Fitness landscapes; LTEE

LECTURE 10
OCT 8, 2010

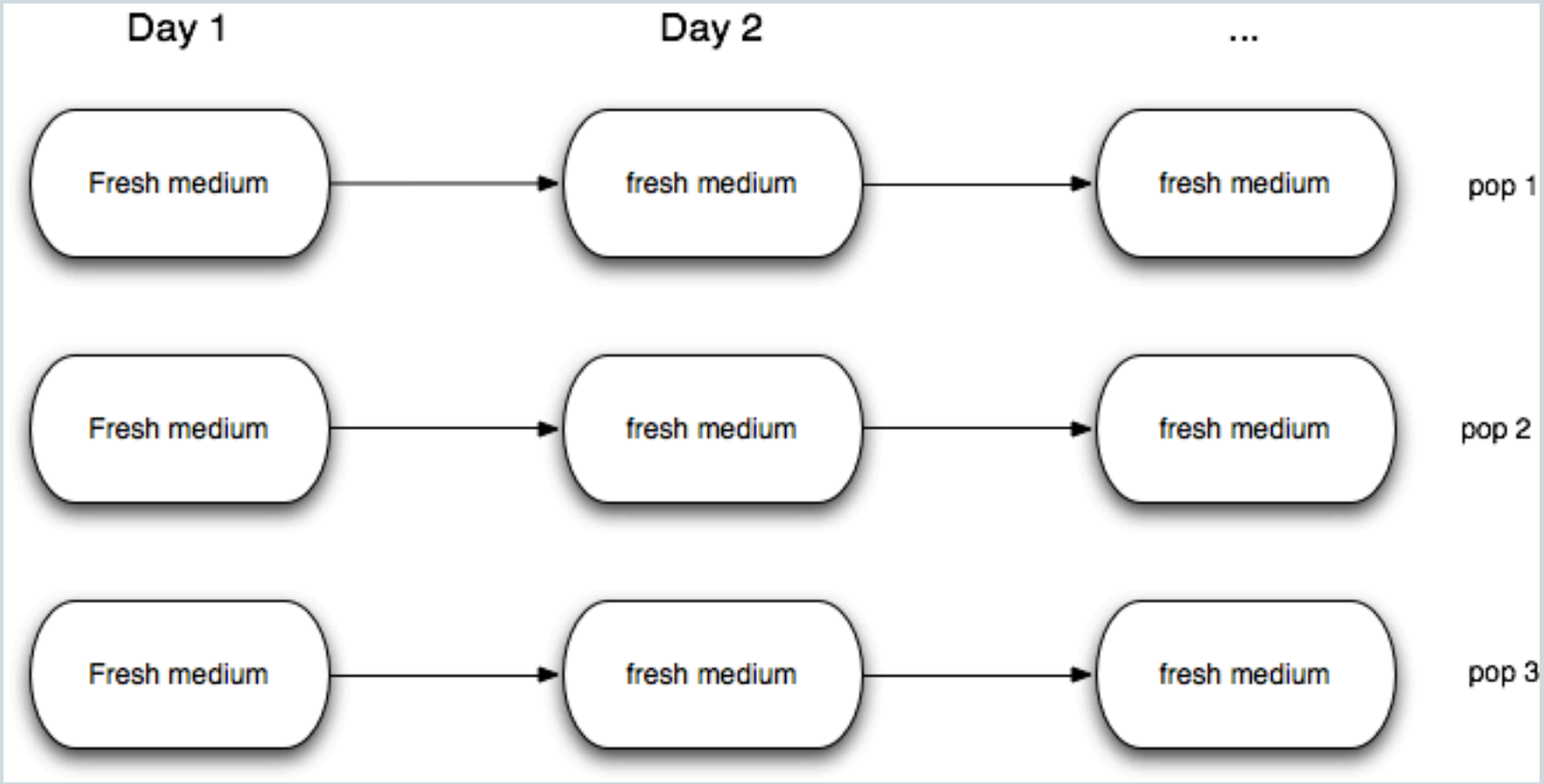
Topics, ‘til now

- Basic computational stuff
  - Running programs remotely
  - Extracting data, some graphing techniques
  - Thinking about computational approaches
- Basic computational science
  - Reproducibility
  - Tractability
  - Doing vs thinking vs doing *science*
- Avida
  - Running avida & some intro configuration

