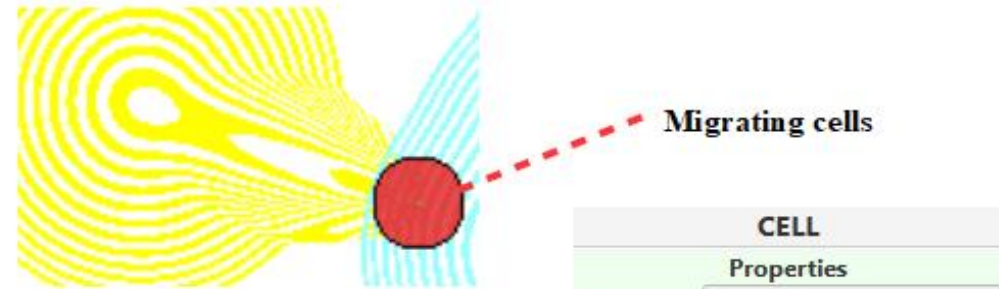
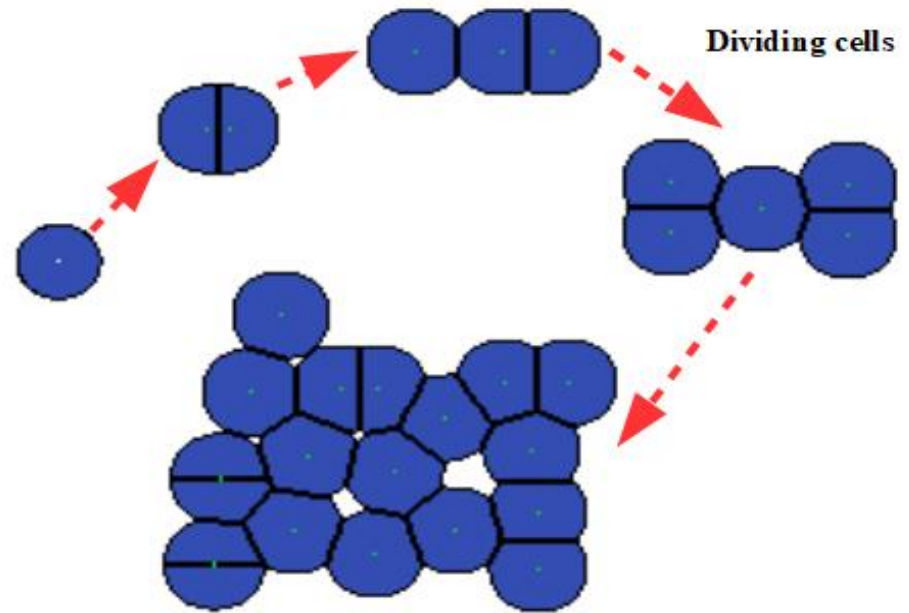
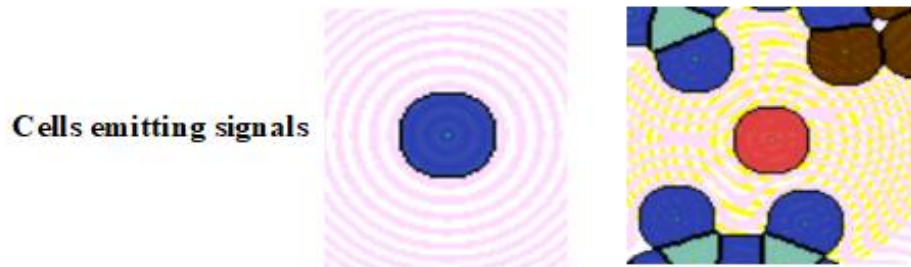
