

Computing with Slime Mold

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Unconventional Computation

November 28, 2016

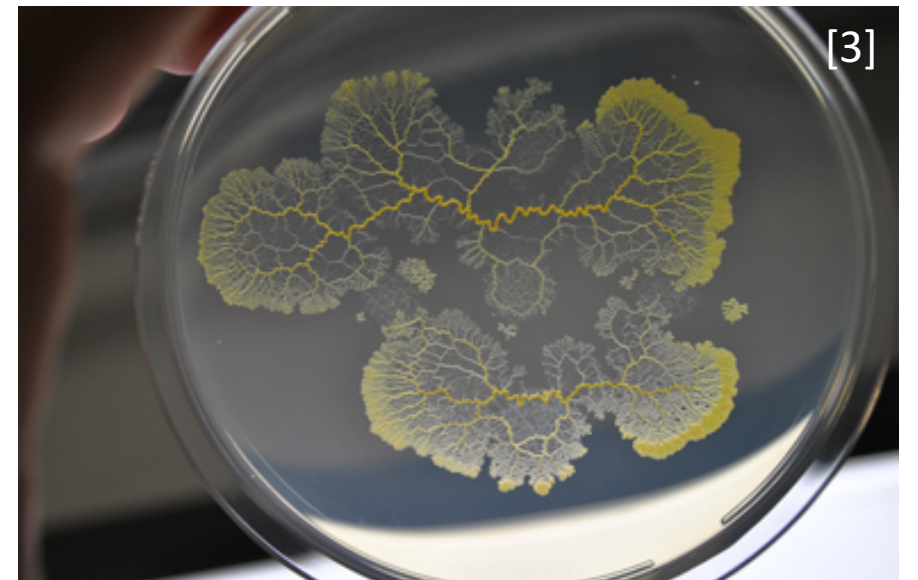
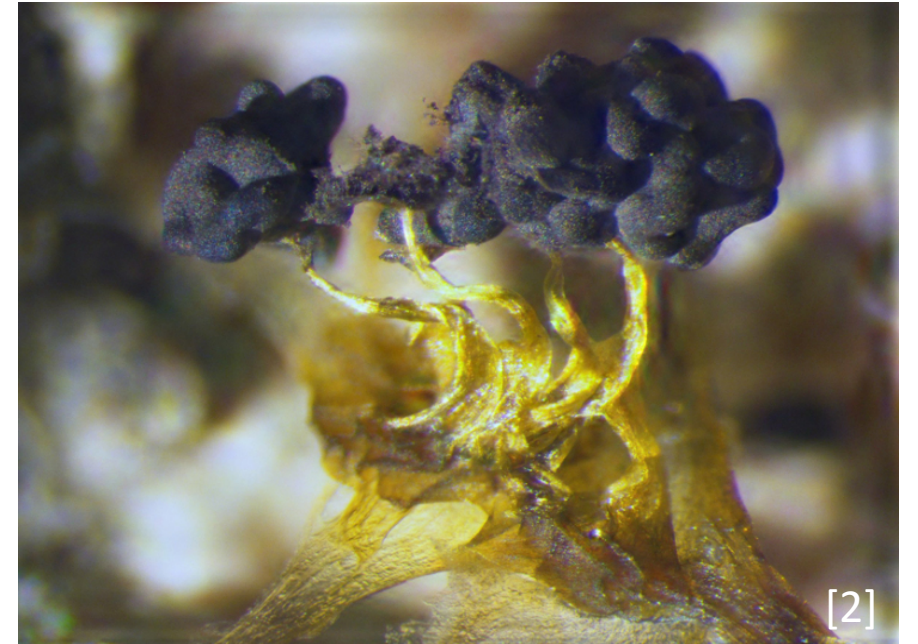
Physarum Polycephalum

- “Multi-headed” slime mold
- Single celled
- Multinucleated
- Reproduce asexually
- Yellow in most phases
- In the wild, eats fungus and bacteria
- In the lab, eats oats and corn flakes



