

#### Description:

RD-3D is a GPU-based finite-difference implementation used to simulate the reaction-diffusion process on a regular network of spacing  $\varepsilon$  with periodic or no-flux boundary conditions at the domain borders.

#### Files:

code folder:  
3D-RD.cu – contains the main function and multithreaded implementation for running GPU kernel functions and writing the data  
kernel.cu – implementation of finite-difference GPU kernel functions  
loading.h – contains functions used to load the data and set up the simulation context  
Makefile – used to compile and run the code  
3D-RD – compiled binary file  
3D-RD.o – intermediate compiling stage  
networks folder:  
Contains data for test examples below.  
Contains python script to generate gaussian bumps networks of different heights and standard deviations (requires python3 interpreter + numpy library).  
output folder:  
Contains test examples outputs.

#### Compile:

Requirements:  
NVIDIA graphics card, NVIDIA C Compiler (nvcc), Nvidia toolkit, GNU c++ compiler (g++)  
Installation guides:  
<https://docs.nvidia.com/cuda/index.html#installation-guides>  
<https://gcc.gnu.org/install/index.html>  
Required software installation takes a couple of minutes.

To compile the code, enter the directory containing the code and type:

make

To clean the last build type:

make clean

#### Run:

To run the test example on a regular 10 by 10 network of hexagonal prisms or gaussian bumps use the following command line arguments:

Argument 1: network type (1 – hexagonal prisms, 0 – gaussian bumps)  
Argument 2: initial conditions if network type is 1 (1 – uniformly colored scales, 0 – randomized uniform steady state)  
Argument 2: gaussian bumps sigma (integer) if network type is 0  
Argument 3: total height of the simulation domain  
Argument 4: domain thickness between prisms/gaussian bumps  
Argument 5: mesh spacing epsilon

Examples:

Top simulation view will be outputted for hexagonal prisms and bottom view for gaussian bumps.

Image outputs come in .ppm format and are stored every 10000 iterations.

Initial conditions and the final state will be stored as point clouds in .ply files.

Hexagonal prisms are simulated with periodic and gaussian bumps with no-flux boundary conditions.

All examples were ran on NVIDIA Titan V graphics card.

Example 1: Uniformly colored prisms as initial condition

To run this example type:

```
./3D-RD 1 1 20 6 1
```

The results will be stored in output/prisms\_1\_6\_20\_1 folder and can be compared with provided expected output in output/prisms\_1\_6\_20\_1\_out.

The run takes approximately 1 minute.

Example 2: Randomised uniform steady state as initial condition

```
./3D-RD 1 0 20 6 1
```

The results will be stored in output/prisms\_0\_6\_20\_1 folder and can be compared with provided expected output in output/prisms\_0\_6\_20\_1\_out.

The run takes approximately 1.5 minutes.

Example 3: Randomised uniform steady state as initial condition (always used for gaussian bumps).

```
./3D-RD 0 7 20 6 1
```

The results will be stored in output/gauss\_6\_20\_7\_1 folder and can be compared with provided expected output in output/gauss\_6\_20\_7\_1\_out.

The run takes approximately 1 minute.

To generate gaussian bumps network:

Python script gaussian\_bumpy.py generates a network of 10 by 10 gaussian bumps. Command line arguments are:

Argument 1: Maximum network height (integer)

Argument 2: Domain thickness between gaussian bumps  
(integer)  
Argument 3: Standard deviation of the bumps (integer)

Example:

```
python gaussian_bumps.py 20 6 7
```

Bottom simulation domain is always defined as  $z = 0$ .

Top layer of the generated network is  
gauss10by10\_6\_20\_7\_top\_layer.ply while gauss10by10\_6\_20\_7.txt is  
used for simulation.