Lecture -- 10 -- Start

Outline

1. Science, Method & Measurement
2. On Building An Index
3. Correlation & Causality
4. Probability & Statistics
5. Samples & Surveys
6. Experimental & Quasi-experimental Designs
7. Conceptual Models
8. Quantitative Models
9. Complexity & Chaos
10. Recapitulation - Envoi

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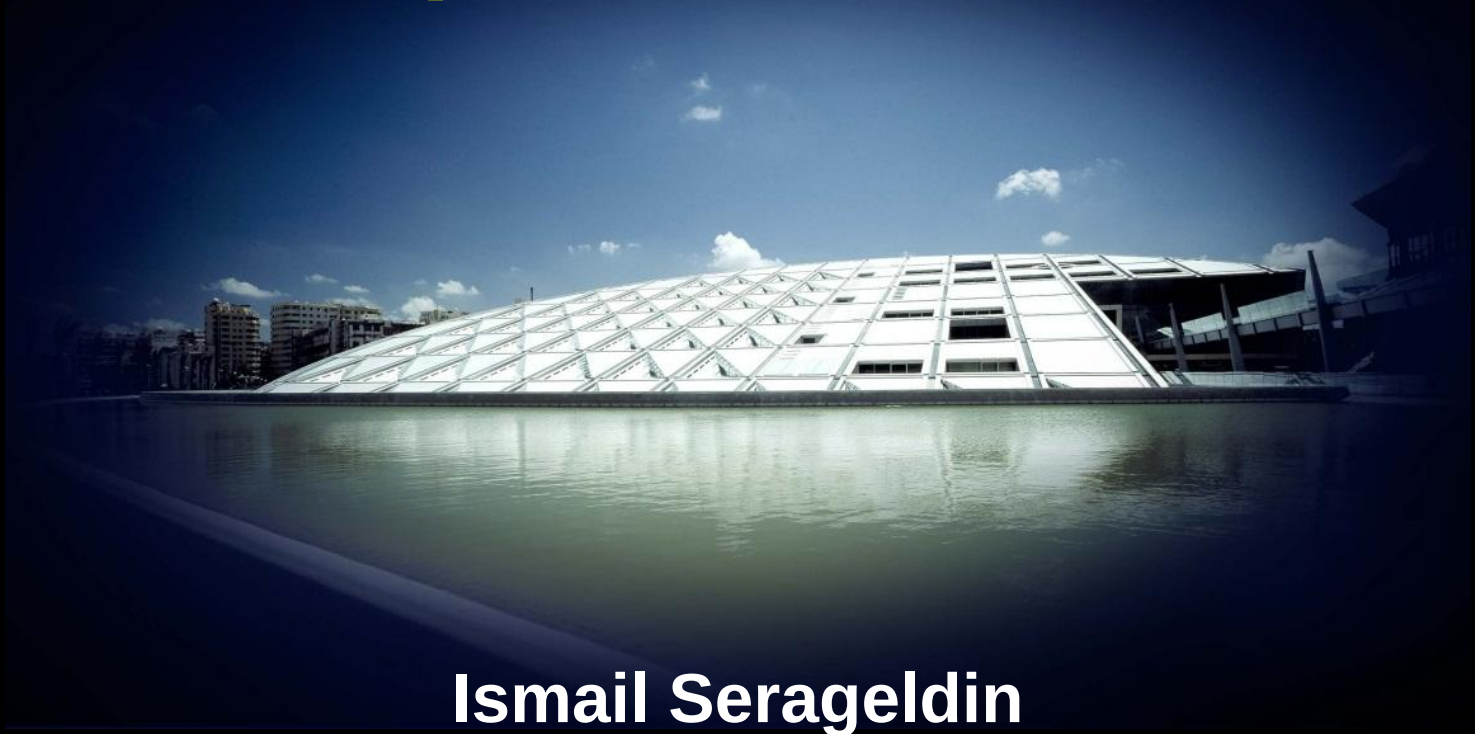
10. **Recapitulation - Envoi**

Quantitative Techniques for Social Science Research

Lecture # 10:
Recapitulation – Envoi



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Alexandria

2012

Recapitulation

This Course Is About How to Think about Social Science Research

What is Social Science?

- Social science is the field of study concerned with society and human behaviors.
- "Social science" is commonly used as an umbrella term to refer to a plurality of fields outside of the natural sciences. These include: anthropology, archaeology, criminology, economics, education, history, linguistics, communication studies, political science and international relations, sociology, geography, law, and psychology.

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The Method of Science

OBSERVATION: Sense specific physical realities or events.

HYPOTHESIS: Create a statement about the general nature of the phenomenon observed.

PREDICTION: Forecast a future occurrence consistent with the hypotheses.

EXPERIMENT: Carry out a test to see if predicted event occurs.

If results DO match prediction, hypothesis is supported.

