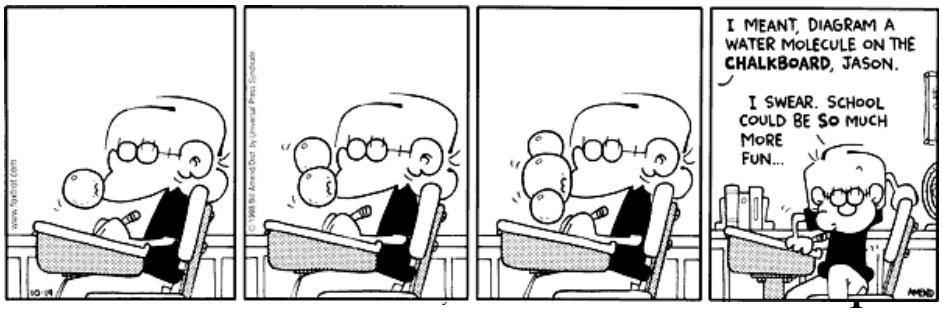
October 24, 2013 Physics 131 Prof. E. F. Redish

- **Theme Music: Kenny Rogers**

  The Gambler

- **Cartoon: Bill Amend**

  FoxTrot

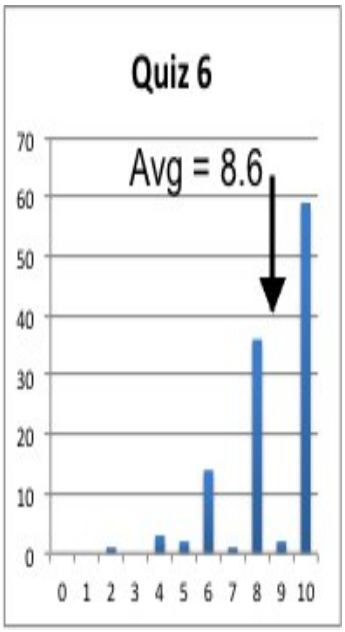


National Science Foundation / Alfred P. Sloan Foundation Study Wants to Hear from Students in This Course

- Talking About Leaving Revisited (TALR): Study aims to understand students' motivations & experiences in courses required for a degree in science, technology, engineering, and math
- Findings will be used to influence nation-wide efforts to improve the education of future scientists, engineers, and computer scientists
- Receive $20 cash for participating in a 60-90 minute focus group interview. Email invitation forwarded from instructor with the subject heading **"Volunteer your experiences for a national study, receive $20"**
- Look for end of semester survey: Student Assessment of their Learning Gains (SALG)

Quiz 6

	1	2.1	2.2	3.1	3.2	3.3	3.4
A	6%	0%	4%	**86%**	10%	**76%**	17%
B	**88%**	2%	**90%**	1%	1%	0%	2%
C	6%	11%	5%	0%	0%	1%	0%
D	0%	**83%**	0%	0%	2%	2%	1%
E	0%	4%	1%	9%	**87%**	16%	**74%**
N	0%	0%	0%	1%	0%	3%	4%

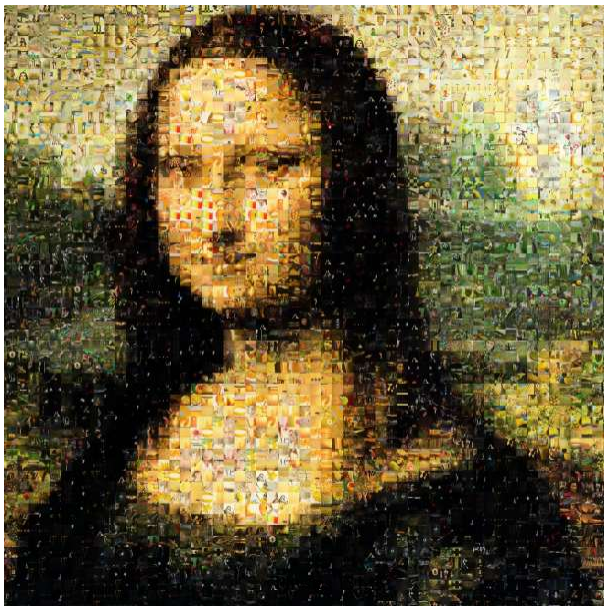


Emergent Properties

The question: Can the properties of a system can be explained in terms of the properties of its component parts (so, biology can be explained by chemistry, chemistry by physics)?

Emergence – some phenomena are undetectable when looked at "in the small". They emerge only when looking at the system as a whole rather than its parts.

Example of emergence



Biological Example of Emergence

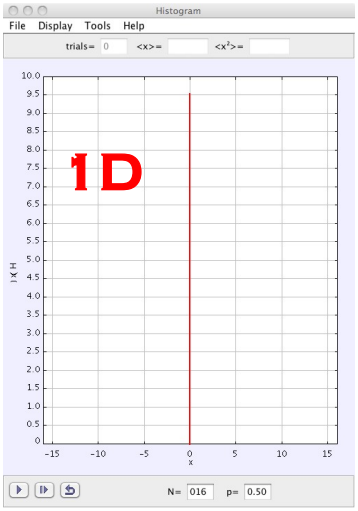
- Evolution
  - If a single species of birds on an isolated island have a range of bill thicknesses, they may all survive and interbreed well under normal circumstances.
  - If the climate shifts so that the birds at the two extremes are more likely to survive than those in the middle – by only a little bit! – after a few decades the population may consist only of birds with only the smallest and largest bills.
  - If the climate now stays shifted, after a few millennia, genetic drift can take the two populations apart so that they can no longer interbreed and would be identified as different species.
  - The shifts are in fact visible over only a few generations.

 Jonathan Weiner, *The Beak of the Finch*

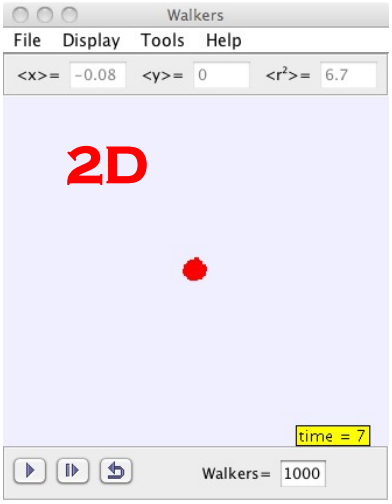
Foothold principles: Randomness

- Matter is made of of molecules in constant motion and interaction. This motion moves stuff around.
- If the distribution of a chemical is non-uniform, the randomness of molecular motion will tend to result in molecules moving from more dense regions to less.
- This is **not** directed but is an emergent phenomenon arising from the combination of random motion and non-uniform concentration.

What happens when there are a lot of particles?



Stp_RandomWalk1D.jar



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