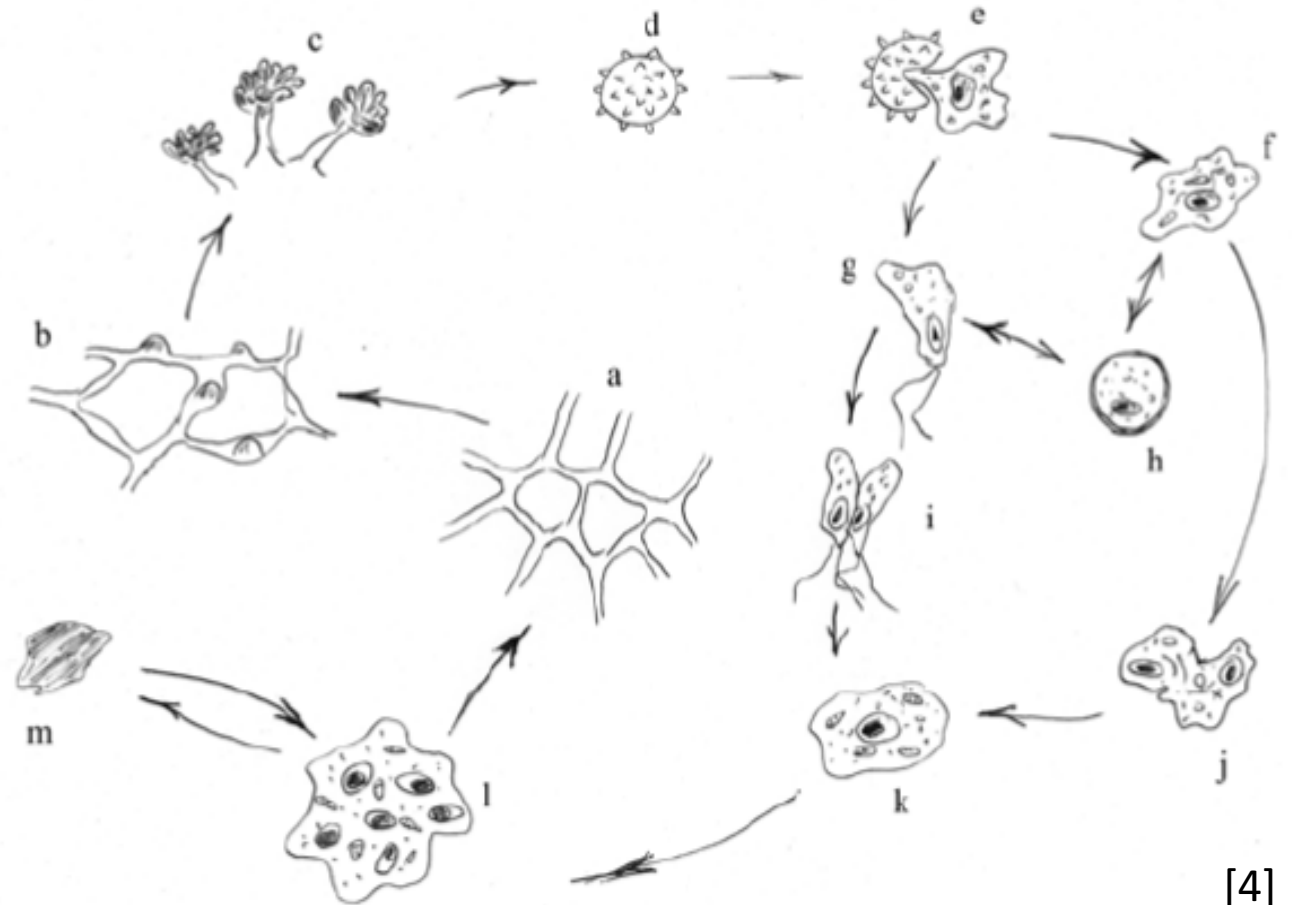
Physarum Polycephalum

- Easy to find and grow
- Found in damp, shady, cool areas
 - Sensitive to light and wind
- Plasmodium grows 1mm/h
- Desiccated form can be stored for years
- One of largest single celled organisms ever grown
 - 59.2 sqft and 6.6 lbs
- Over 34,000 genes



