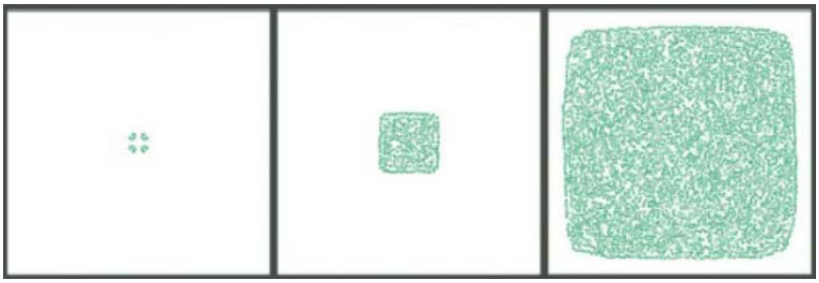
Project – Reaction-Diffusion model

In this project you will solve two coupled partial differential equations (PDEs) known as the Grey-Scott reaction-diffusion model. The model describes how the concentrations of two chemical reactants evolve in space and time. This could look something like in the image below.



The concentrations of the two chemical reactants are denoted *U* and *V* respectively. The PDEs are given by

$$\frac{\partial U}{\partial t} = D_u \nabla^2 U - UV^2 + F(1-U),$$
$$\frac{\partial V}{\partial t} = D_v \nabla^2 V + UV^2 - (F+k)V.$$

Diffusion Reaction

F, *k*, D_u and D_v are constants, ∇^2 is the Laplacian operator that when applied to a scalar field *p* can be estimated by

$$\nabla^2 p = \frac{p_{i+1,j} + p_{i-1,j} + p_{i,j+1} + p_{i,j-1} - 4p_{i,j}}{(\Delta x)^2}$$

Note that the blue box above does not indicate that parentheses should be put around the reaction expression.

To solve the two PDEs a simple time integration scheme (forwards Euler) can be used.
For the PDE "$\partial y/\partial t = f$" time can be advanced by the step size Δt when the value of y is known at time t:

$$y_{t+\Delta t} = y_t + \Delta t f$$

TASK:
Implement and present a solution to the Grey-Scott reaction-diffusion model using the supplied template code. I.e. implement the host function 'rd' and the kernel 'rd_kernel' in the file 'rd_kernels.cu'. Try to make an efficient implementation. Play around with different settings of the constants.