Lazy Constructors

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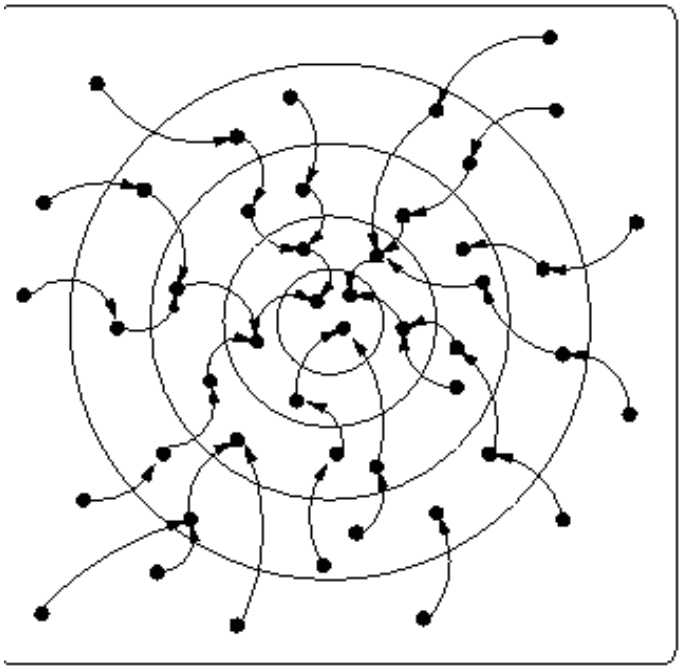
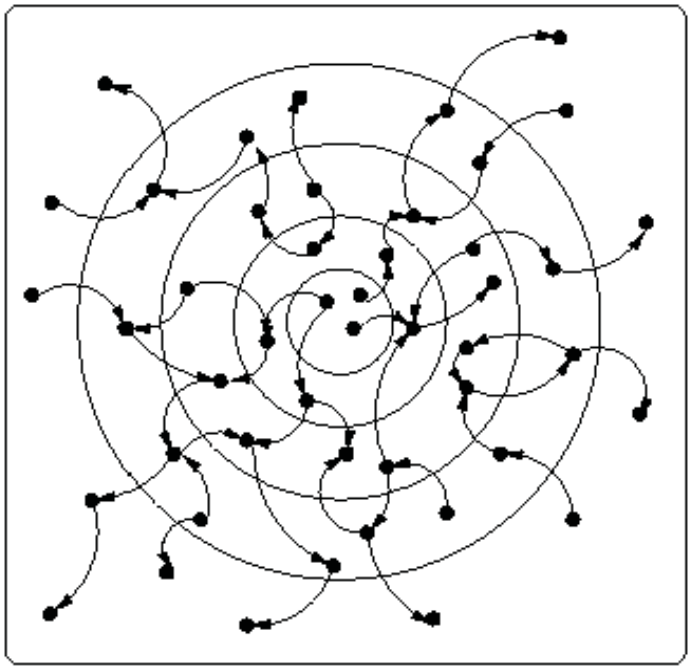
Spartan Universal Computer – the first universal Turing machine implemented as a cellular automaton within the Game of Life

JvN Universal Computer Constructor

Engineering vs. Evolution



Engineering!



Evolution?

Taken from McMullin, Barry (2000) John von Neumann and the Evolutionary Growth of Complexity, *Artificial Life*, 6(4) pp. 347–361.

