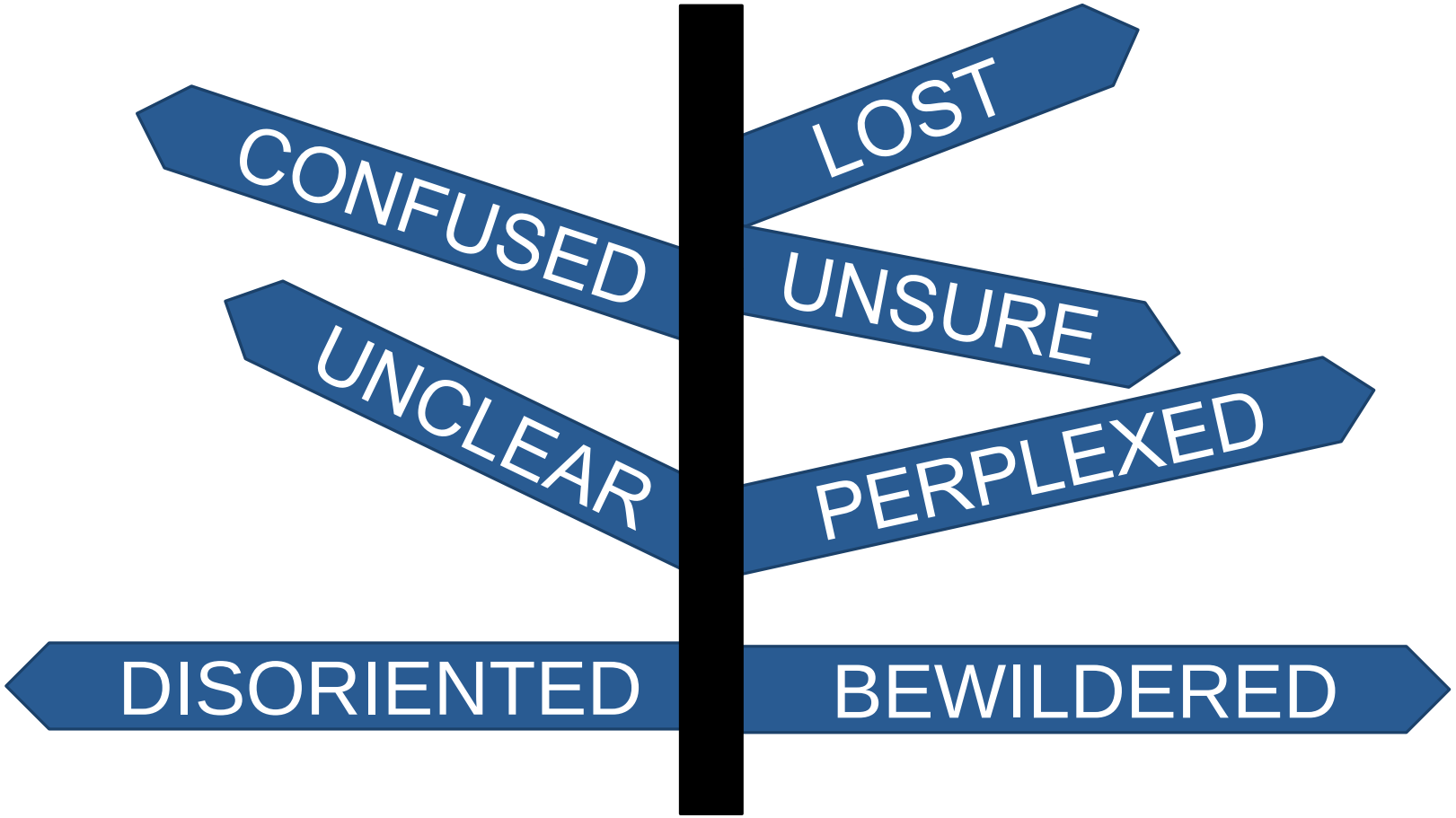
Stochastic Thinking and Random Walks, Segment 1

