Reasoning and Decision Making

How reliable is vision?

How reliable is vision?
How good is human reason?

Behind one of these doors I have hidden money, behind the other two a cat.

You get to pick which one to open. But before you open it, I will open one of the other doors, revealing a cat.

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

Which is the better option?

http://www.shodor.org/interactivate/activities/monty3/

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 she can perform which is accurate 79% of the time (that is, 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 to die?
- Answer: your risk of death is 8%!

When is evidence diagnostic?

Data from 250 patients:
- Is dizziness associated with brain tumors?
- Which information is relevant?

<table>
<thead>
<tr>
<th>Brain tumor</th>
<th>Dizziness</th>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>160</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>40</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
### Sensible Policy Making

- You are a member of the health commission and must choose between these two policies:
  - Program A: 200 people will be saved 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 78%

### Exemplary Reasoning in Science

**Heredity Prior to Mendel:**
- The basic idea that offspring are similar to their parents had been obvious to people for ages
- It also was 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

An Augustinian monk, Mendel studied physics and natural science in Vienna, but lived most of his adult life in the cloister at Altbrunn (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

Mendel’s Procedure

Cross-pollinate between pure breeding lines with alternative traits—yellow/green, smooth/dented

All members of the F1 generation exhibit the dominate traits

Allow members of the F1 generation to self-pollinate

<table>
<thead>
<tr>
<th>Character</th>
<th>F1 Ratio</th>
<th>F2 Ratio</th>
<th>F2/F1 Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of seed</td>
<td>3:1</td>
<td>3:1</td>
<td>1</td>
</tr>
<tr>
<td>Color of albumin</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
<tr>
<td>Color of seed coat</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
<tr>
<td>Form of pods</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
<tr>
<td>Color of unripe pods</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
<tr>
<td>Position of flowers</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
<tr>
<td>Length of stem</td>
<td>1:1</td>
<td>1:1</td>
<td>1</td>
</tr>
</tbody>
</table>

First Generation from Hybrids
**F₂ Generation**

Produced by self-fertilization of members of the F₁ 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 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 patterns would otherwise be mysterious!
- Message: Successfully predicting what would otherwise be mysterious is typically the way hypotheses gain support.