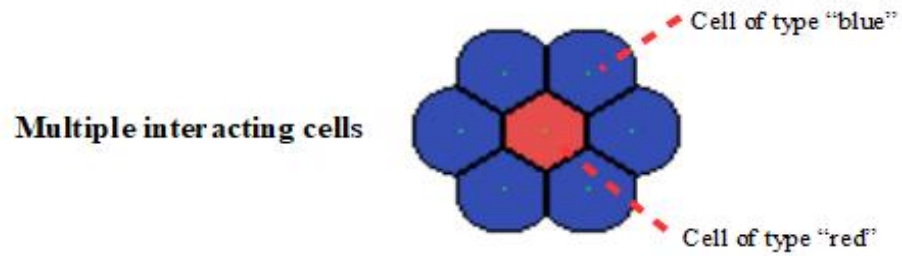
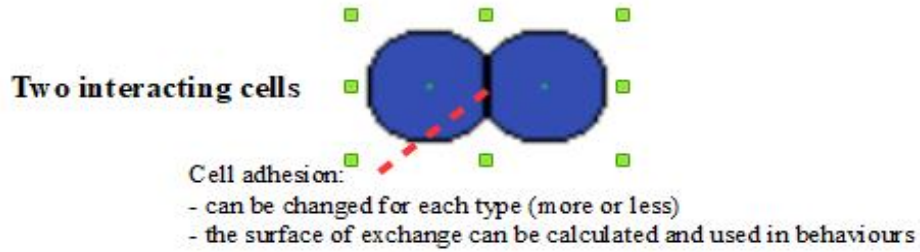
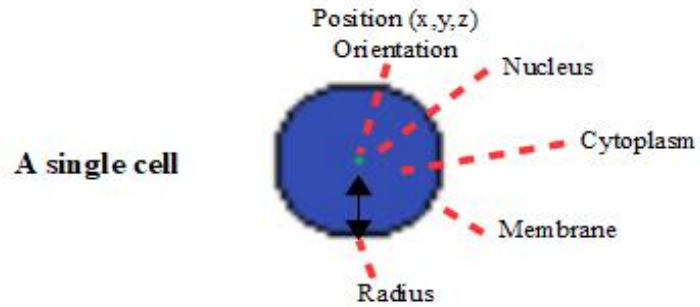
Add cells



