

# GPUexplore: GPU Explicit-State Model Checking

Anton Wijs  
Eindhoven University of Technology

joint work with

Thomas Neele & Dragan Bošnački  
Eindhoven University of Technology

**Model checking** involves rigorously analysing the design of a concurrent software or hardware system ('model'). The goal is to determine whether a given desired functional property is satisfied by the model.

**Errors can be detected early in system development.**

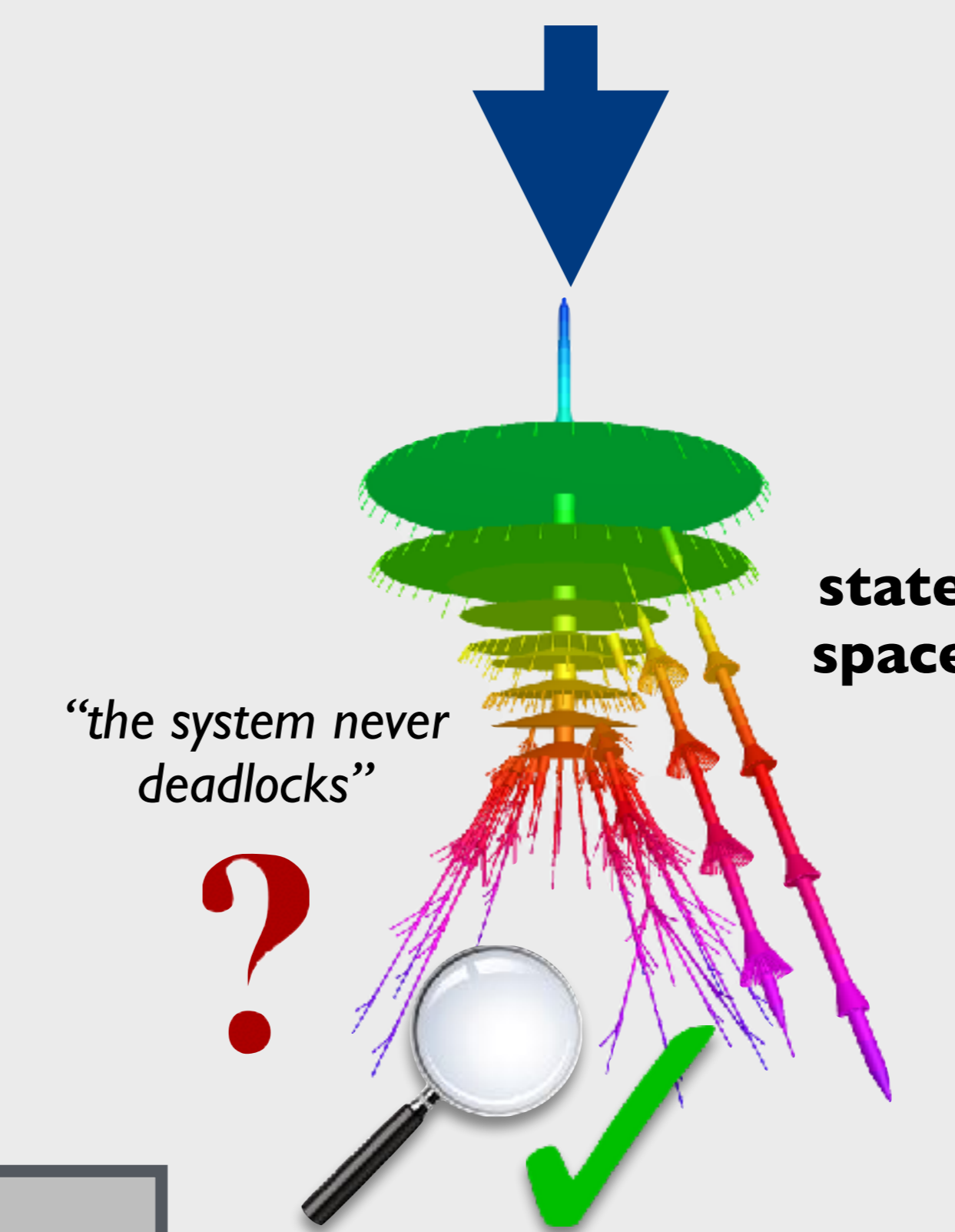
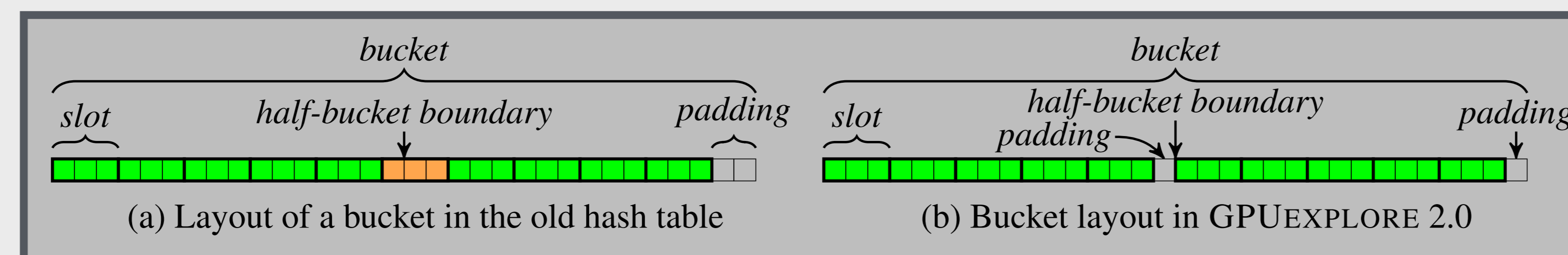