If results DO NOT match prediction → **RECYCLE**

REVISED HYPOTHESIS

PREDICTION

EXPERIMENT

The Method of Science

Observation

↓

Hypothesis

↓

Prediction

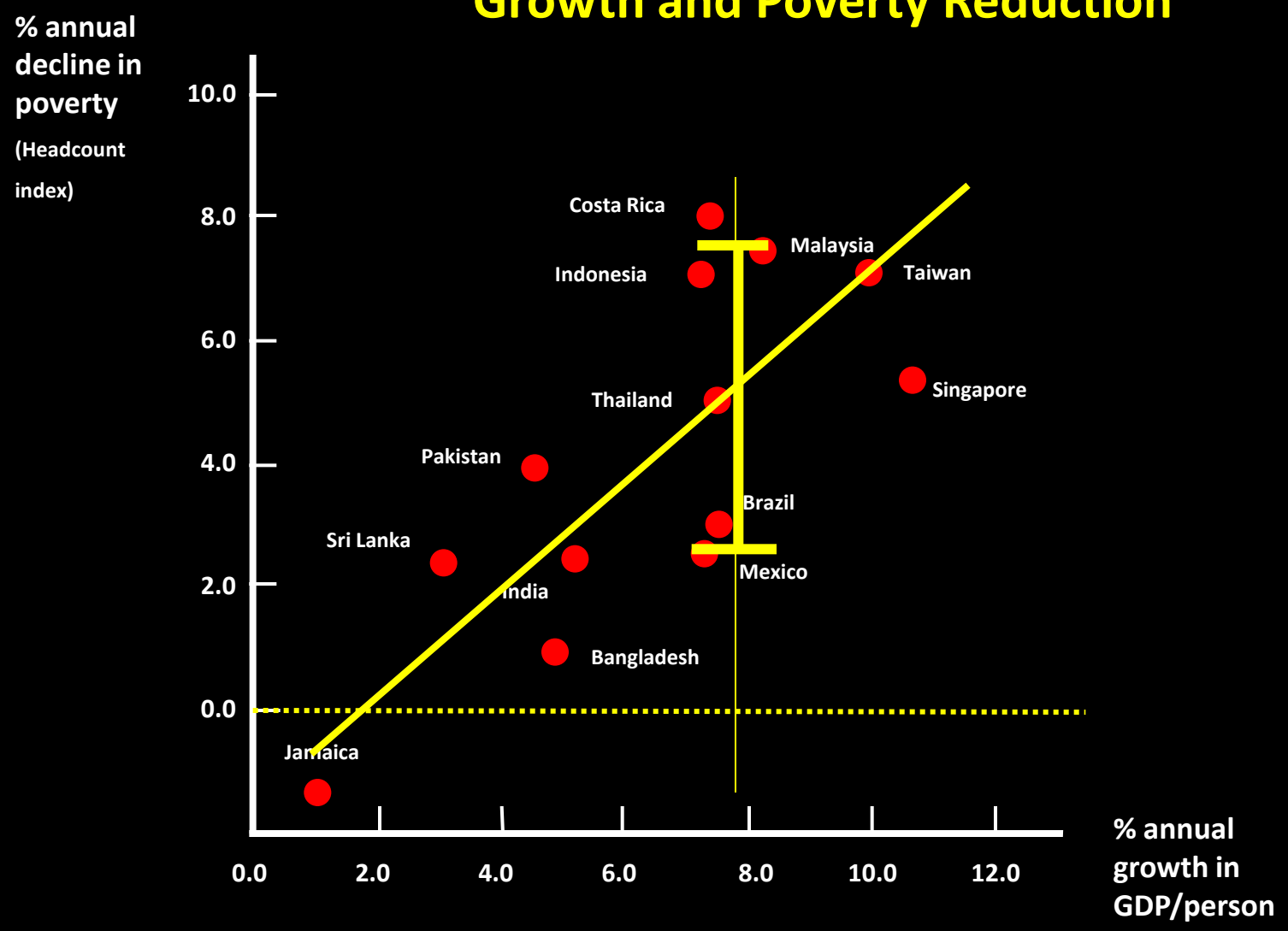
↓

Experiment

↓

Interpretation

Growth and Poverty Reduction



Four Kinds (Types) of Scales

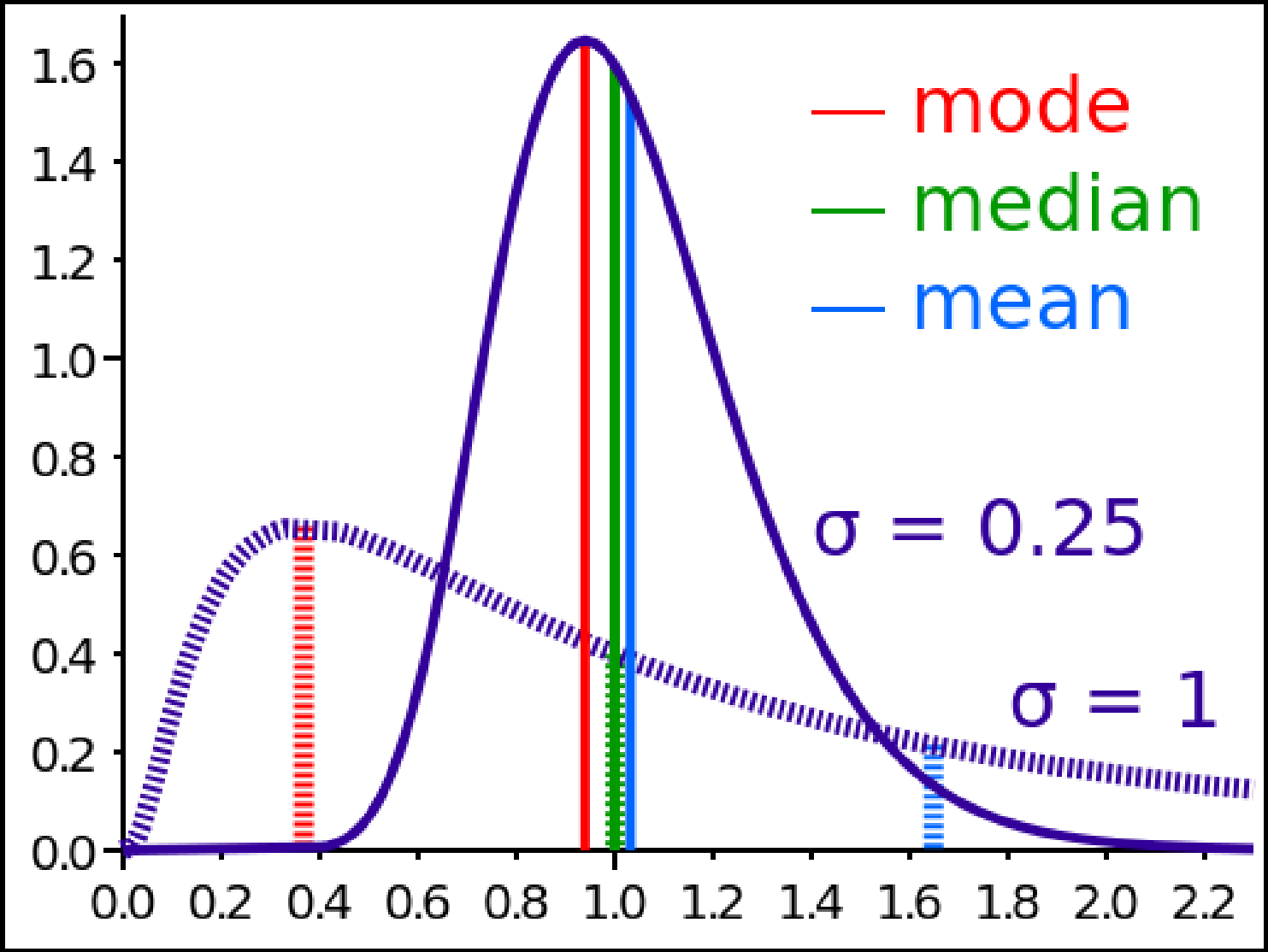
- Nominal
- Ordinal
- Interval
- Ratio

Average?

- **Mean:** usually add up the values for all the observations and divide them by the number of observations