Propriétés des
cellules

Comportements
des cellules

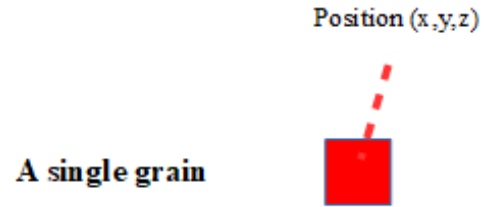
CELLS



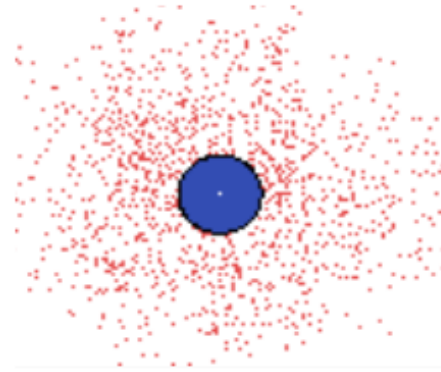
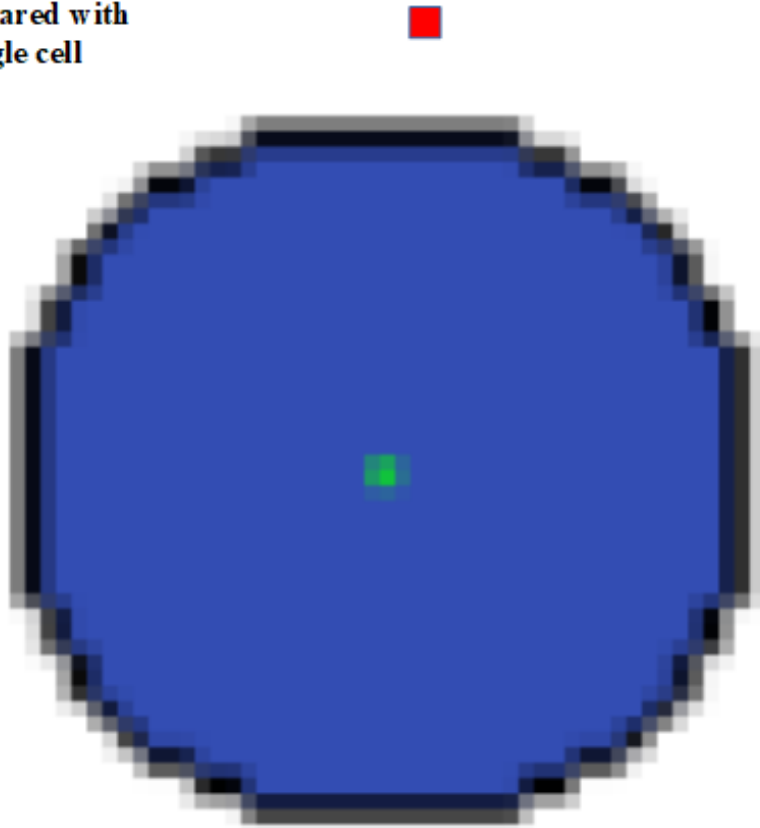
Other parameters
Age, Pressure, Cell contacts and Membrane flexibility