Remainder of course

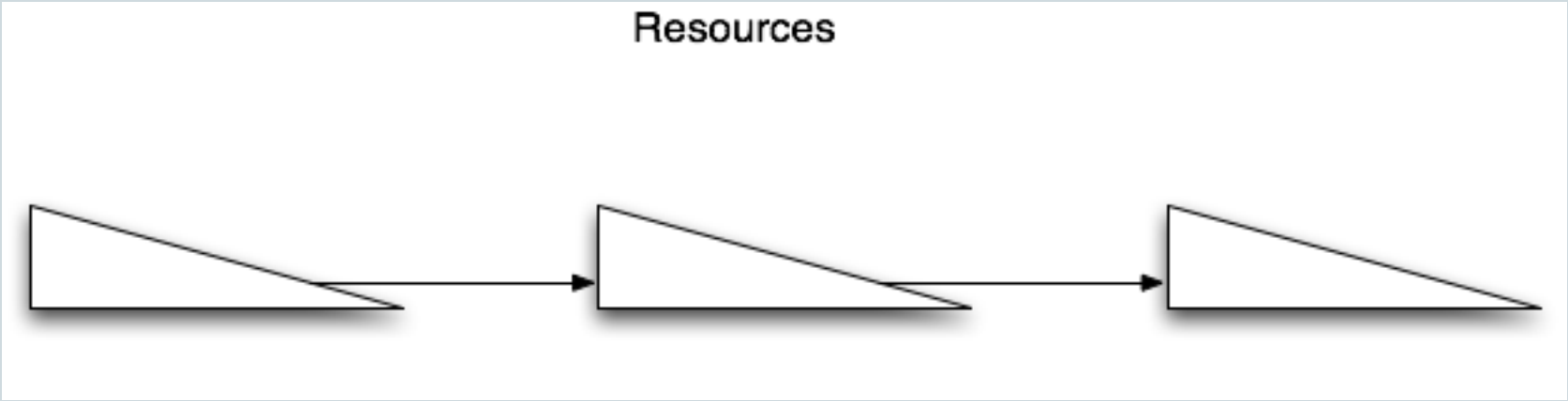
- Doing an actual experiment with Avida
  - LTEE-like Avida
- The long-term evolution experiment (Lenski)
  - Basic approach
  - Resequencing the lines: technology
  - Analyzing resequencing data
    - Big! data
    - Research-y question of analyzing next-gen sequencing data
- …intermixed with misc lectures by people on Avida and E. coli research