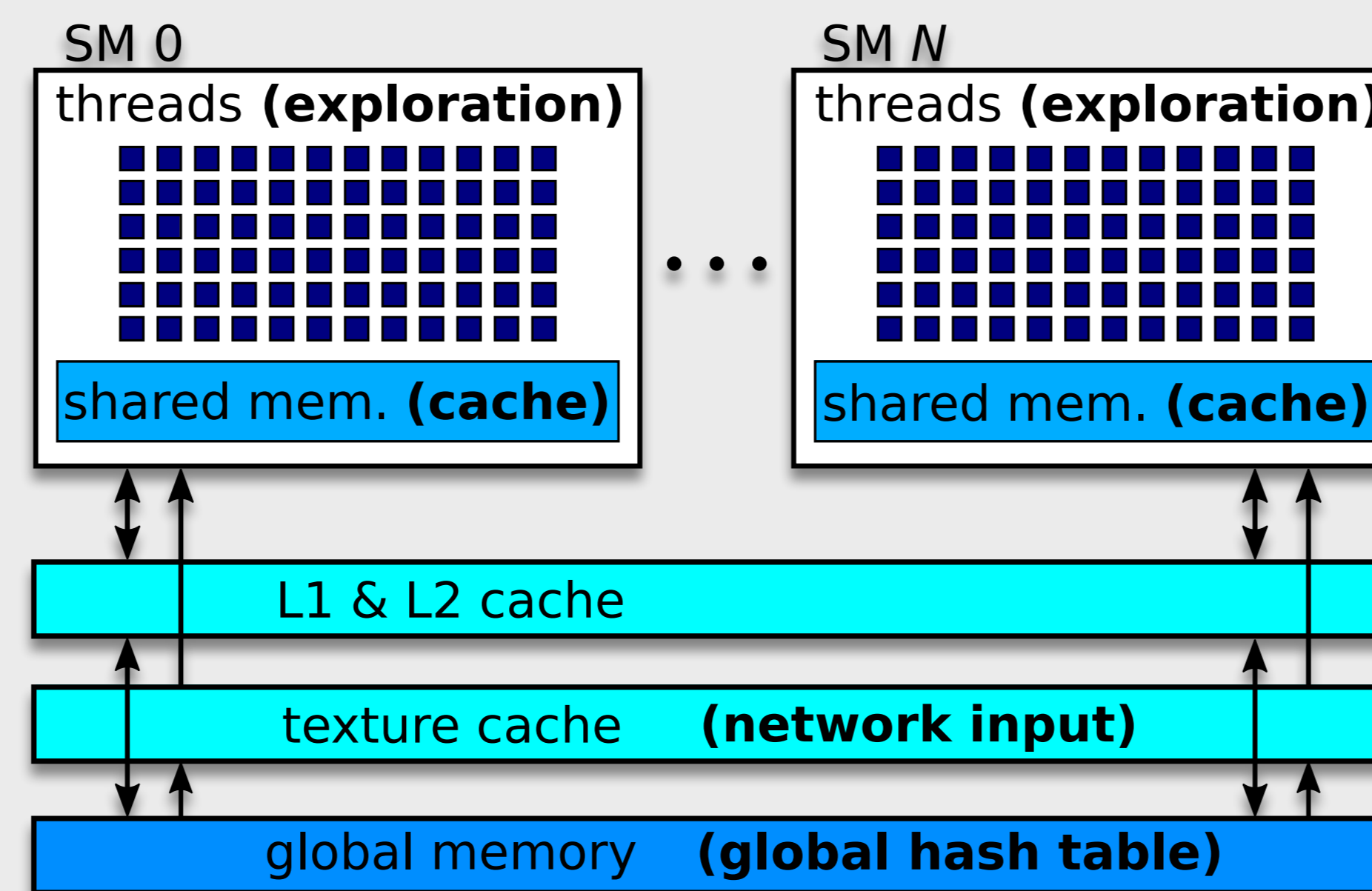
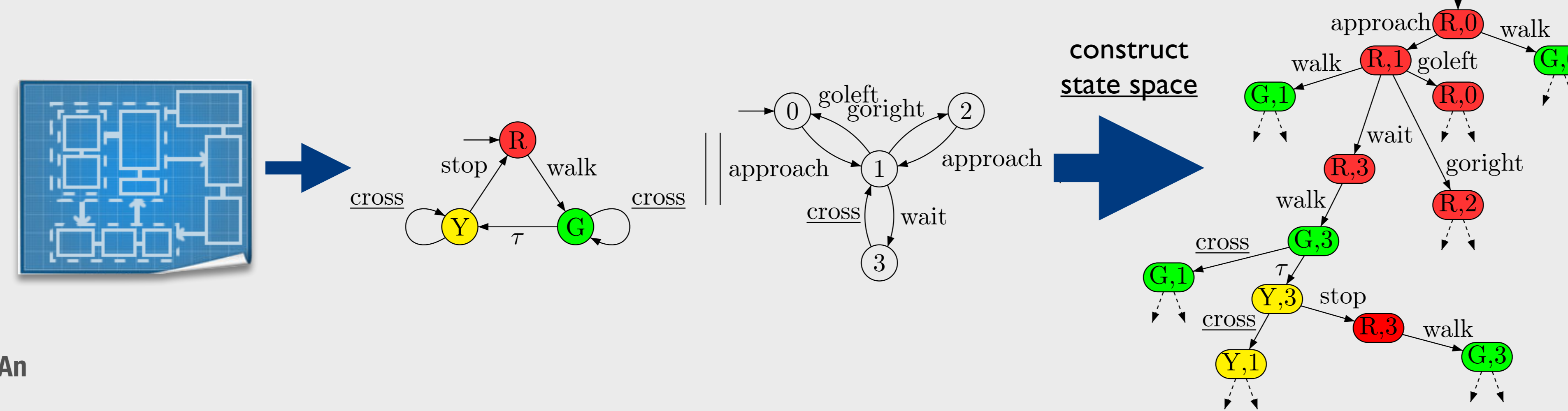
A model implicitly describes all potential functional behaviour of the system. An **explicit representation** of this behaviour is called a **state space**.