The Minimal Self-Replicator

- Complexity

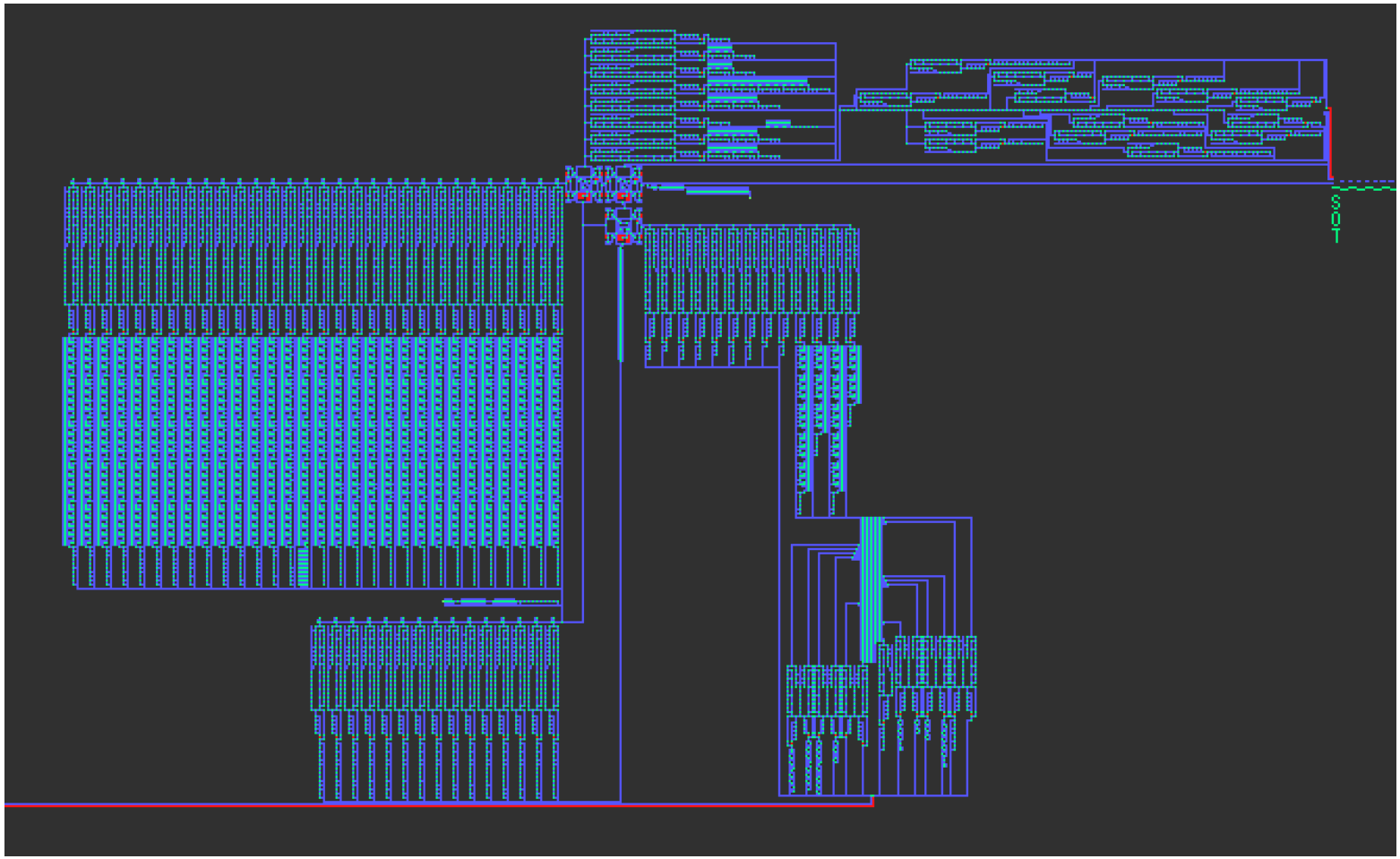
  Operations performed (number and kind of organs)

  Distribution between configuration and tape

  - Size – area of configuration and length of tape
  - Algorithm versus data structures
  - Tape - code compression

