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)
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 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?

1D

2D

Stp_RandomWalk1D.jar  Stp_RandomWalk2D.jar