CELL	
Properties	
Name	Cell2
Color	■ #e64d4d
Radius	<input type="range" value="13"/>
Mobility	<input type="range" value="50"/>
New Behavior	
OK	Signal <input checked="" type="checkbox"/>
OK	Chemotaxis <input checked="" type="checkbox"/>

GRAINS

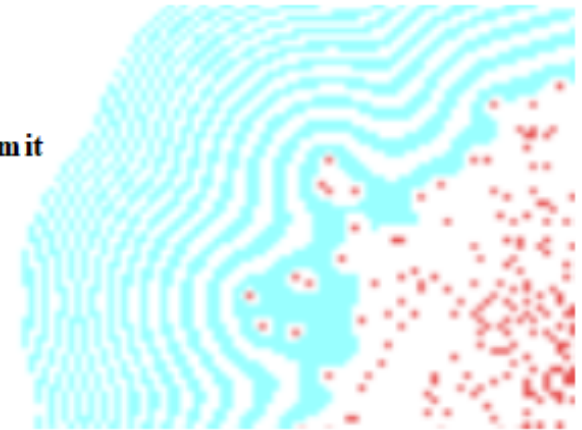


A grain as compared with a single cell



A cell can produce and consume grains

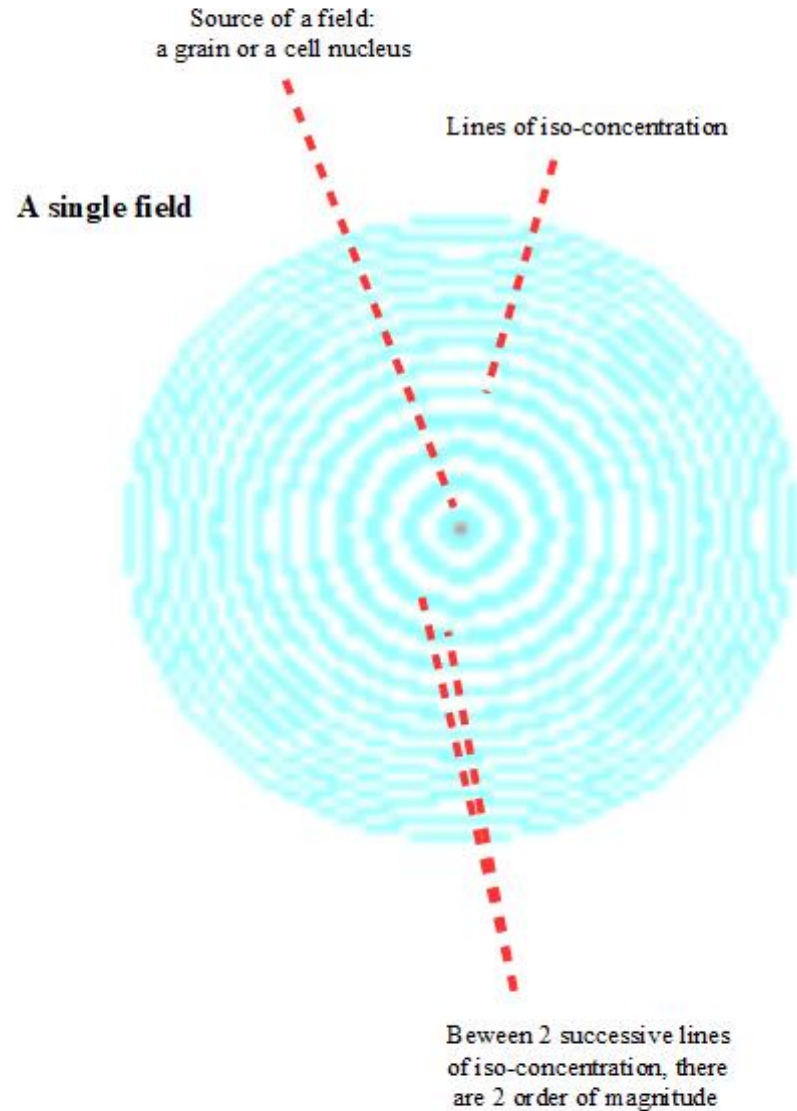
Grains can, like cells, emit signals.



Grains have roughly the same abilities as cells: signalling, migration, division, deletion, differentiation, transformation (grain => cell or cell => grain).

The behaviours are described using the same graphical manner.

FIELDS

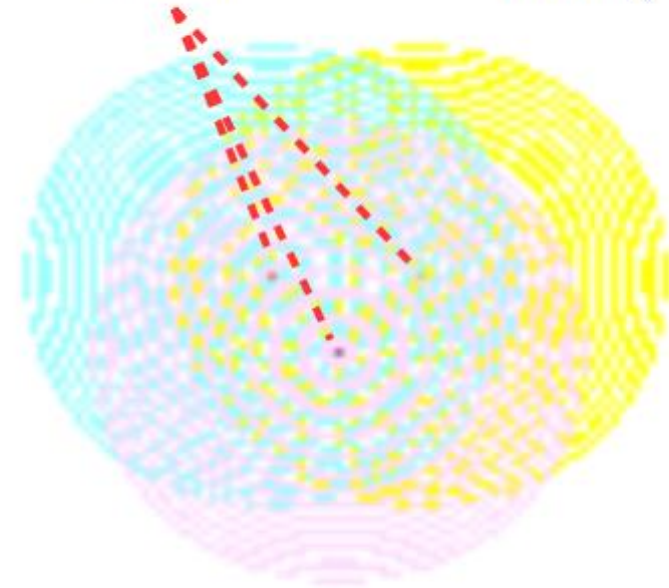


A field has:

- a concentration per matrix element,
- a diffusion rate and
- a degradation rate

3 sources of field

Independent fields can overlap.



