Reasoning and decision making
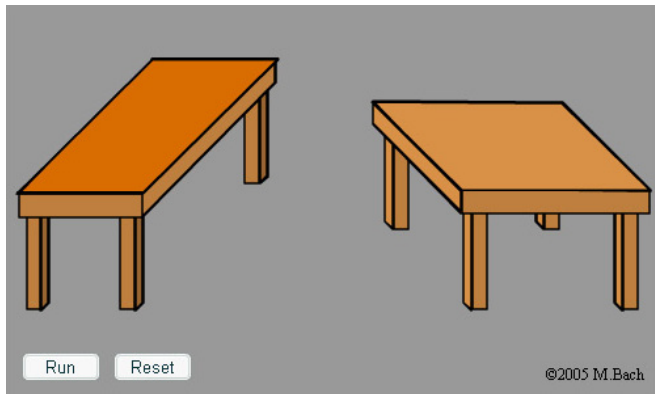
http://philosophy.ucsd.edu/faculty/wuthrich/

12 Scientific Reasoning

Acknowledgements: Bill Bechtel

How reliable is vision?
Shepard's turning tables

http://www.michaelbach.de/ot/sze_shepardTables/index.html

Run   Reset   ©2005 M.Bach

Compare the two tables in the figure. Which would be easier to get through a narrow door? How do size and shape of the two tables tops compare?

Shepard's turning tables

- The phenomenon plays on interchange of 2- and 3-dimensional interpretations of the figure.
- If it depicted a scene in real 3-dim space, then the tables would certainly have different shapes and sizes.

Shepard, R N (1981), 'Psychological complementarity'. In M Kubovy and J R Pomerantz (eds.), *Perceptual Organization*. Hillsdale, NJ: Lawrence Erlbaum Associates, 279-342.

Shepard R N (1990), *Mind Sights: Original Visual Illusions, Ambiguities, and other Anomalies*. New York: W H Freeman and Company.

How good is human reason?
The Monty Hall problem

- Suppose that behind one of these three doors I have hidden a car, behind the other two a goat.
- You get to pick which one to open (you keep what's behind the door), but before you open it, I will open one of the other doors, revealing a goat:

The Monty Hall problem (continued)

- Now I give you a choice: stay with your first pick, or change to the other door.

- Which is the better choice?

- Surprisingly, it turns out that switching is the better choice since you will win the car in 2/3 of all cases, while staying only wins 1/3 of the time. (For an explanation, see the links below)

http://www.nytimes.com/2008/04/08/08monty.html

http://math.ucsd.edu/$\sim$crypto/Monty/monty.html

How good is human reason?
A bad doctor's visit

- You go to see your doctor with a puzzling ailment.
- Your doctor tells you that it is characteristic of a disease that is affecting 1% of the population and if you have it, it means certain death.
- There is a simple test he can perform which is accurate 79% of the time (i.e., 21% of the time it gives false positives). You agree to the test.

- Now your doctor looks really worried: The test came back positive.
- How worried should you be? How likely are you going to die?
- Answer: your risk of death is 8%!

When is evidence diagnostic?

Data from 250 patients.

- Question: Is dizziness associated with brain tumors?
- Which information is relevant?

		Brain tumor	
		present	absent
Dizziness	present	160	40
	absent	40	10

Reasoning and fallacies
Exemplary reasoning in science
Optical illusions
Common fallacies

Sensible policy making: a decision-theoretic paradox

- You are a member of the health commission and must choose between these two policies:

    - Program A: 200 people will be saved $\Rightarrow$ 72%
    - Program B: 1/3 chance of saving 600 people and 2/3 chance of saving no one

- You are on the disaster management board and must choose one of two options:

    - Program C: 400 people will die
    - Program D: 1/3 chance that no one will die and 2/3 chance that 600 people will die $\Rightarrow$ 78%

Exemplary reasoning in science: Mendel and heredity

Heredity prior to Mendel:

- The basic idea that offspring are similar to their parents had been obvious to people for ages.