- **Median:** the number at which half the observations are smaller and the other half are bigger

- **Mode:** the number that appears most frequently in the distribution of observations.



Mean, Median, Mode

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An Index is

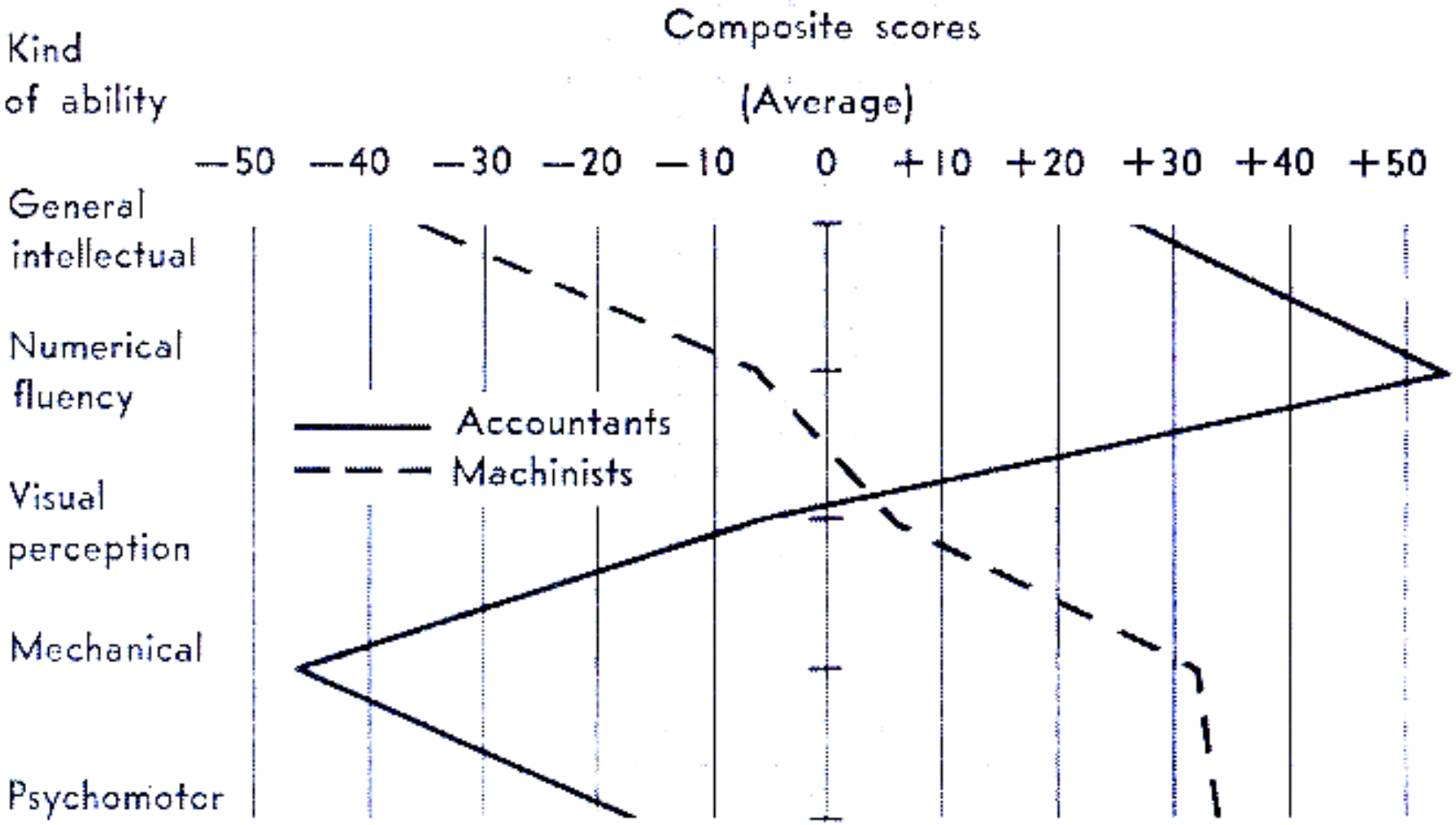
- A composite measure, usually involving ratio(s), intended to simplify the interpretation of a situation

- Examples: Price index, inflation rate, poverty index, success rate in an examination, etc.