Life Cycle

- a. Plasmodium
- b. Sporulation begins
- c. Sporangia
- d. Spore
- e. Germinated spore
- f. Myxamoeba
- g. Swarm cell
- h. Micro-cyst
- i. Fusion of 2 swarm cells
- j. Fusion of 2 myxamoebae
- k. Zygote
- l. Plasmodium
- m. Sclerotium



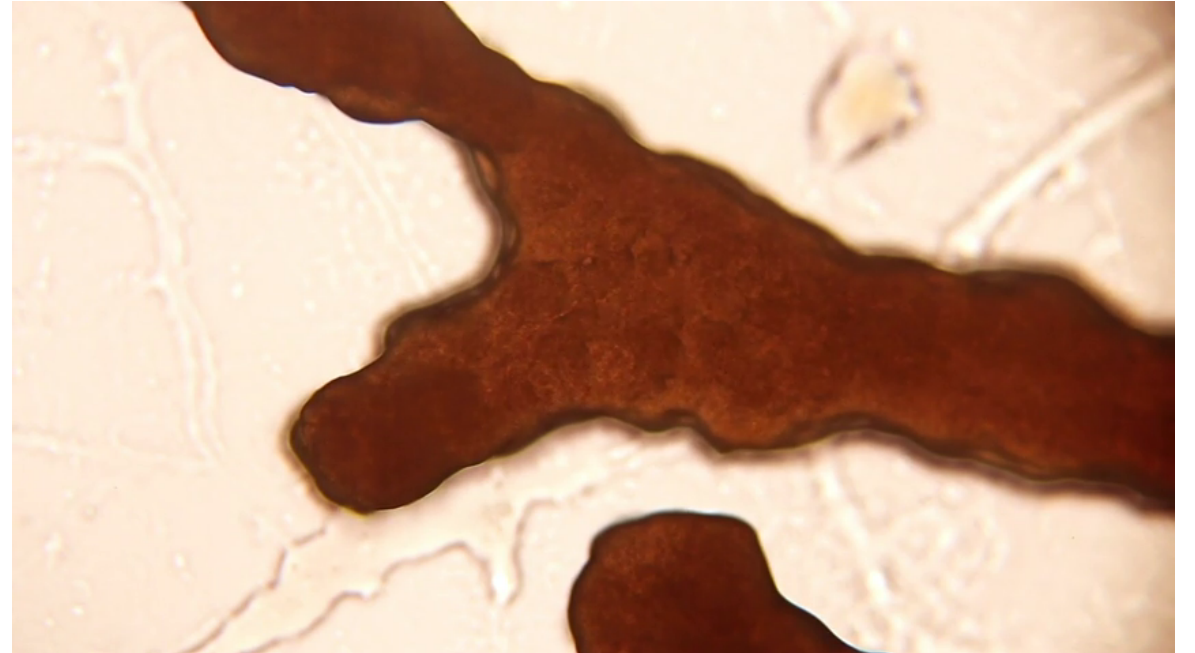
Time Lapse



[5]

Behavior

- Plasmodium
 - Network of biochemical oscillators
- Protoplasm moves in rhythmic, wave manner
 - Excitation: movement toward stimulus (food)
 - Contraction: movement away from stimulus (cold air)



Behavior

- Memory
- Learning
- Decision making
- Self-recognition
- Nakagaki cold snap tests

