Hypothesis Generation

Part 2

1

"I will listen to any hypothesis but on one condition – that you show me a method by which it can be tested."

-August William von Hoffmann

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Rules

- Good hypotheses are _____ and _____.
    – Testable hypotheses *can be evaluated.*
        • *Example: The rate of the reaction is controlled by mass transfer effects*
        • We can construct experiments whose results will either contradict or support this hypotheses
            – What observation would verify the hypothesis?
            – What observation would falsify the hypothesis?
        • **Both answers** (supported, falsified) are *meaningful*.

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The Form of Hypotheses

- Most commonly, hypotheses take three formats:
    – **a question**: "Does temperature affect fermentation?"
    – **a conditional statement**: "Temperature may affect fermentation."
    – **an If, then statement**, "If fermentation rate is related to temperature, then increasing the temperature will increase gas production.

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Form and Falsifiability

Are QUESTIONS falsifiable?

– "Does temperature affect fermentation?"

– Bock notes that **_hypotheses should be declarative sentences._**

Are CONDITIONAL STATEMENTS falsifiable?

– "Temperature may affect fermentation."

Are IF-THEN STATEMENTS falsifiable?

– "If fermentation rate is related to temperature, then increasing the temperature will increase gas production."

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Falsifiability

- "*Falsifiability*" is **_a key characteristic of a good hypothesis_**.

- For a theory or hypothesis to be falsifiable, it must be possible in principle to make an observation that would show the proposition to be false, *even if that observation has not been made.*

  – Example, the proposition "All crows are black"

    • Would be falsified by observing one white crow.

  – Example, the proposition "Rooster crowing makes the Sun come up"

    • Would be falsified by observing that Sun rises even in places where there are no roosters.

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Testability vs. Falsifiability

- **Hypothesis A:** "Our universe is surrounded by another, larger universe, with which we can have absolutely no contact."

  – By its very nature it this hypothesis **_is not testable_**.

  – There are no observations that a scientist could make to tell whether or not the hypothesis is correct.

- Ideas such as Hypothesis A are interesting to think about, but science has nothing to say about them. Hypothesis A is a **speculation**, not a hypothesis.

- Often the requirement that a scientific hypothesis must be testable is phrased as "_____."

  – A scientific prediction is not something that is going to happen, rather a prediction suggests a **test** (observation or experiment) for the hypothesis.

  – To say that a hypothesis "*generates predictions*" means the same thing as saying the hypothesis "is testable".

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Testability vs. Falsifiability

- **Hypothesis B:** "There are other inhabited planets in the universe."

- Hypothesis B may be either correct or wrong.

  – If **Hypothesis B** is correct, there are several ways that its correctness can be proven.

    • A space probe finds an inhabited planet

    • We receive some sort of signals from space

    • Alien spacecraft or space probes visit earth

    • Etc.

  – **If Hypothesis B is wrong, *there is no test that will prove it*.**

    • If one of our space probes never finds an inhabited planet, it doesn't mean that one doesn't exist. If we never receive signals from space, that does not prove that the hypothesis is wrong, either.

    • Hypothesis B is not **_falsifiable_**.

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Testability vs. Falsifiability

- **Hypothesis C:** "Any two objects dropped from the same height above the surface of the earth will hit the ground at the same time, as long as air resistance is not a factor."

- Hypothesis C **is** a scientific hypothesis because: it is

  - **testable** - pick 2 objects, and drop them.

  - **falsifiable** - If anyone finds 2 objects that don't hit the ground at the same time **and** can show that it is not due to air resistance, then he/she has proven the hypothesis wrong.

- A falsifiable hypothesis "sticks its neck out" for every test. In theory and in practice, if Hypothesis C were wrong, it would be very easy and straightforward to show it.

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Testability vs. Falsifiability

- A hypothesis is essentially worthless unless it is "risky"

- You want to be confident that your hypothesis is correct

  - No confidence from merely accumulating evidence in its favor

    - Relatively easy to gather evidence for just about any idea

  - **To gain real confidence in your hypothesis**

    - Showing that situations that could establish its falsity don't, in fact, happen.

    - **Must** make predictions that *could* contradict it.

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The End

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