An index should be

- **Robust:** not thrown off by random or partial variations
- **Discriminating:** distinguishes between different cases
- **Efficient:** reasonably easy to build and to measure
- **Effective:** captures what we want to measure

Ability Scores: Accountants Vs. Machinists



I.Q. measures

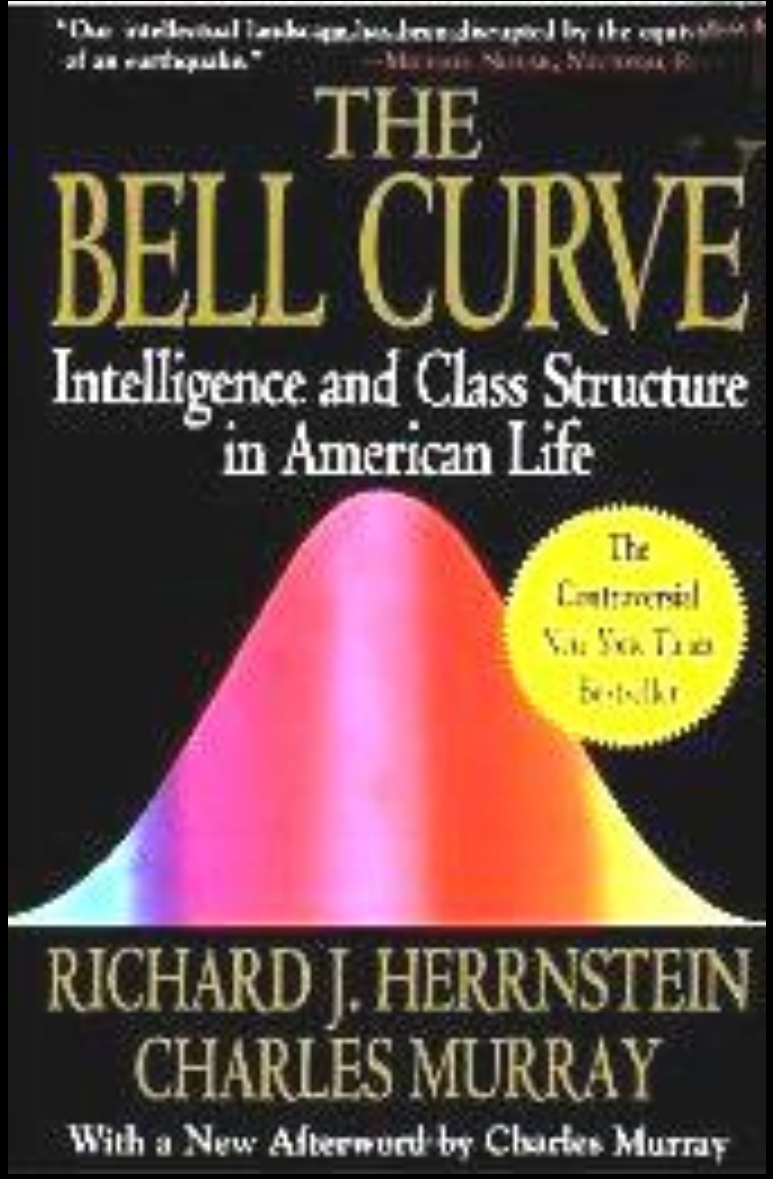
- I.Q. is an index constructed by dividing the score of an individual (child) of a certain age on a specific test over the average score that a person should have at that age.
- If the person matches that average score, the I.Q. = 100
- It is sometimes expressed as mental age over biological age
- It says nothing more than what you would say of a child being somewhat tall or somewhat short, for his age,

The multiple intelligences

1. Logical-mathematical
2. Spatial
3. Linguistic
4. Bodily-kinesthetic
5. Musical
6. Interpersonal
7. Intrapersonal
8. Naturalistic
9. Existential