  Goal – move complexity from configuration to tape, and ideally to construct

Partial Constructor



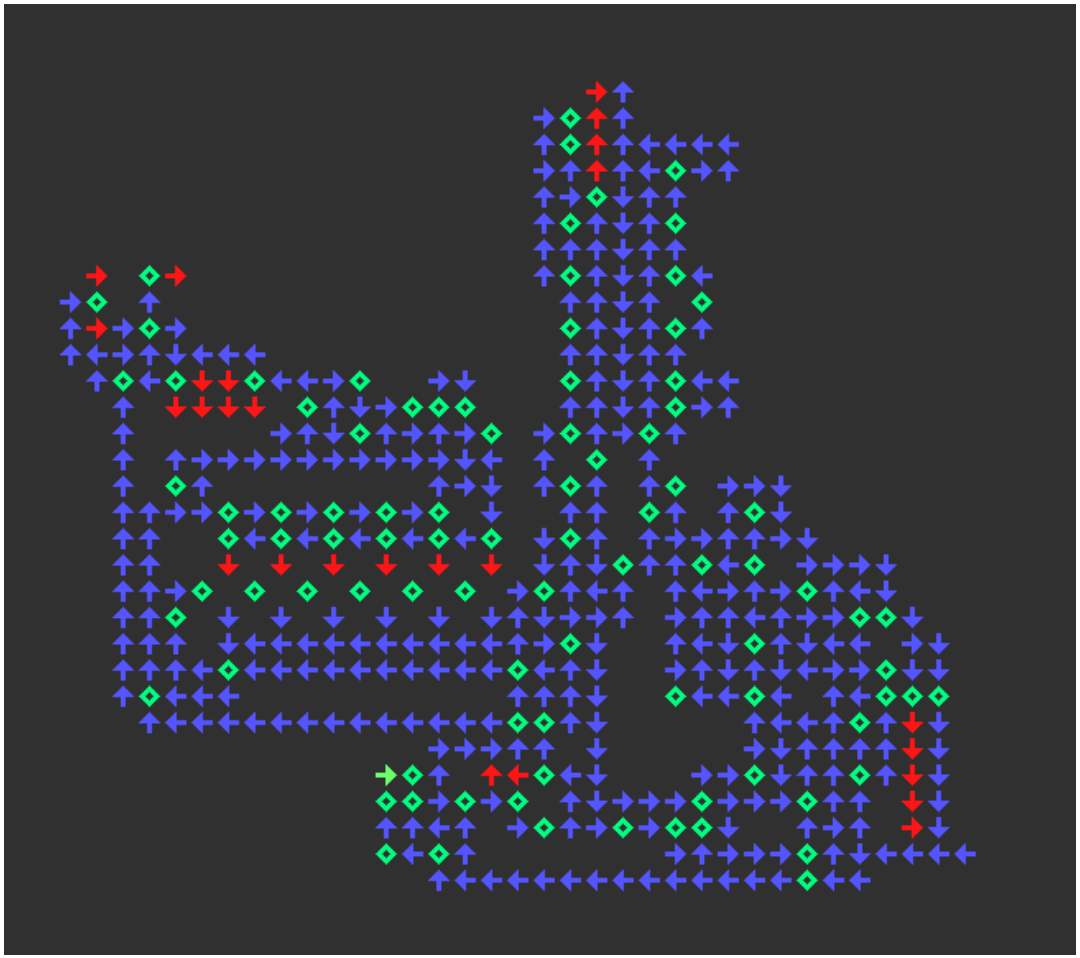
Self-Replication Minimisation

Time and Space

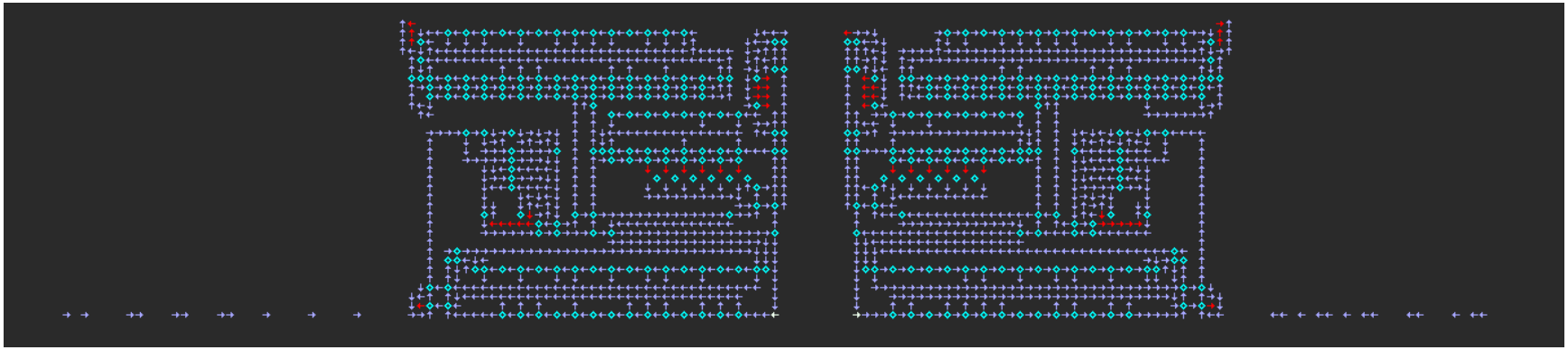
- Reduce the size of the configuration
- Reduce the size of tape code instructions
- Reduce the number of tape code instruction
- Read more than one bit from tape at a time

Mapping and characterising the configuration power set

Lambda_G



The Partitioned Lambda_Pg



Constructor Classification Scheme

- Unit – fundamental to the underlying system of cellular automata
- Passive
  - Asynchronous, a memory user
  - Synchronous, not a memory user
    - Lambda_Q – with recognisers – 10 tapes
    - Lambda_R – without recognisers – 20 tapes
- Active
- Meta

Observations

- There is an hierarchy of constructors, very few of which are universal
- Similarity with hypercycles – catalytic systems
- Useful in understanding the nature of construction

- How to improve these models?