Long-term evolution experiment w/E. coli

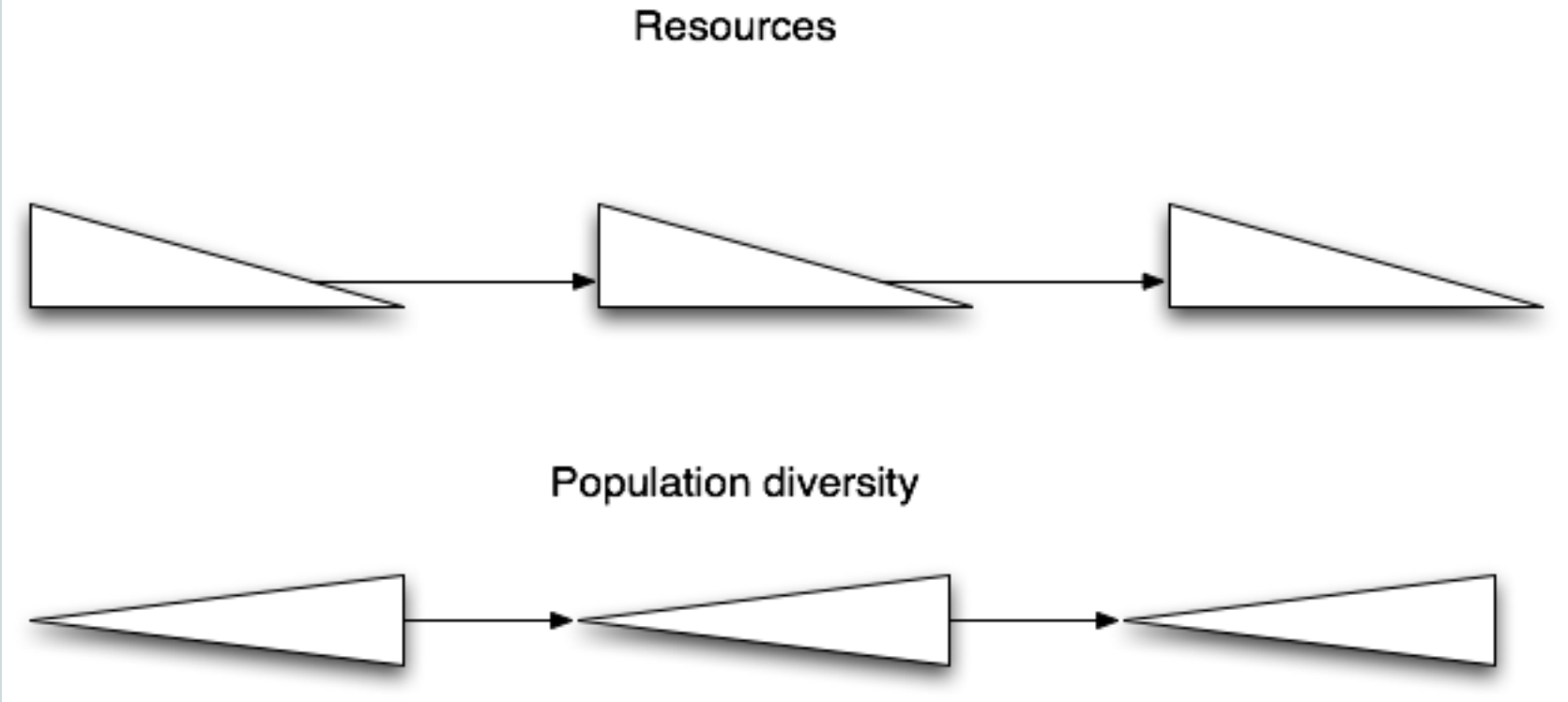


Serial transfer of 12 populations of E. coli

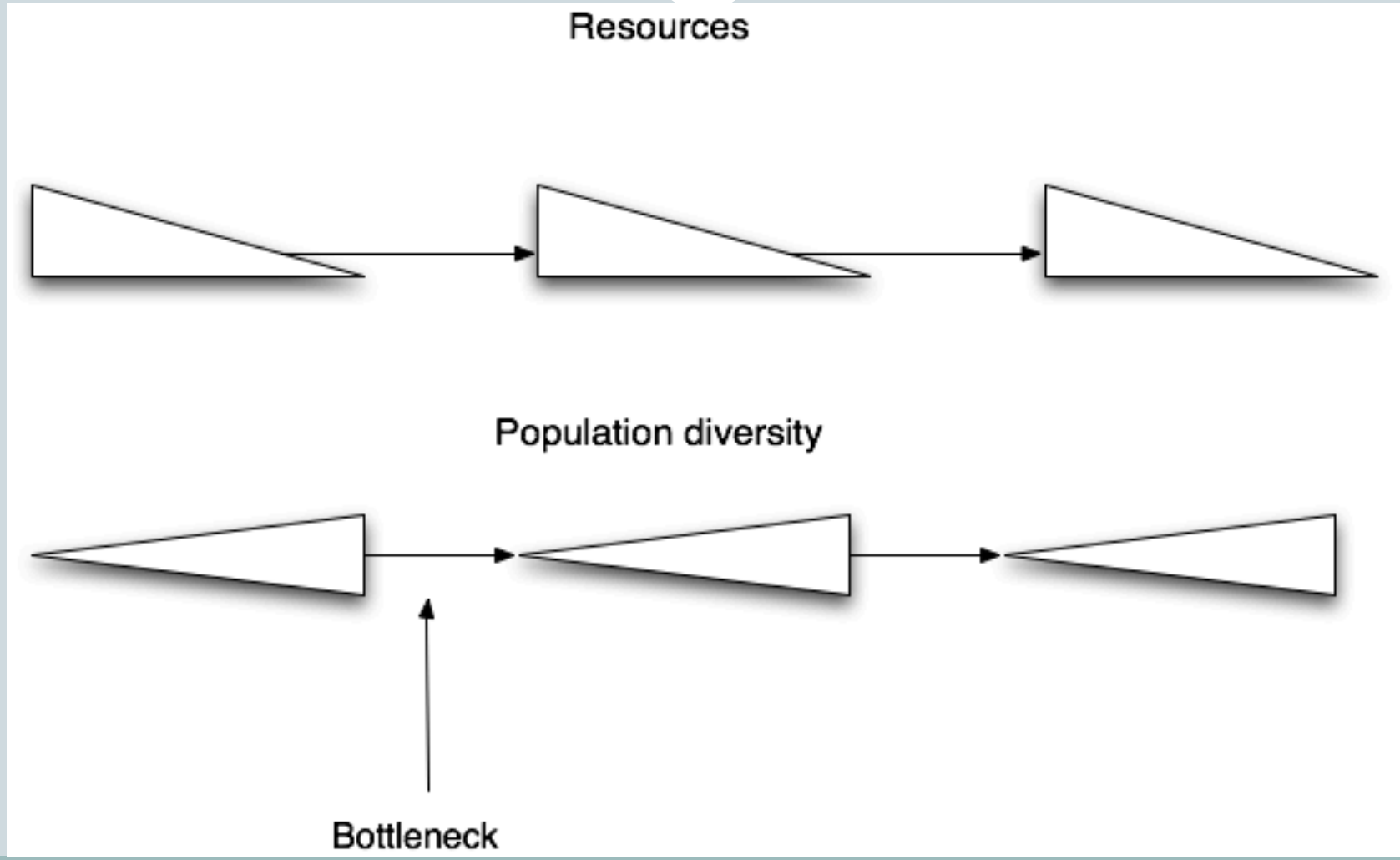
Similar conditions (boom/bust), day after day