Misreading the index

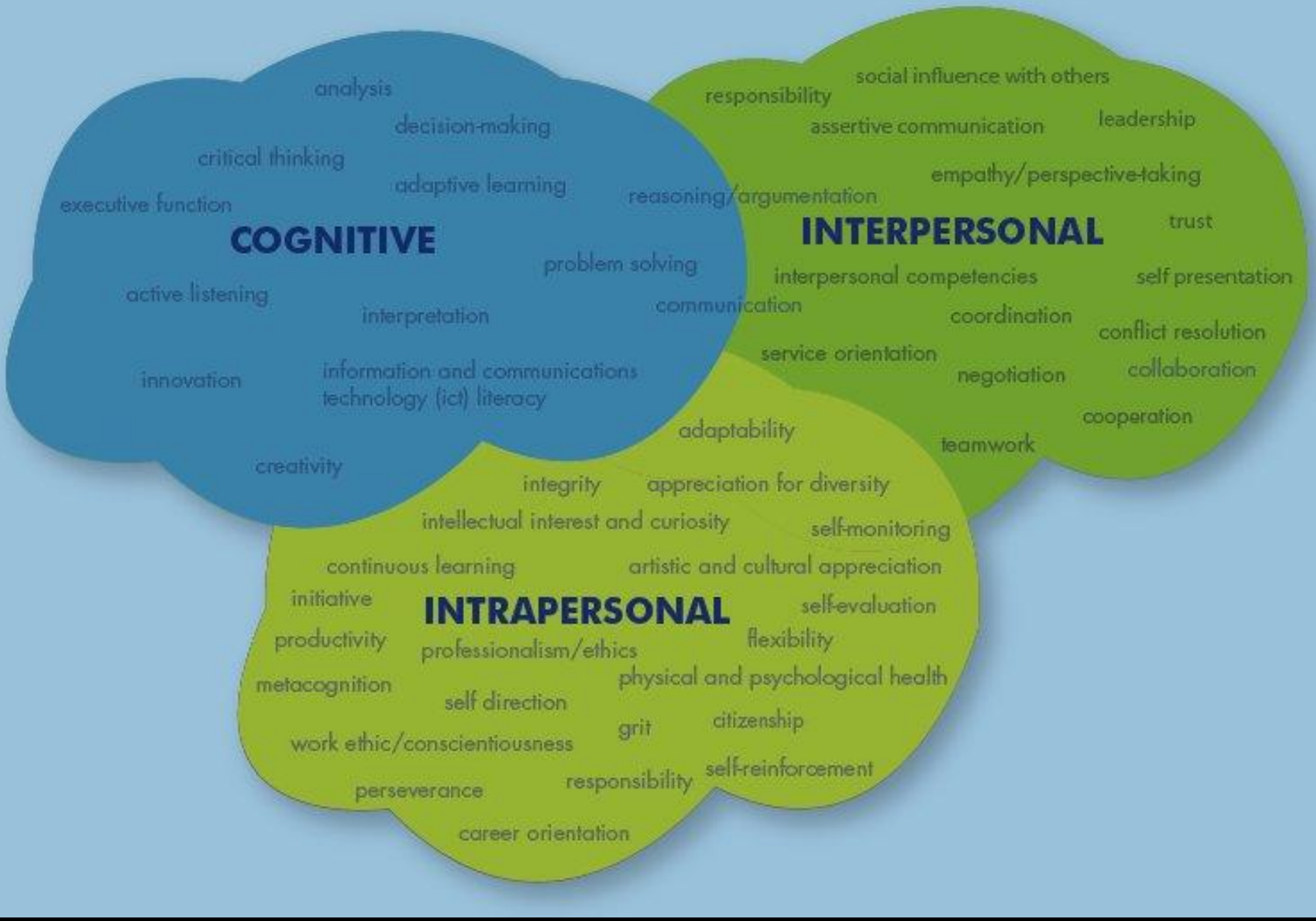
- History is full of examples of people misreading the index
- Some even wanted to use it for racist purposes and argued for Eugenics
- In the USA, where race is a big issue, there was a recent case of the Book called “The Bell Curve”



IQ, Nature and Nurture

Many alternative theories of Intelligence

- Cattell–Horn–Carroll theory
- Fluid and crystallized intelligence
- Theory of multiple intelligences
- Three stratum theory
- Triarchic theory of intelligence
- PASS theory of intelligence


COGNITIVE
analysis
decision-making
critical thinking
adaptive learning
executive function
reasoning/argumentation
problem solving
active listening
interpretation
communication
innovation
information and communications technology (ict) literacy
creativity
INTERPERSONAL
social influence with others
responsibility
assertive communication
leadership
empathy/perspective-taking
trust
interpersonal competencies
self presentation
coordination
conflict resolution
service orientation
negotiation
collaboration
cooperation
teamwork
INTRAPERSONAL
adaptability
integrity
appreciation for diversity
intellectual interest and curiosity
self-monitoring
continuous learning
artistic and cultural appreciation
initiative
self-evaluation
productivity
professionalism/ethics
flexibility
metacognition
physical and psychological health
self direction
grit
citizenship
work ethic/conscientiousness
self-reinforcement
perseverance
responsibility
career orientation

Understanding P_α

$$\therefore P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^\alpha$$

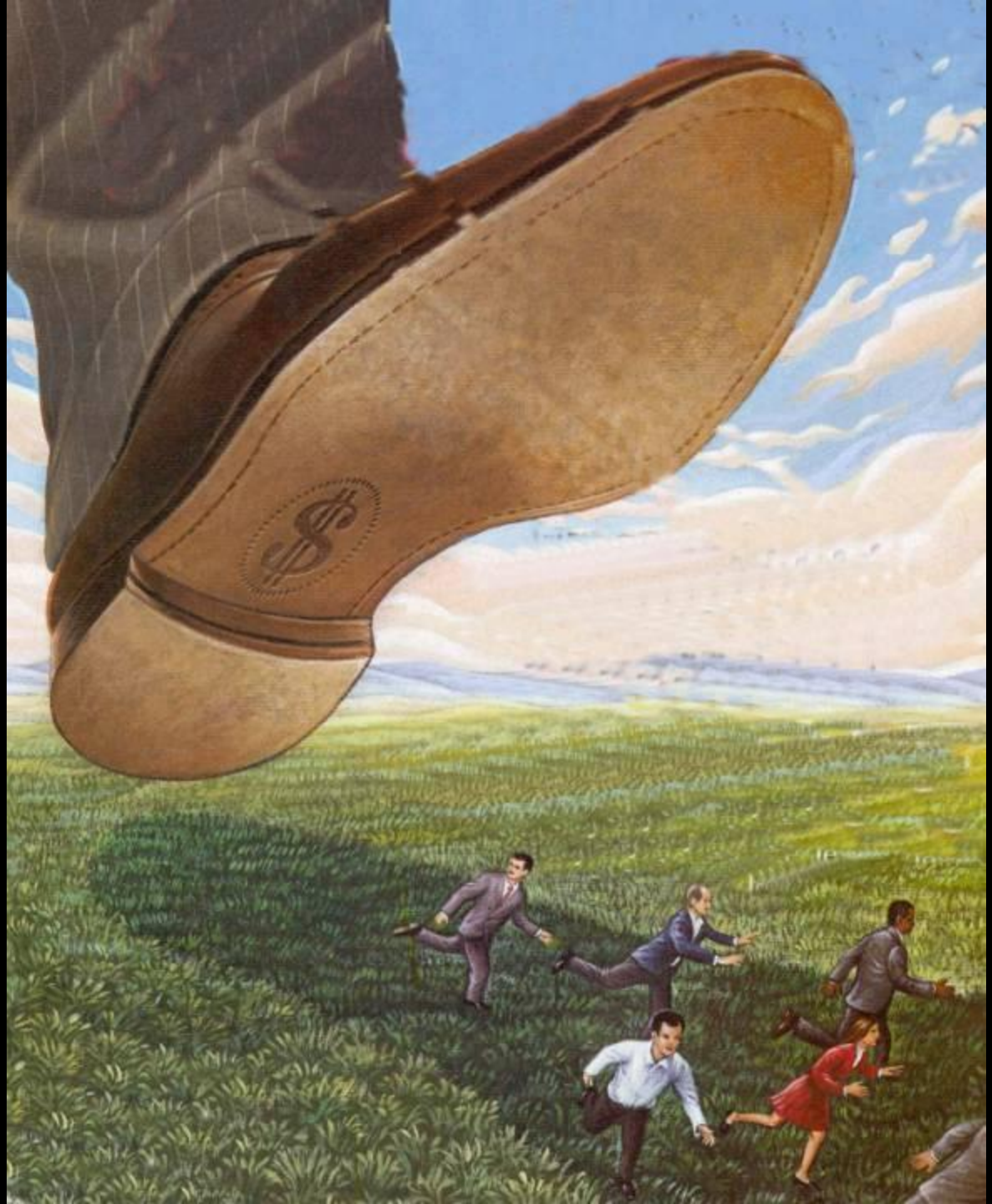
P_α is the weighted mean over the poor population