Cells and grains use fields

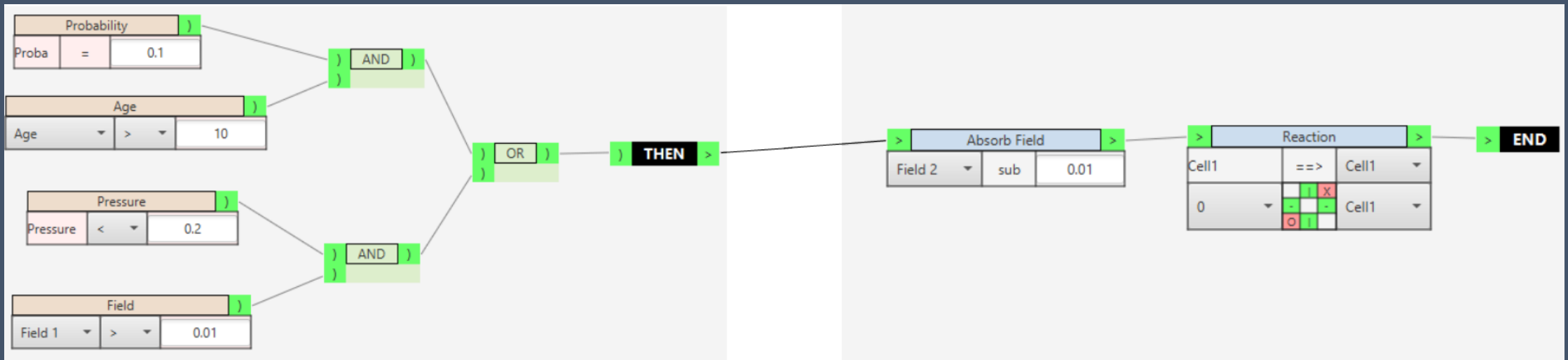
The fields can be detected by grains or cells to differentiate, move, divide or die.

Behaviours

Conditions

Logical gates

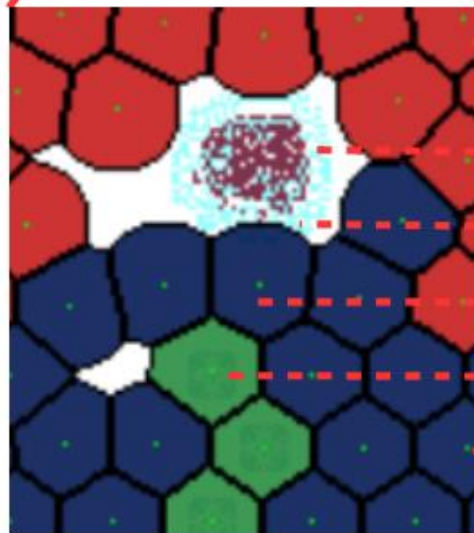
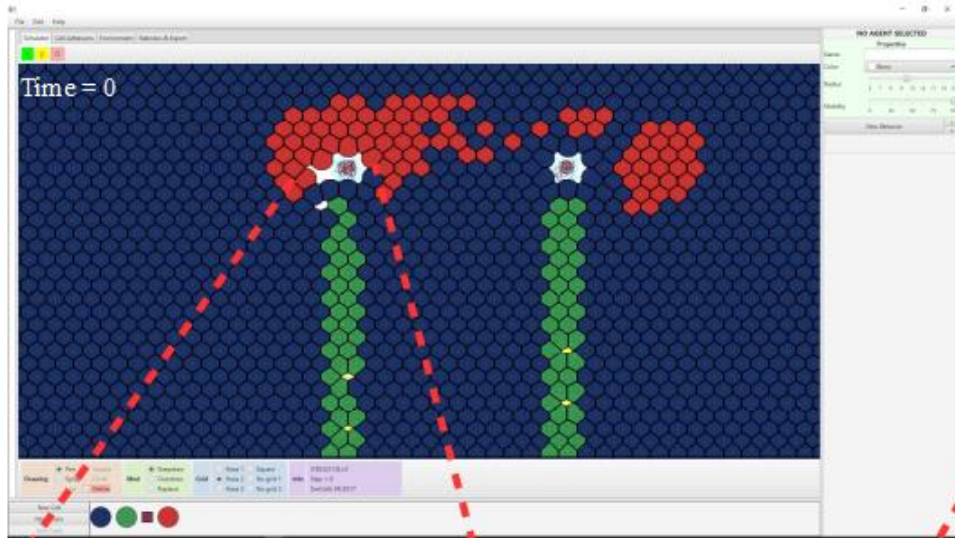
Actions



=> OpenCL code generation

PROSTATE EXAMPLE

Simulation of the prostate tissue inflammation after surgery.