Population diversity (?)



Bottlenecking effect…



Questions…

- Do we see same dynamics, same “conclusion”, for each line?
- What are the targets of selection?

Change in cell volume

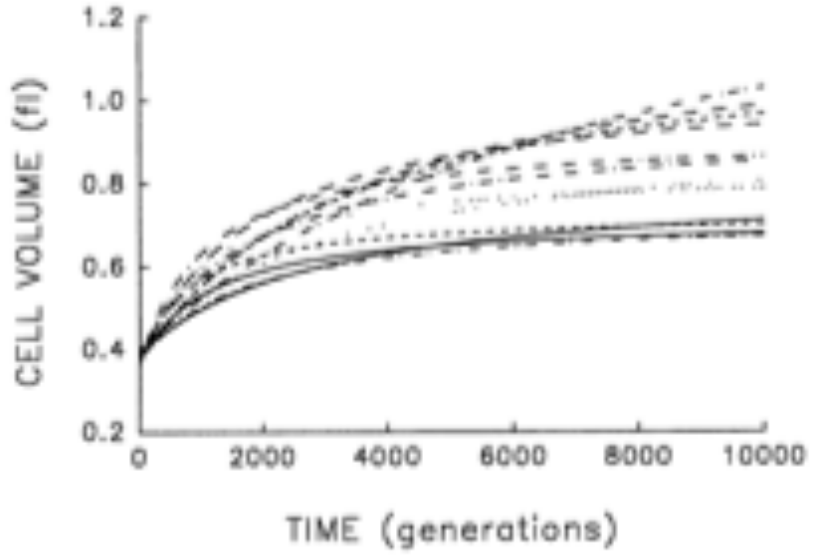


FIG. 2. Trajectories for average cell volume in 12 replicate populations of *E. coli* during 10,000 generations. Each curve represents the best fit of a hyperbolic model to data obtained for one population at intervals indicated in Fig. 1.