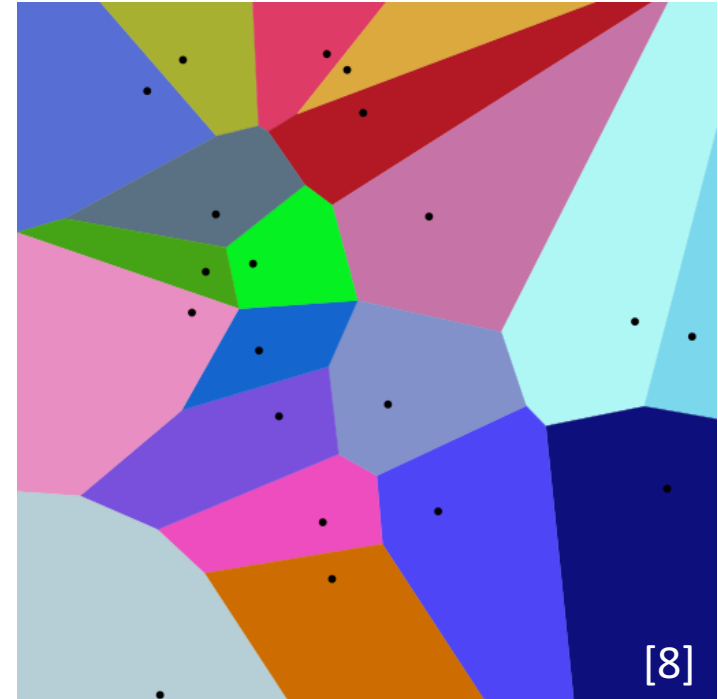


Computing

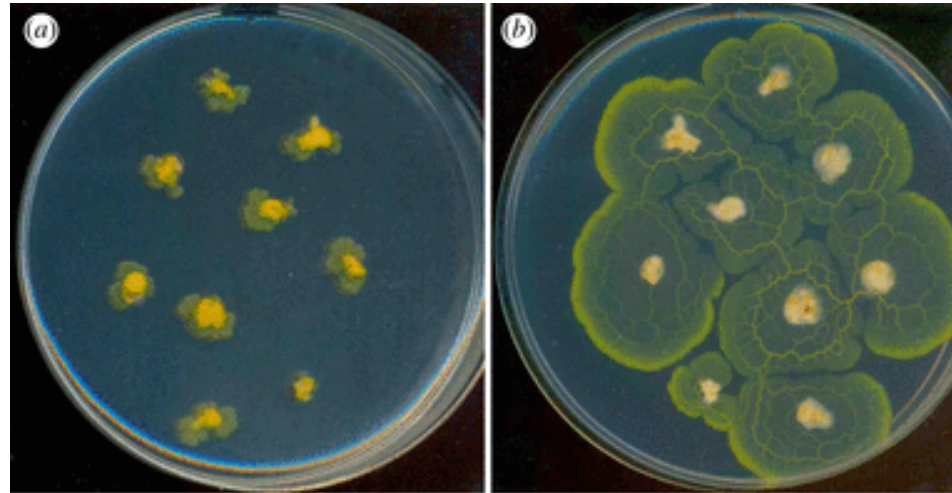
- Why is this important in computing?
 - Massively parallel
 - Local connections
 - Parallel inputs and outputs
 - Fault tolerance
- Physarum computing is a fairly recent concept
 - Most publications have been within the last 20 years
- Experiments
 - Voronoi diagram approximation
 - Shortest path
 - Maze solving

Voronoi Diagram

- Given a set of points (seeds) in the Euclidean plane
- Partition plane into convex polygons
- Each polygon contains exactly 1 seed
- Every point in a polygon is closer to its seed than any other seed

