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Assignment on Massively Parallel Algorithms - Sheet 5

Due Date 23. 09. 2020

Exercise 1 (Heat Transfer, *10 Credits*)

Download the Framework `heat_transfer`, compile, and run it. You will see an animated simulation of heat flowing through some medium.

Hint: You need `freeglut` for the framework.

a) Extend the program to support a fixed number (known at compile time) of heat sources and heat sinks.
Hint: These are simply grid cells remaining at a fixed high or low temperature throughout the simulation.

b) Consider a set of n variable heat sources and sinks. In contrast to part a, the heat sources and sinks are now are circular with the diameter as an additional parameter. The number and positions of the heat sources/sinks are not known at compile time. They can, for example, be set by the user during run-time. (You can but don't have to implement the user-driven positioning of sources/sinks). For simplicity, you can use a simple array to store the sources/sinks. But be prepared to be asked to change them during the presentation of your solution.)
Develop an efficient algorithm to reset the temperature of the heat sources/sinks in each simulation step. Think about both expensive memory accesses and computational effort. Is it better to parallelize with respect to the sources or the simulation grid? Explain your decision.

c) Let's disturb the flow of heat with a displacement field. That means after each time step, there is a displacement step that moves all temperature values, perhaps like a gentle breeze wafting through a heated room, or perhaps like a slowly swirling vortex. (You do *not* need to move the heat sources and heat sinks themselves.)
The displacement vector is a two-dimensional parameter passed to the kernel function. The direction of the vector determines the direction of the displacement field, and the length of the vector, the area's strength.