Change in mean fitness relative to ancestor

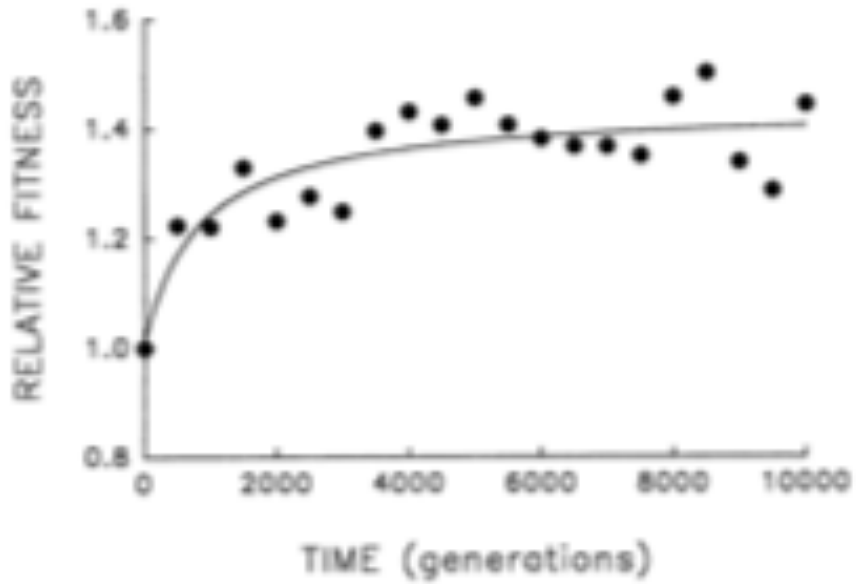


FIG. 4. Trajectory for mean fitness relative to the ancestor in one population of *E. coli* during 10,000 generations of experimental evolution. Each point is the mean of three assays. Curve is the best fit of a hyperbolic model.

Change in mean fitness relative to ancestor

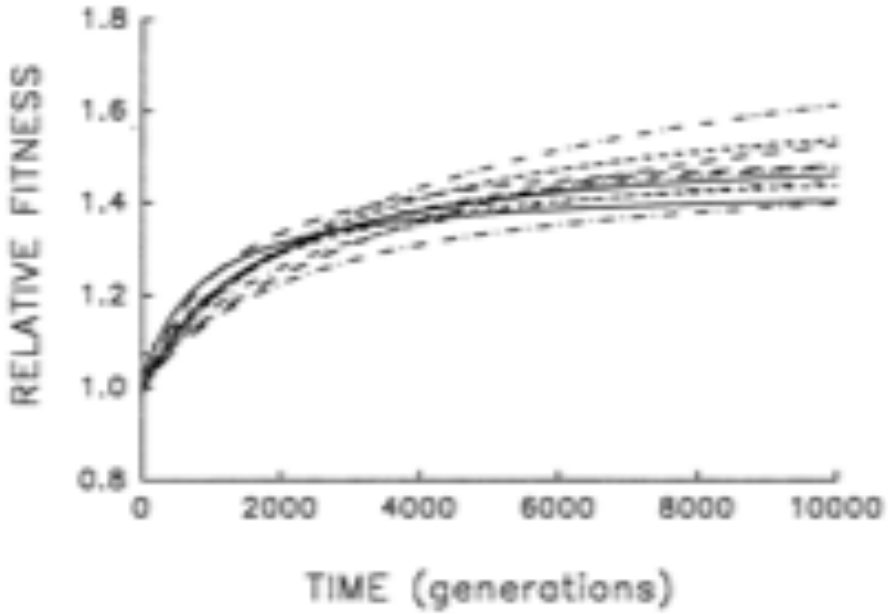


FIG. 6. Trajectories for mean fitness relative to the ancestor in 12 replicate populations of *E. coli* during 10,000 generations. Each curve represents the best fit of a hyperbolic model to data obtained for one population every 500 generations.

Questions…

- Do we see same dynamics, same “conclusion”, for each line? (No)
- What are the targets of selection? (Don’t know, but can see some correlates)
- How are the genomes evolving? (We’ll talk about that later ;)

Can we do a similar experiment in Avida?

YES

What can we control?

EVERYTHING

What can we measure?

EVERYTHING

Questions

How to do serial transfer?

Dominant genotype only; or randomly chosen subset of varying sizes; or …?

Population size?

- How big a population?
- How many to transfer?

Population structure

- Nearest neighbor/2D?
- Well-mixed?

Starting organism?

- Do we want a highly evolved starting organism?
- If so, should we change the environment prior to starting the serial experiment?

Varying resources

- Constant influx (chemostat)
- Boom/bust
- Bust/boom
- Etc.

Do we want to have sex?

- 1- or 2-point recombination with neighbors.
- Does it favor modularity of genome?
- How would you measure that, anyway?

Limited resources?

- With Avida, it's possible to require that a given resource exist in order to gain fitness from a particular action.
- We can emulate boom-bust vs steady, for example.

What to measure & compare?

Up to you.

Some hand-wavy hypotheses

- There is a critical point in dilution factor for serial transfer: below this point, evolution stops (or regresses). *IDENTIFY THAT POINT*.

- Boom-bust / serial transfer dynamics will accelerate evolution relative to a single evolving population. *TEST ME*.

Your HW

For Monday, come up with either an experiment (and then a hypothesis) or a hypothesis (and then an experiment).