**State space construction** is the main operation performed by a model checker. It involves starting from the initial system global state, and identifying the valid transitions to successor states. By repeating this operation for all constructed states, the complete state space is explored. While doing this, the model checker can check the validity of the property of interest.

**GPUexplore** is the first model checker to fully run on (CUDA enabled) GPUs. Thread blocks fetch discovered states from a global hash table, and construct successor states. These are temporarily stored in a local cache residing in shared memory. At the end of a construction iteration, the new states are added to the hash table.

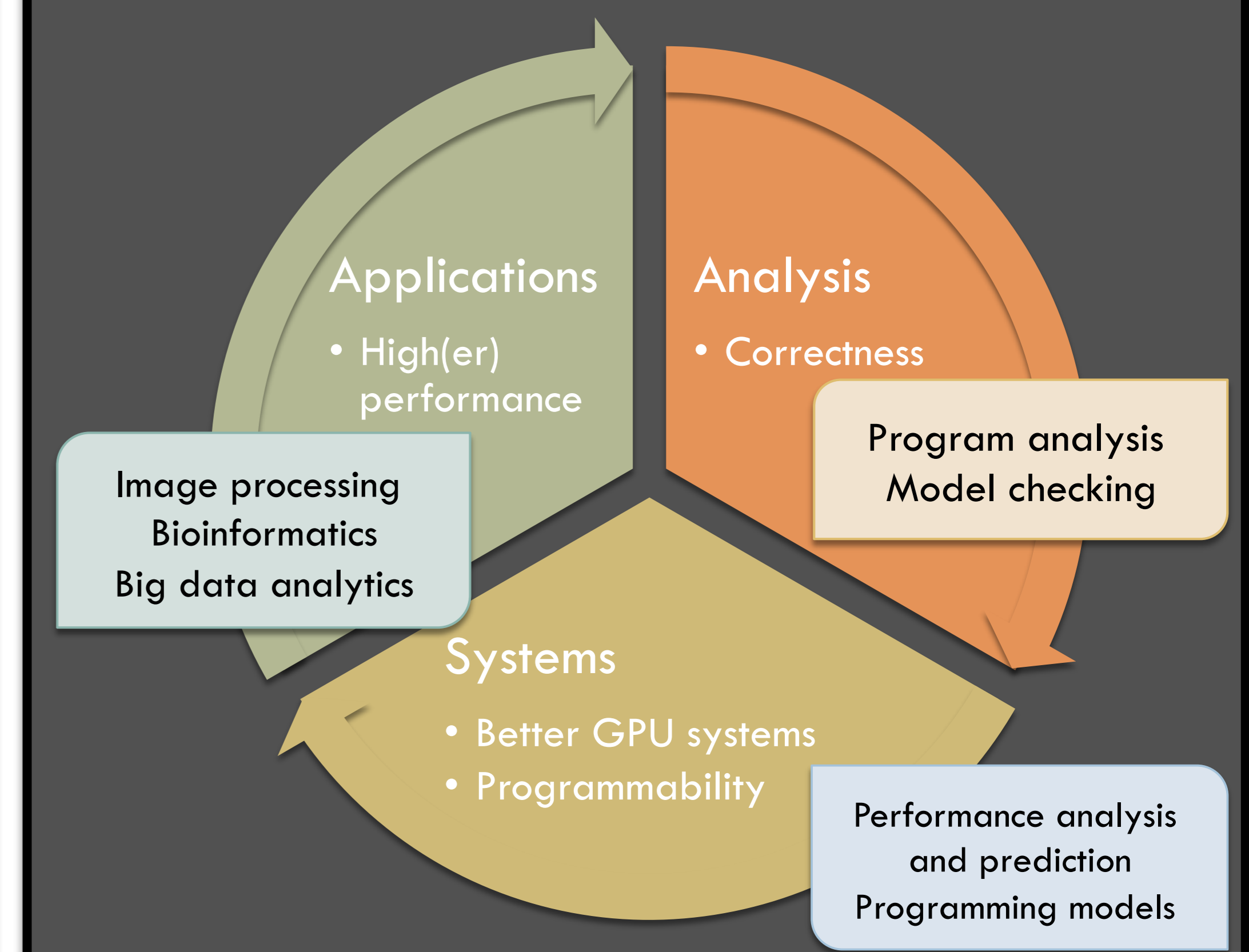
**A novel hash table design** is used to store states. It supports correctly working with states spanning multiple integers.

The hash table is partitioned into **buckets**. A bucket can be read by a warp using a single memory access. By ensuring that each element slot completely resides in one half of the bucket, half-warps can add states without being interrupted.



**On average 120x speedup when exploring large state spaces!**

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GPGPU



[http://fmt.ewi.utwente.nl/NIRICT\\_GPGPU](http://fmt.ewi.utwente.nl/NIRICT_GPGPU)

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GPUexplore is available at  
<http://www.win.tue.nl/~awijs>