- It was also clear that offspring varied from their parents.

Animal and plant breeders capitalized on these differences:

- By controlling mating and eliminating undesired organisms, breeders were able to produce plants and animals with desired traits.

- By multiply breeding offspring and eliminating variants, breeders could generate pure breeds.

Gregor Mendel (1822-1884)

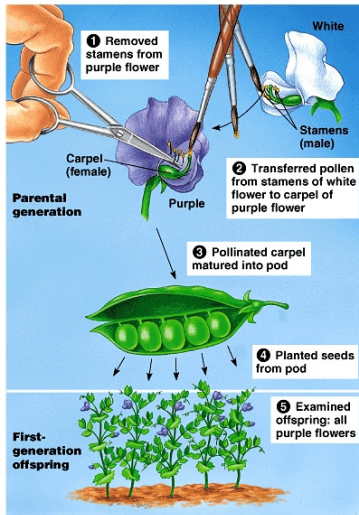- Born in Silesia, then in the Austrian Empire and now Czech Rep, studied at Olomuc and Vienna (physics and natural science), joined Augustinian order
- lived most of his adult live in the cloister at Altbrünn (now Brno in the Czech Republic)
- Starting in 1856, he conducted plant breeding experiments in the cloister's garden...

Mendel's breeding experiments

- Choice of peas: naturally self-pollinated but easy to cross-pollinate
- Mendel introduced the vocabulary of dominant and recessive characters

Seed		Flower	Pod		Stem	
Form	Cotyledons	Color	Form	Color	Place	Size
Grey & Round	Yellow	White	Full	Yellow	Axial pods, Flowers along	Long (6-7ft)
White & Wrinkled	Green	Violet	Constricted	Green	Terminal pods, Flowers top	Short (≮ -1ft)
1	2	3	4	5	6	7

Mendel's procedure

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- Cross-pollinate between pure breeding lines with alternative traits—yellow/green seeds, smooth/dented seeds etc.
- All members of the F_1 generation exhibit the dominant traits.
- Allow members of the F_1 generation to self-pollinate.

First generation from hybrids (F_2)

Form of seed	Round / Wrinkled	5474	1850	2.96:1
Color of albumin	Yellow / Green	6022	2001	3.01:1
Color of seed coat	Violet flowers / White flowers	705	224	3.15:1
Form of pods	Inflated / Constricted	822	299	2.95:1
Color of unripe pods	Green / yellow	428	152	2.81:1
Position of flowers	Axial / terminal	651	207	3.14:1
Length of stem	Long / short	787	277	2.84:1

F_2 generation

- Produced by self-fertilization of members of the F_1 generation
- Individuals with recessive traits bred pure
- One out of three of those showing the dominant character produced only offspring with the dominant character
- ⇒ Theoretical problem for Mendel: what could **explain** these and other patterns he found?
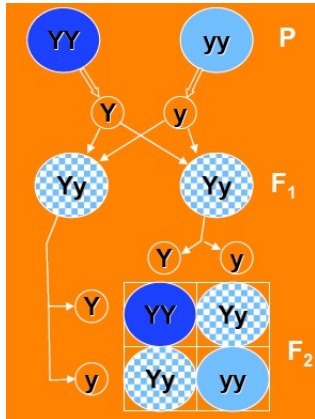
Mendel's hypothesis

Behind the characters lay factors:

- pollen and egg cells each possessed the factor for either the dominant or the recessive trait

What evidence does Mendel have for these factors?

- Only that they account for the inheritance pattern he saw and others he predicted.

- Without his hypothesis, these other predictions would not have been made.

Features of Mendel's reasoning

- He designed a study that could reveal structure in the phenomena.

- He found a systematic pattern in the phenomena.

- He proposed a hypothesis that could explain the pattern.

- He supported this hypothesis by both the pattern he initially observed and others which it predicted. These pattern would otherwise be mysterious!

- Message: Successfully predicting what would otherwise be mysterious is typically the way hypothesis gain support.