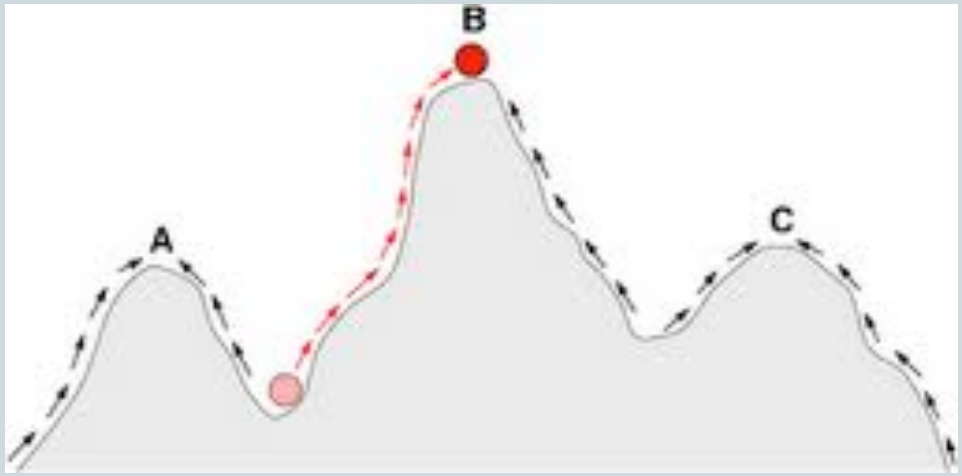
(Groups of 2-5 are fine.)

Write this down in a paragraph.

Send it to me and Heather.

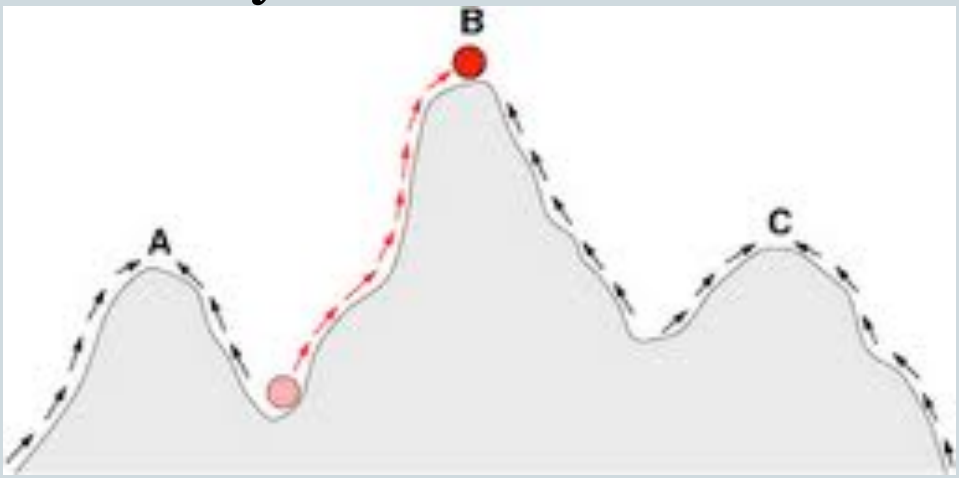
Fitness landscapes

- Goal: reach high fitness!
- 1D evolution: your "number" (a genotype) can only move some small amount delta.



Fitness landscapes

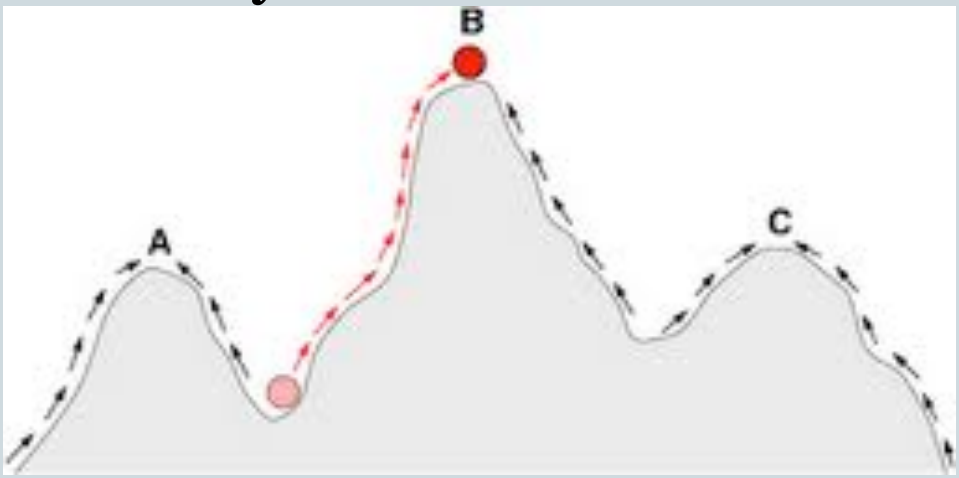
- 1D evolution w/o phenotype: your “number” (a genotype) can only move some small amount delta.



