Bio-inspired computational models

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1 Team & Topics

2 James

3 Alec

4 Yezhou

5 Water

6 Thanks

7 Samples
• Patrice Delmas, Michael Dinneen, Radu Nicolescu, Jing Sun

• PhD students: James Cooper, Alec Henderson, Yezhou Liu

• Main area: bio-inspired computing models and applications

• Specific focus: cP systems (Radu)
  • P systems: cells, multisets, formal rewriting rules
  • Unbounded space (TM); + unbounded processing power, cell creation/division/dissolution
  • cP systems: + nested multisets, logic, CSP messaging

• More generally: nature-inspired computing models
James – NP-complete problems

Hamiltonian cycles and TSP in **linear time**, with 5 rules only!
Belief propagation (BP) models for image processing
Distributed dynamic programming (DP)
Astronomy / radio-astronomy: detecting exo-planets using distribution + AI and Einstein-Khvol’son lenses
- PSPACE-complete problems
- QSAT in linear time! ... sub-linear time?
- Water computing
Sudoku in sub-linear time & formally verified

https://en.wikipedia.org/wiki/Sudoku
Yezhou

- Software cP simulations
- Formal verification of cP systems
- Formal definition and algorithm for nested multisets unification (cP)
Water computing – Can you see the logical gates?

https://i.ytimg.com/vi/pg__Fac1Y00/maxresdefault.jpg
Water computing – Subtraction
Water computing

- Turing complete – via $\mu$-recursive functions
- Speedup, by asynchronous processing?
- Hardwired $\Rightarrow$ programmable (RAM, PRAM)?
Thanks

• Thanks for your attention!
• Questions?
Euclid’s algorithm

- Consider

1. $a(144), a(88)$ // $a(8 \cdot 18), a(8 \cdot 11)$
2. $a(11...1), a(11...1)$

- Evolution and result

1. $a(144), a(88) \Rightarrow a(56), a(88) \Rightarrow a(56), a(32) \Rightarrow a(24), a(32)$
2. $\Rightarrow a(24), a(8) \Rightarrow a(16), a(8) \Rightarrow a(8), a(8) \Rightarrow b(8)$

- Rules

1. $S_0 a(X) a(X) \rightarrow_1 S_1 b(X)$
2. $S_0 a(XY1) \rightarrow_1 S_0 a(Y1) \mid a(X)$
Minimum of mset of positive numbers – $O(1)$

- **Pre-/post-contents**

  1. $a(7) a(42) a(3) a(7) \Rightarrow \ldots b(3)$

- **Two rules, destructive, without negation** $O(1)$

  1. $S_0 \ a(YZ1) \rightarrow_+ S_1 \lambda | a(Y)$
  2. $S_1 \ a(X) \rightarrow_1 S_1 \ b(X)$

  + = max-parallelism

- **One single rule, non-destructive, but with negation** $O(1)$

  1. $S_0 \lambda \rightarrow_1 S_1 \ b(YZ1) | a(YZ1) \neg a(Y)$

- **Quiz**: without negation, but non-destructive?