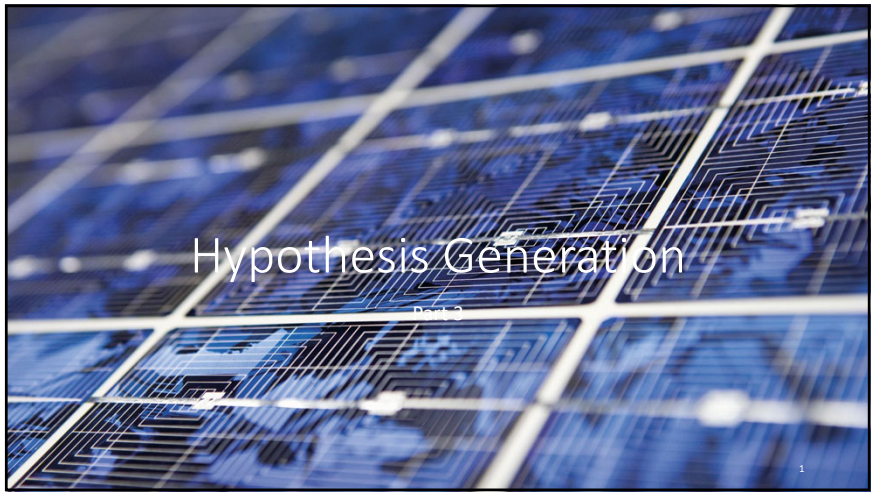

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"The great tragedy of Science – the slaying of a beautiful hypothesis by an ugly fact."

-Thomas Henry Huxley

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Rules for Good Hypotheses

- *Good hypotheses are _____; for example, they do not predict a relationship that is already well-established.*
  - Children in households whose annual income is greater than $50,000 will spend fewer days per year in homeless shelters than children in households whose annual income is less than $50,000. (?)

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3

Rules for Good Hypotheses

- *Good hypotheses are _____; if the statement can be simplified without losing essential content, it must be simplified.*
  - A diet high in calories administered to a randomly selected mostly sedentary population for a period of six months will, on average, result in weight increase within that population.

Simplifies to:

- ❑ A diet high in calories will result in weight increase.

This is also trivial!

4

4

Occam's Razor

Attributed to 14th century Franciscan friar, William of Occam

(Frustra fit per plura, quod fieri potest per pauciora)
It is vain to do with more what can be done with less

Or

(Essentia non sunt multiplicanda praeter necessitatem)
Entities are not to be multiplied beyond necessity

5

5

Occam's *RAZOR*

– '**Cut away**' *nonessential* description, rationalization, and explanation:

– "This philosophical razor advocates that when presented with competing hypotheses about the same prediction, one should select the solution with the fewest assumptions,[4] and that this is not meant to be a way of choosing between hypotheses that make different predictions."

– Wikipedia (https://en.wikipedia.org/wiki/Occam%27s_razor)

- "Objects fall to earth not because of gravity, but instead because little invisible creatures jump up and down on all non-attached objects and push them to earth."
- Is this the ***simplest*** explanation?

The **simplest** explanation that accounts for **all observations** is most likely to be the correct one.

6

6

Occam's Razor

- Some practical implications of Occam's razor
  - ***Select the most dominant effects*** to investigate
  - Simplify your models and explanations to ***account for the most important effects and observations***
  - Decide *how good a model needs to be for it to provide a useful explanation or calculation or prediction* – try to use quantitative limits

7

7

Rules for Good Hypotheses

- Good hypotheses are _____ (rather than empirically) based.
  - Grounded in basic scientific and engineering arguments
    - Thermodynamics
    - Fluid mechanics
    - Electromagnetics
    - Kinetics
    - Conservation principles
    - Etc.…
  - Allow interpretation of results in terms of ***fundamental scientific principles***
  - Allow experiments to be designed rationally
  - Allow uncompromised, unequivocal assessment
  - Make the hypothesis testing process meaningful

8

8

Rules for Good Hypotheses

- *Good hypotheses specify the _____ of the relationship(s) of the variables under consideration*
- *if the hypothesis concerns correlations among variables, it specifies whether the direction of the correlation (association) is positive or negative*.
  - Example:
    - A child's success in school depends the education level of his or her family

    Better stated:
    - Children of educated parents are more successful in school compared to …

9

9

Rules for Good Hypotheses

- *Hypotheses about correlations among variables _____ of each variable.*
  - Example:
    - Children whose parents have college degrees will have higher scores on the LEAP test than children whose parents are not college graduates.

    Better stated:
    - LEAP test cores will be positively correlated with the education level of children's parents.

10

10

Rules for Good Hypotheses

- *Hypotheses about correlations among variables should involve _____*
  - Example:
    - LEAP test cores will be positively correlated with the education level of children's parents.

11

11

Rules for Good Hypotheses

- *In general, good hypotheses do not predict a _____*
  - Example:
    - Undergraduate GPA will **not** be related to how well students do in this course.
  - Better to assume the correlation and see if the hypothesis can be falisified:
    - Undergraduate GPA **is a good indicator** of how well students do in this course.

12

12

Poor Hypotheses

- Poor hypothesis: *Banging on my TV will make it work right.*
  - What is '***work right***'?
  - How do we accept that this may be true one day and not the next?
- Another: *The temperature of the solution will influence the reaction rate.*
  - *What is the influence?*

13

13

Hypothesis Development

- The first hypothesis you write will probably not be great
  - Expect to spend some time editing
  - Use the rules covered in this class!!!
- Recall our discussion of problem definition
  - How you state an hypothesis will determine the kinds of experiments you do
  - Vague, poorly worded hypotheses will likely lead to poorly designed experiments, and poorly planned research

14

14

Example

- Let's apply the rules for good hypotheses to improve an hypothesis (You'll be doing this in your homework!)
- How can we improve:
  - *Plant growth may be affected by the color of the light.*

Let's use the rules…

15

15

Example

Plant growth may be affected by the color of the light.

- Is it *falsifiable*?
  - Not as it is written … "may be?"
  - Reword:

*Plant growth **is** affected by the color of the light.*

- Affected how?
- Is it testable?
  - Yes, but it's not clear how…let's come back to that one later

16

16

Example

*Plant growth **is** affected by the color of the light.*

- *Recall: Good hypotheses specify the **nature** or **direction** of the relationship(s) of the variables under consideration; if the hypothesis concerns correlations among variables, it specifies whether the direction of the correlation (association) is positive or negative.*

  – What variables are being considered here?
    - plant growth – "affected" … how?
    - color of light
  – What is the direction of correlation? –
  – Reword:

*Plant growth **increases** as the color of the light is changed.*

17

17

Example

*Plant growth **increases** as the color of the light is changed.*

- *Good hypotheses are worded in such a way as to **indicate clearly how they will be tested**.*
- *Hypotheses about correlations among variables **address the full range of values** of each variable.*
- *Hypotheses about correlations among variables involve continuous variables*

- Looking at each variable:
  – Plant growth:
    - *How do we measure plant growth?*
    - *What plant species do we use for the experiment?*
  – Color of light:
    - *What colors (or wavelengths) or light?*
    - *What intensity?*

18

18

Example

Plant growth increases as the color of the light is changed.

- Rewording the hypothesis:

Algae cell mitosis** increases as the wavelength of light decreases from **750 nm to 350 nm.

The density of algae cells** in samples exposed to light for the same length of time will be **greater** as the wavelength of light **decreases** from **750 nm to 350 nm.

19

19

The End

20

20