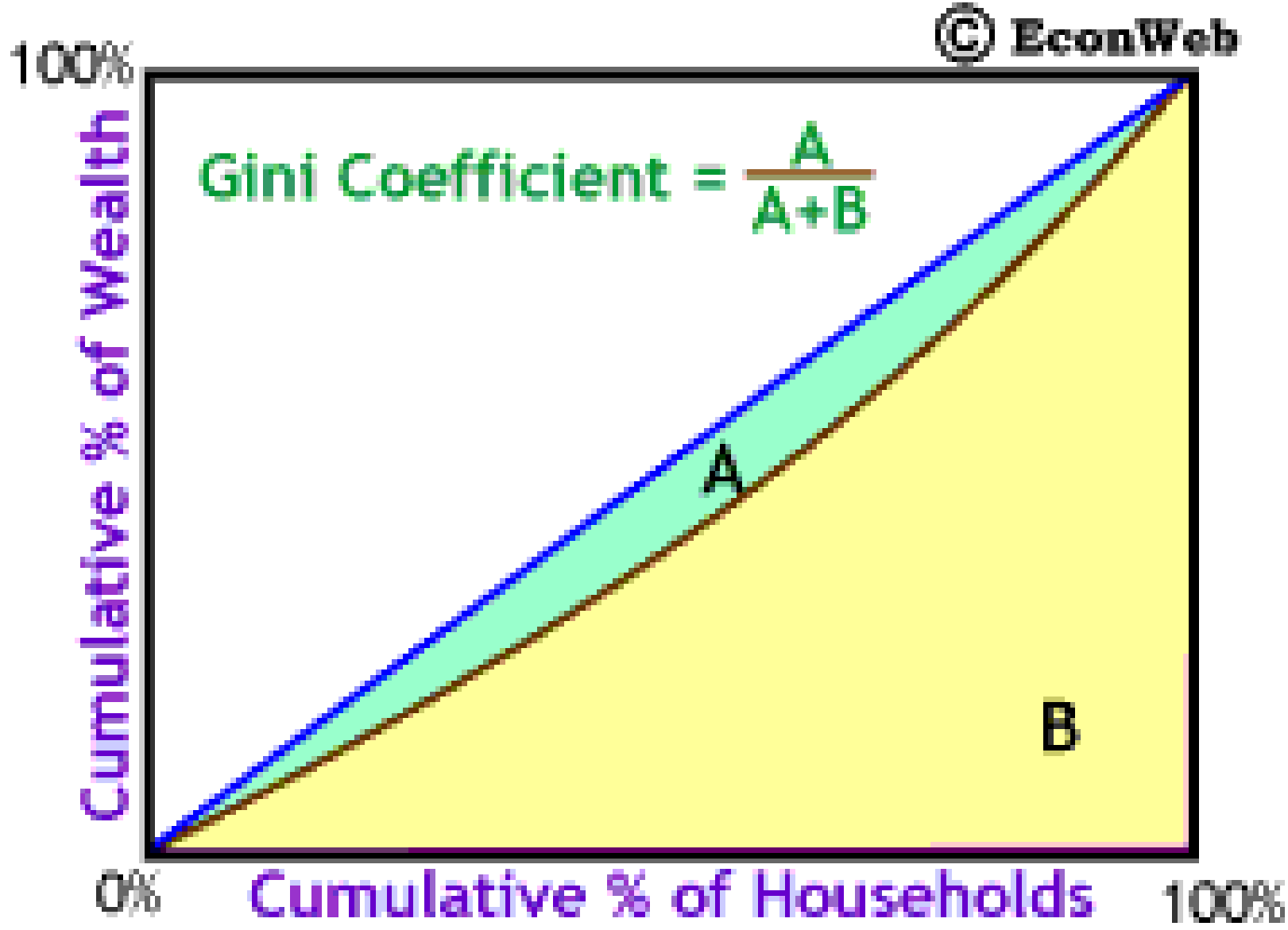
The measure = $\left(1 - {y_i}/{z}\right)^\alpha$ for poor $(y_i < z)$