Cancerous cells

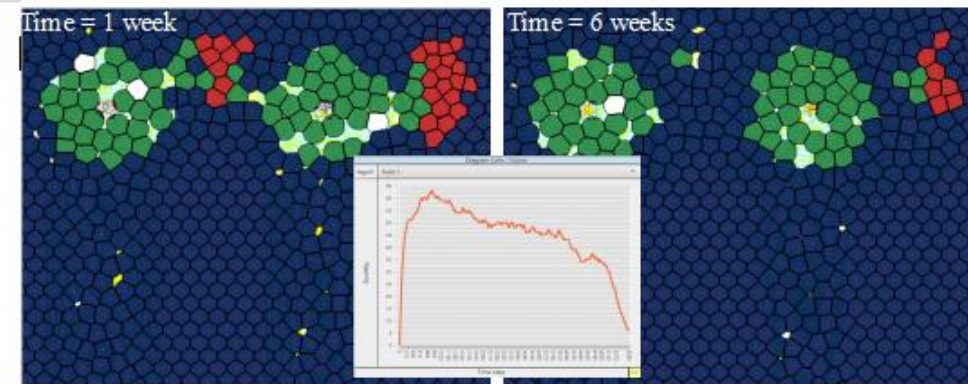
Radio active grains

Radio active field (2)

Inflammation field (1)

damaged cells

Healthy cells



Probability	)	AND	)	THEN	>	Reaction	>	END
Proba	=	0.01				Tumeur	==>	Tumeur
Pressure	<	0.2				0		Tumeur
Field	)	THEN	>	Reaction	>	END		
Field 2	>	1.0E-15		Tumeur	==>	Prostate InflammÃ©e		
Probability	)	THEN	>	Put Field	>	END		
Proba	=	1.0		Field 2	add	0.01		
Probability	)	THEN	>	Reaction	>	END		
Proba	=	0.001		Grain Radioactif	==>	0		
Probability	)	THEN	>	Put Field	>	END		
Proba	=	1.0		Field 1	add	0.01		
Probability	)	THEN	>	Reaction	>	END		
Proba	=	0.01		Prostate InflammÃ©e	==>	0		
Field	)	THEN	>	Reaction	>	END		
Field 2	>	1.0E-7		Prostate	==>	Prostate InflammÃ©e		
Pressure	)	THEN	>	Reaction	>	END		
Pressure	<	0.01		Prostate	==>	Prostate		
				0		Prostate		