- How do you go from point A to point B??

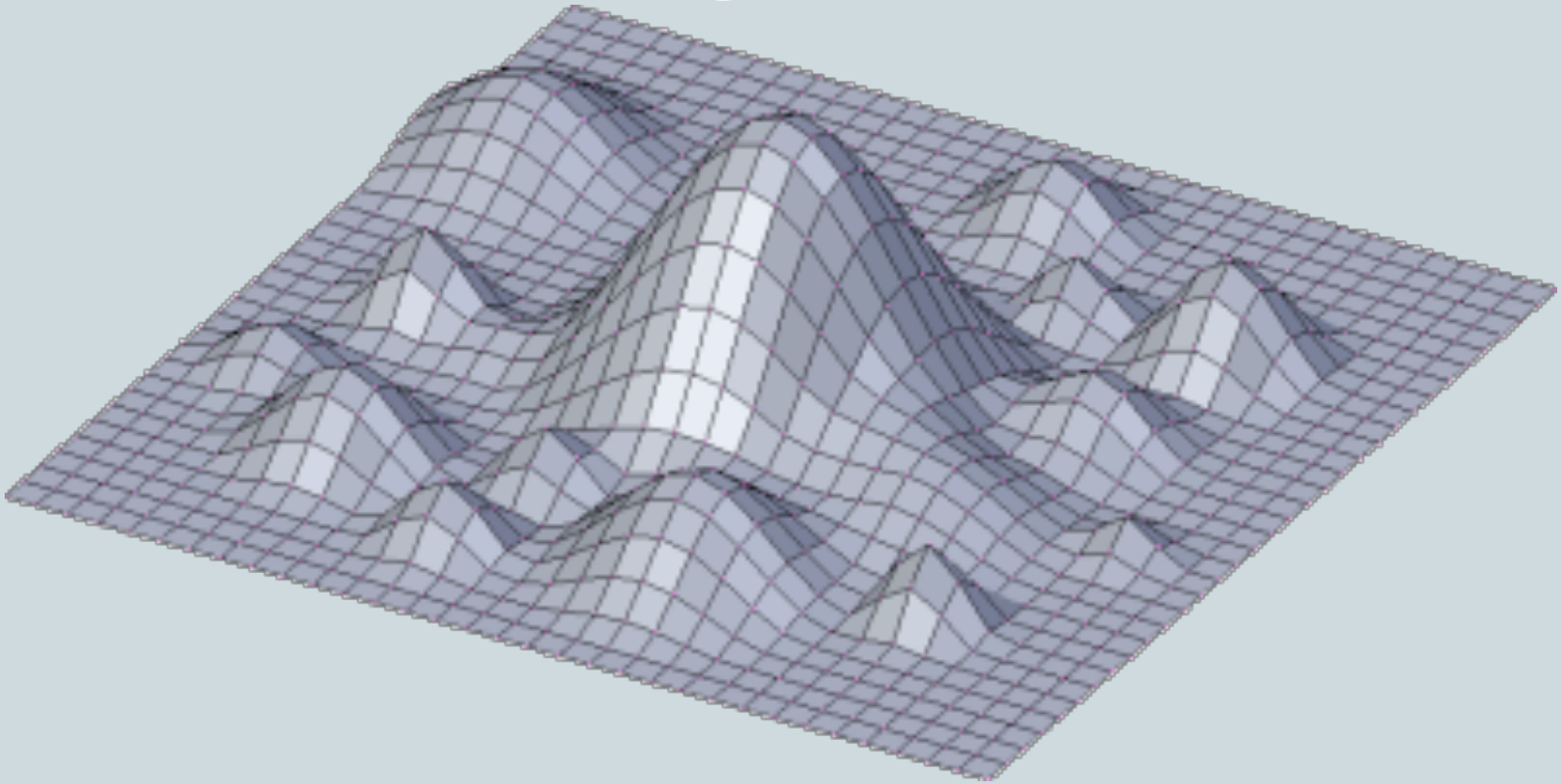
Fitness landscapes

- 1D evolution w/o phenotype: your "number" (a genotype) can only move some small amount delta.

