Research Methodology

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Process of research

- Consists of three broad steps:
  - Pose a question
  - Collect data pertinent to the question
  - Present an answer
- Collection of information includes
  - Collection
  - Organisation
  - Analysis

Research Questions

- The answer must increase our understanding of an issue
  - Not just **us, personally,** but of humanity in general
  - So it should be new in some way
  - Textbook problems are not new; so not research problems
- Must be answerable (a.k.a. meaningful)
- Must be **tractable**
  - This is a new word for us – dictionary does not help
  - Comp Sci: Time to solve increases polynomially with problem size
  - Non-technically: should finish your thesis in a reasonable time

How to recognise a tractable problem?

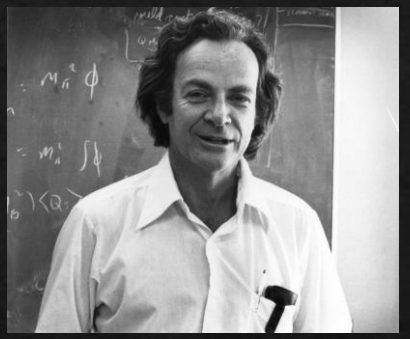
- Supervisor tells you
  - Not necessarily the end of the story
- Otherwise? (Also, how to proceed)
  - **Try to state the problem as clearly as possible**
  - Intuition
  - Reductionism
- These are methodologies! (But not for the actual problem)

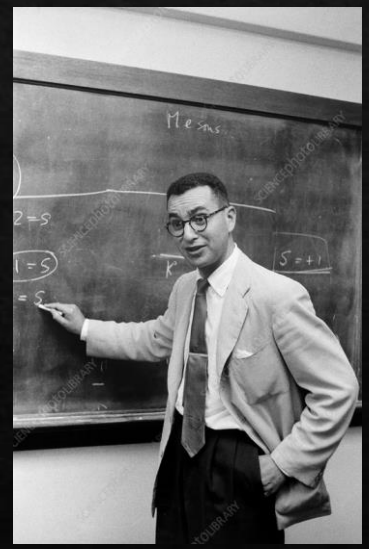
Intuition

- Popular meaning: hunch, without apparent logic
  - In reality: educated guess or informed hunch
  - Requires/Uses
    - Imagination
    - Background knowledge
    - Experience
    - Familiarity
    - Convergent thinking
    - Etc.
- Using all this, we make a guess for the solution

Intuition

- Feynman's algorithm for solving problems
- Gell-Mann "explained" it thus:
  - Feynman writes down the problem
  - Then he thinks very hard
  - Then he writes down the solution.
- We can think of this as a joke
- But we can also take it (or part) as an actual method
- State the problem as clearly as possible
- Intuition is in the second step





Intuition

- "The accurate intuitions of experts are better explained by the effects of prolonged practice than by heuristics."
- "When confronted with a problem [...] the machinery of intuitive thought does the best it can. If the individual has relevant expertise, she will recognise the situation, and the intuitive solution that comes to her mind is likely to be correct."
- "Intuition is nothing more and nothing less than recognition."
- These are taken from **Thinking, Fast and Slow,** by Daniel Kahnemann, (Nobel memorial prize in Economic Sciences, 2002)

Intuition

- But intuition can fail
- Do the following simple experiment next time you meet a friend
  - Give them the following problem
  - A bat and a ball together costs Rs. 1100
  - The bat costs Rs. 1000 more than the ball
  - What is the price of the ball?
- Most people would say Rs. 100 without thinking (i.e. with intuition)
- Thinking increases the likelihood of getting the correct answer
- Overconfidence causes intuition to fail