= 0 for non $-$ poor $(y_i > z)$

A better statement about P_α

- If $\alpha = 0 \quad \therefore P_0 =$ Amount of poverty
- If $\alpha = 1 \quad \therefore P_1 =$ Depth of Poverty
- If $\alpha = 2 \quad \therefore P_2 =$ Severity of Poverty (usually associated with hunger)





Increasing Gini Coefficient
Due to Increasing Inequality

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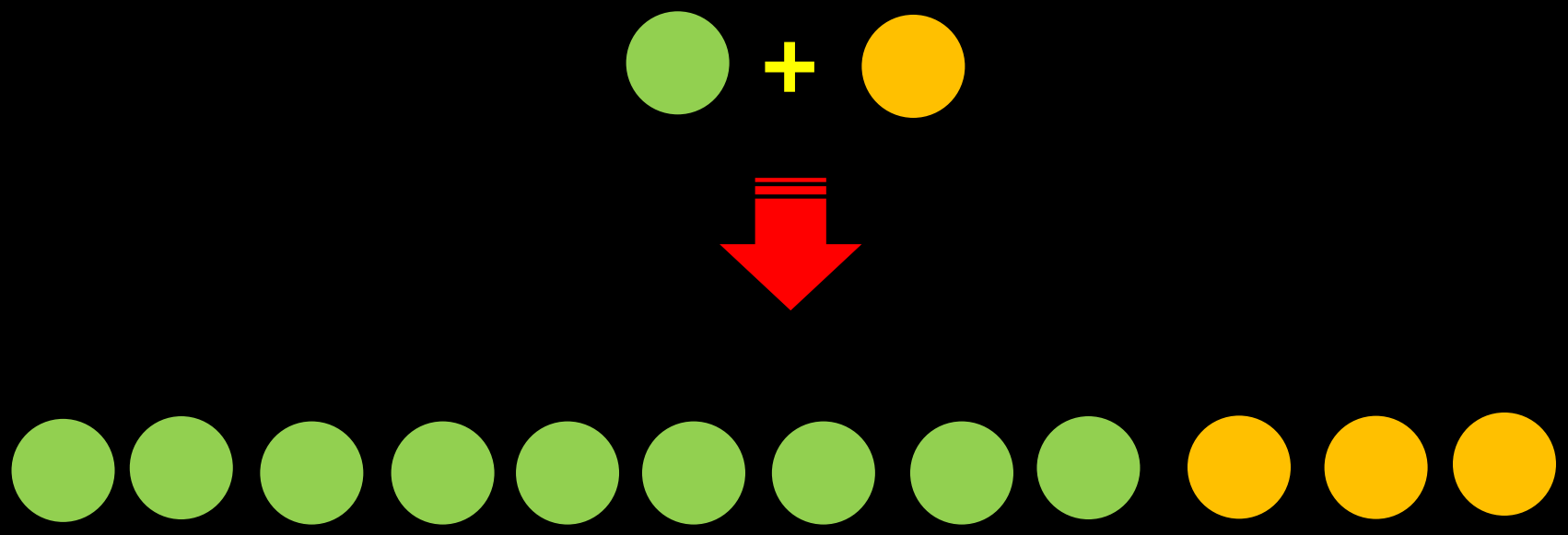
Chi Square

Chi-Square

- **Chi-square is a statistical test commonly used to compare observed data (o) with data we would expect (e) to obtain according to a specific hypothesis.**

- **For example, based on Mendel's laws, we expect that in a cross between pure green (dominant) and pure yellow (recessive) peas the proportion of green to yellow offspring would be 3:1**

Example:
Green and Yellow Peas



Theoretical Outcomes: 3 Green :1 Yellow

Correlation & Causation: Five Possibilities

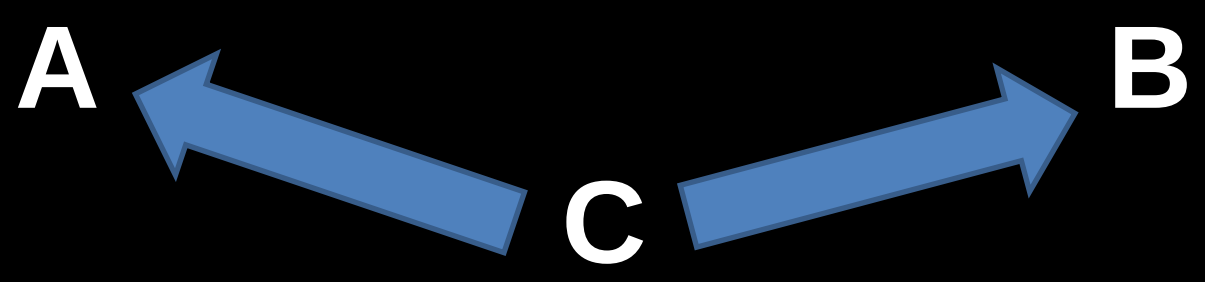
- A may be the cause of B.

Correlation & Causation: Five Possibilities

- A may be the cause of B.
- B may be the cause of A.

Correlation & Causation: Five Possibilities

- A may be the cause of B.
- B may be the cause of A.
- **Some unknown third factor C may actually be the cause of both A and B.**



Correlation & Causation: Five Possibilities

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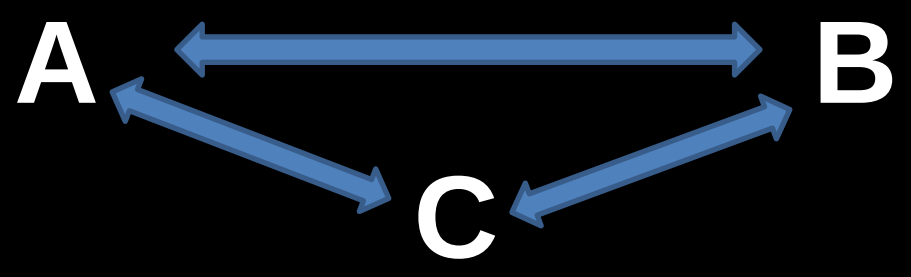


- There may be a combination of the above three relationships.