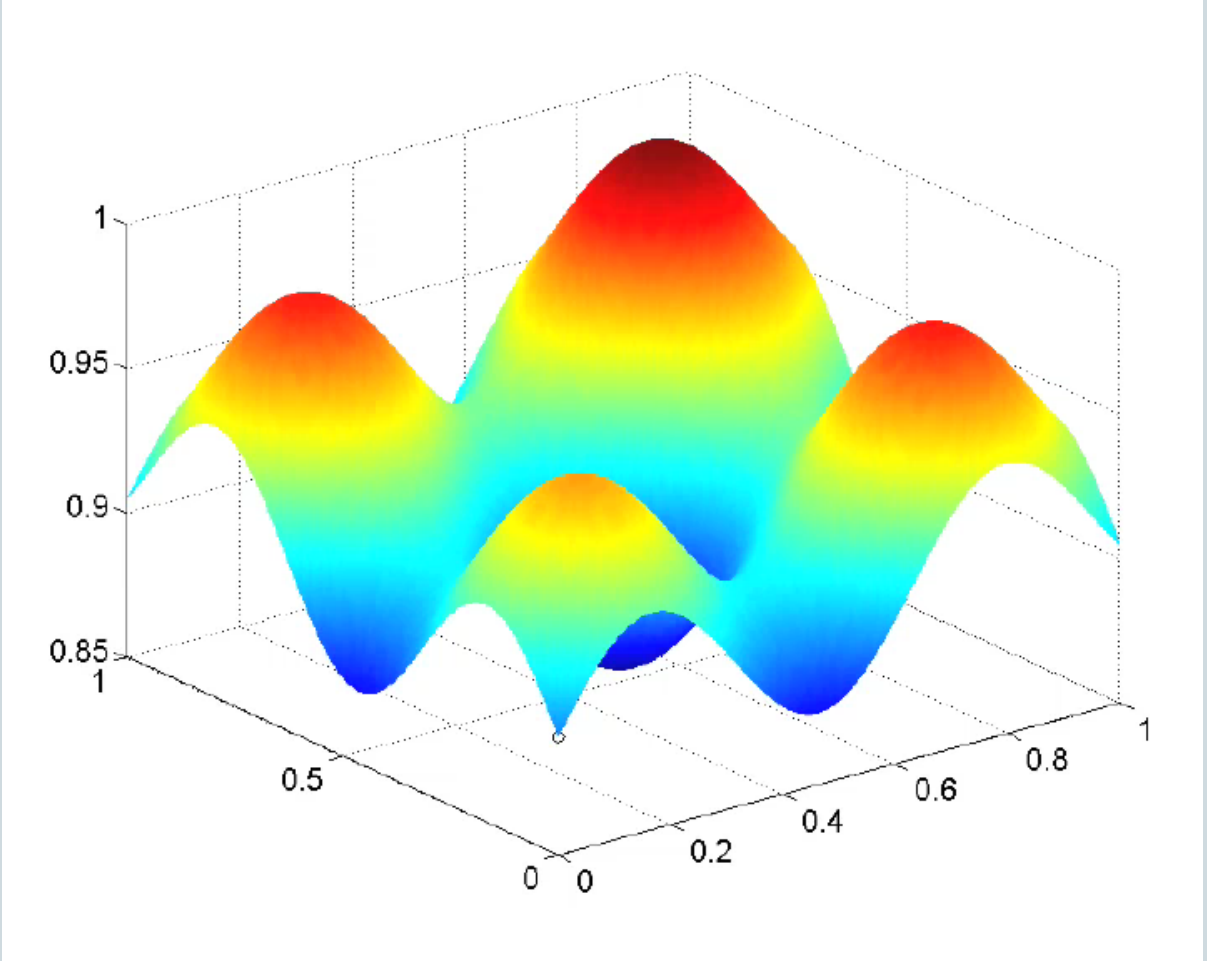


- An *analogy* for multi-dimensional fitness landscapes with genotype-phenotype.

More complicated fitness landscapes



Populations



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Thinking about serial passage experiment re fitness landscapes

- With each transfer, what are you doing to the population in terms of its presence on the fitness landscape (bottlenecking)?

- How does the fitness landscape *change* within each run over time (as, for example, resources are depleted; or the neighborhood fills up)