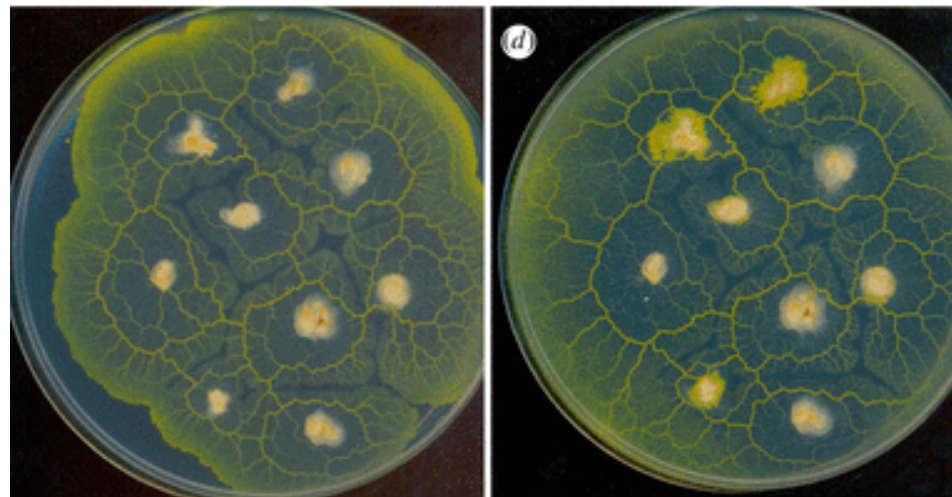


Voronoi Approximation



$t = 0$ h

$t = 10$ h

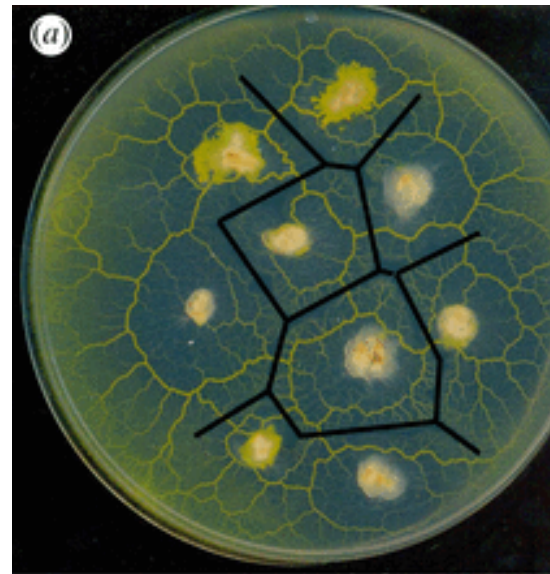


$t = 16$ h

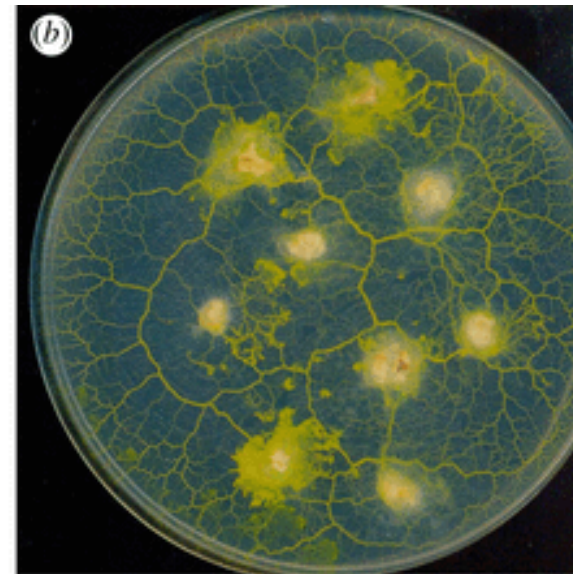
$t = 22$ h

[9]

Voronoi Approximation



$t = 22$ h



$t = 34$ h

[9]

Shortest Path



[10]

Maze Solving



[11]

Observations

- Notice the setup of the experiments
 - Where is the slime mold placed?
 - Where are the stimuli (inputs and outputs)?
 - Is the container important to the process?
 - What happens if not stopped?
 - Total time?
 - Limitations?
- Failures and imperfections documented

Other Experiments

- Physarum logic gates
- Minimum spanning tree
- Physarum transportation
- Physarum boats

Resources

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- [2] User:ian. *Physarum Spores*. Digital image. *The Slime Mold Collective*. N.p., 8 Mar. 2016. Web. 24 Nov. 2016.
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- [3] User:Hans-Gunther Dobereiner. *Physarum Polycephalum on Agar*. Digital image. *The Slime Mold Collective*. N.p., 30 Apr. 2015. Web. 24 Nov. 2016
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<https://www.youtube.com/watch?v=GY_uMH8Xpy0>
- [6] Heather Barnett: *What Humans Can Learn from Semi-intelligent Slime*. Perf. Heather Barnett. *YouTube*. TED, 17 July 2014. Web. 24 Nov. 2016.
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- [8] Weisstein, Eric W. "Voronoi Diagram." From *MathWorld--A Wolfram Web Resource*.
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- [10] *Slime Mold Physarum Find Shortest Path in a Maze*. User:EffettoKirlian. YouTube, 14 May 2011. Web. 24 Nov. 2016.
<<https://www.youtube.com/watch?v=czk4xgdhdY4>>
- [11] *Slime Mould Solves Maze: Original Video*. Perf. User:PhysarumMachines. YouTube, 27 Feb. 2011. Web. 24 Nov. 2016.
<<https://www.youtube.com/watch?v=75k8sqh5tfQ>>

Thank you!
Any Questions?