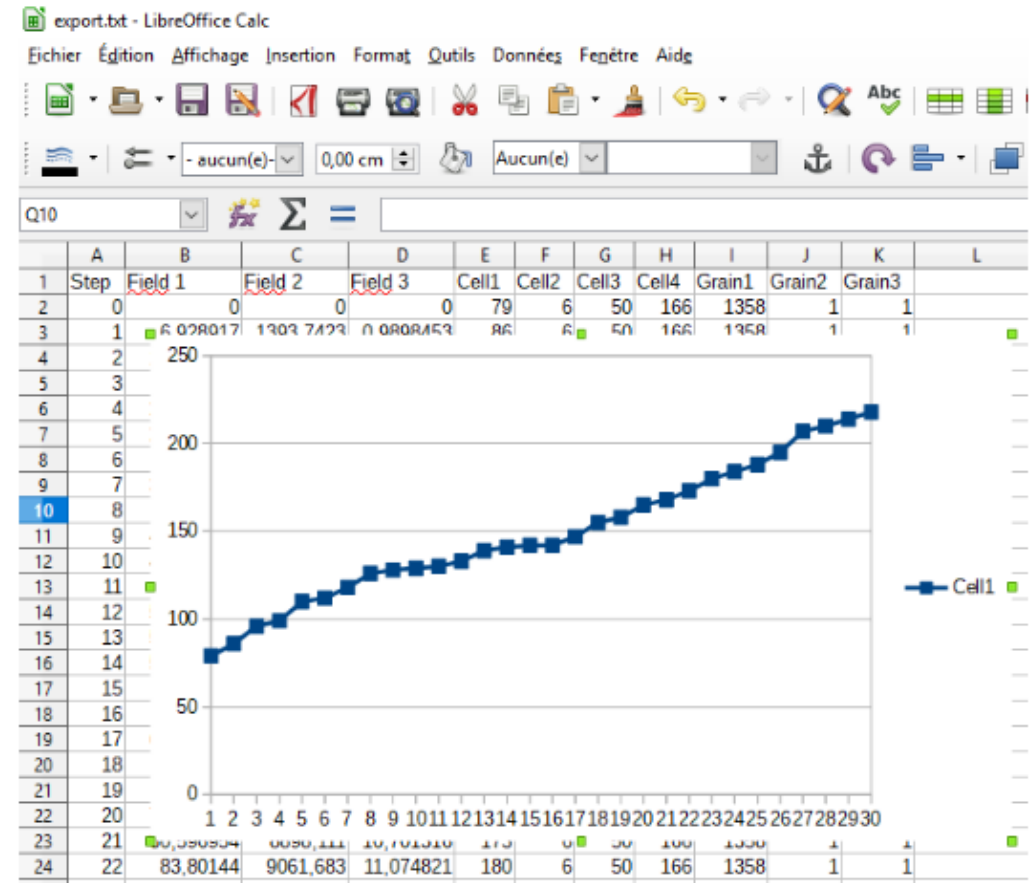
DATA EXPORT

The data can be exported in text format and imported in any spreadsheet software.

export.txt - Bloc-notes

Fichier Édition Format Affichage ?

Step	Field 1	Field 2	Field 3	Cell1
0	0.0	0.0	0.0	79.0
1	6.928917	1393.7423	0.9898453	86.0
2	12.317781	2312.7185	1.7246909	96.0
3	17.08242	3057.946	2.3763053	99.0
4	21.348324	3694.909	2.9800522	110.0
5	25.491438	4253.268	3.5504656	112.0
6	29.60319	4750.611	4.095297	118.0
7	33.426907	5199.3374	4.619305	126.0
8	37.1982	5606.4116	5.1256833	128.0
9	40.915096	5979.703	5.61673	129.0
10	44.484615	6323.1543	6.0941505	130.0
11	48.024998	6641.715	6.5592847	133.0
12	51.518368	6936.8774	7.0131984	139.0
13	54.951576	7212.152	7.4567738	141.0
14	58.453693	7469.5347	7.8906918	142.0
15	61.79137	7710.7256	8.315639	142.0
16	65.05085	7937.1626	8.732066	147.0
17	68.245445	8152.413	9.140487	155.0
18	71.38229	8355.009	9.541306	158.0
19	74.46456	8545.273	9.934803	165.0
20	77.597046	8726.548	10.321404	168.0
21	80.596954	8898.111	10.701316	173.0
22	83.80144	9061.683	11.074821	180.0
23	87.02475	9216.974	11.442173	184.0
24	90.244026	9365.657	11.803589	188.0
25	93.62948	9506.715	12.159227	195.0
26	96.60403	9641.889	12.509305	207.0
27	99.46801	9771.734	12.853949	210.0
28	102.54267	9895.774	13.193395	214.0
29	105.717445	10014.501	13.527763	218.0



Examples

- Download SimCells => <http://virtulab.univ-brest.fr>
- Unzip, go in the folder `bin` => double click `SimCell.bat`

- Multicellular simulations
 - Division
 - Contact
 - Apoptosis
 - Migration
 - Membranar adhesivity
 - Different sizes
 - Mecanotransduction
- Microscopic images integration

Conclusion

- Fully Integrated Dev Software
- Focus on *what* instead of *how* (with limitations)
- 4 scale levels (Cells, Grain, Molecule, Fields)
- Many entities can be simulated (>1 million)
- Used in teaching at Brest (High school, M1 & M2 Bio, M2 Info, 4A Medical school)
- Used in research (next talk)