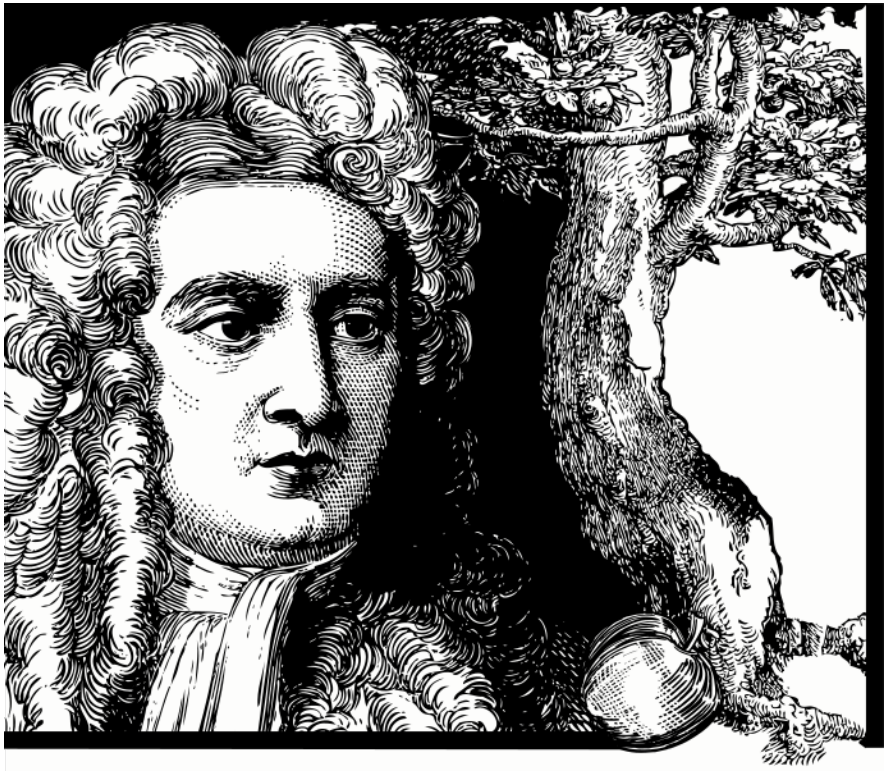
The World is Hard to Understand

- Uncertainty is uncomfortable
- But certainty is usually unjustified



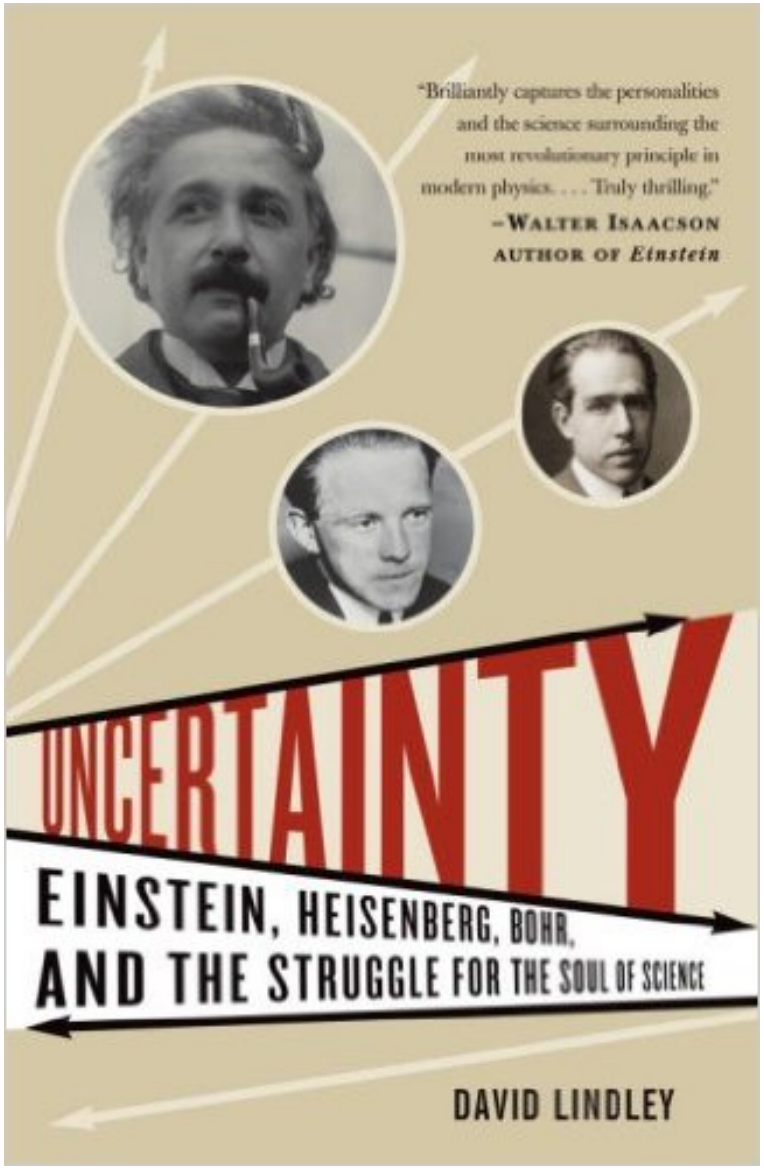
Newtonian Mechanics

- Every effect has a cause
- The world can be understood causally



1643 - 1727

Two Centuries Years Later



Copenhagen Doctrine

- Copenhagen Doctrine (Bohr and Heisenberg) of causal nondeterminism
  - At its most fundamental level, the behavior of the physical world cannot be predicted.
  - Fine to make statements of the form “x is highly likely to
  - occur,” but not of the form “x is certain to occur.”
- Einstein and Schrödinger objected
  - “God does not play dice.” -- Albert Einstein

Does It Really Matter?

- The world may or may not be inherently unpredictable
- But our lack of knowledge does not allow us to make accurate predictions
- Therefore we might as well treat the world as inherently unpredictable
- Predictive nondeterminism

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Stochastic Processes

- An ongoing process where the next state might depend on both the previous states and some random element

```
def rollDie():
    """ returns an int between 1 and 6"""

def rollDie():
    """ returns a randomly chosen int
        between 1 and 6"""
```

Specifications and Implementations

```
def squareRoot(x, epsilon):
    """Assumes x and epsilon are of type float
                x >= 0 and epsilon > 0
    Returns float y such that
            x-epsilon <= y*y <= x+epsilon"""
```

- Specification allows but does not require, a nondeterministic implementation
- Can be tricky when debugging a program that uses it

Implementing a Random Process

```
import random

def rollDie():
    """returns a random int between 1 and 6"""
    return random.choice([1,2,3,4,5,6])

def testRoll(n = 10):
    result = ''
    for i in range(n):
        result = result + str(rollDie())
    print(result)
```