Correlation & Causation: Five Possibilities

- A may be the cause of B.
- B may be the cause of A.
- Some unknown third factor C may actually be the cause of both A and B.
- There may be a combination of the above three relationships.
- **Fifth: It is just a coincidence!**

Pirates and Global Warming

FIRST OCCASION

Pupils	*Teachers* Cold	Warm
Responsive	20	30
Unresponsive	30	20

SECOND OCCASION

Pupils	*Teachers* Cold	Warm
Responsive	10	40
Unresponsive	40	10

TEACHER WARMTH CAUSING PUPIL RESPONSIVENESS

Pupils	*Teachers* Cold	Warm
Responsive	10 (10)	30
Unresponsive	30	(10) 10

PUPIL RESPONSIVENESS CAUSING TEACHER WARMTH

Pupils	*Teachers* Cold	Warm
Responsive	10 (10)	30
Unresponsive	30	(10) 10

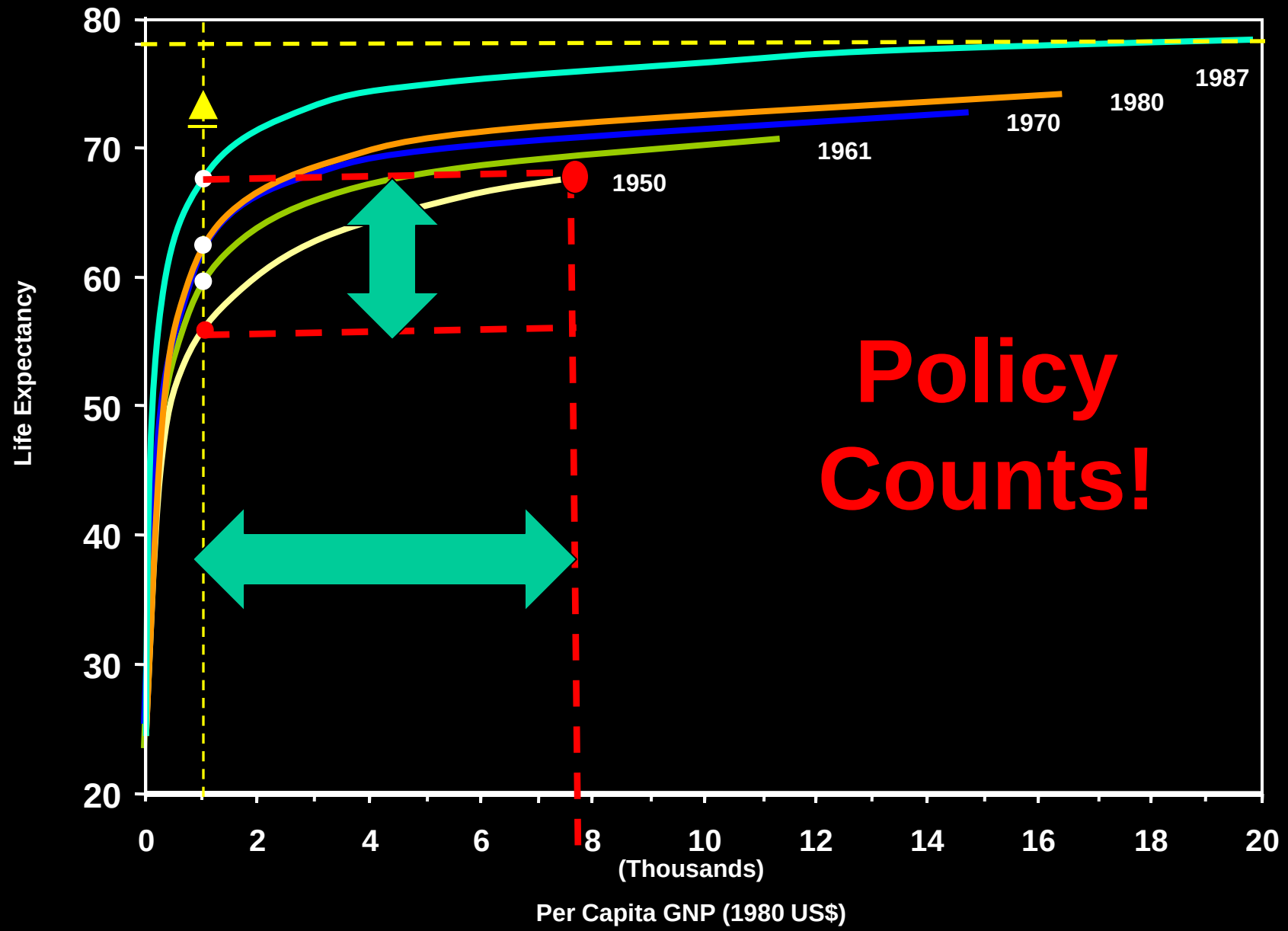
Interpreting Causality: Possible Explanations

Causation

- On the other hand, causation is a one-way direction, one is dependent and the other one is independent.
  - A only goes to B.
  - B cannot go to A.
  - Therefore, the occurrence of B depends on A.
  - A is a predictor to B.

- Every causation always has got a strong correlation, but not all strong correlation is a causation.

Life Expectancy versus Per Capita GNP
Best Fit Relation by Decade



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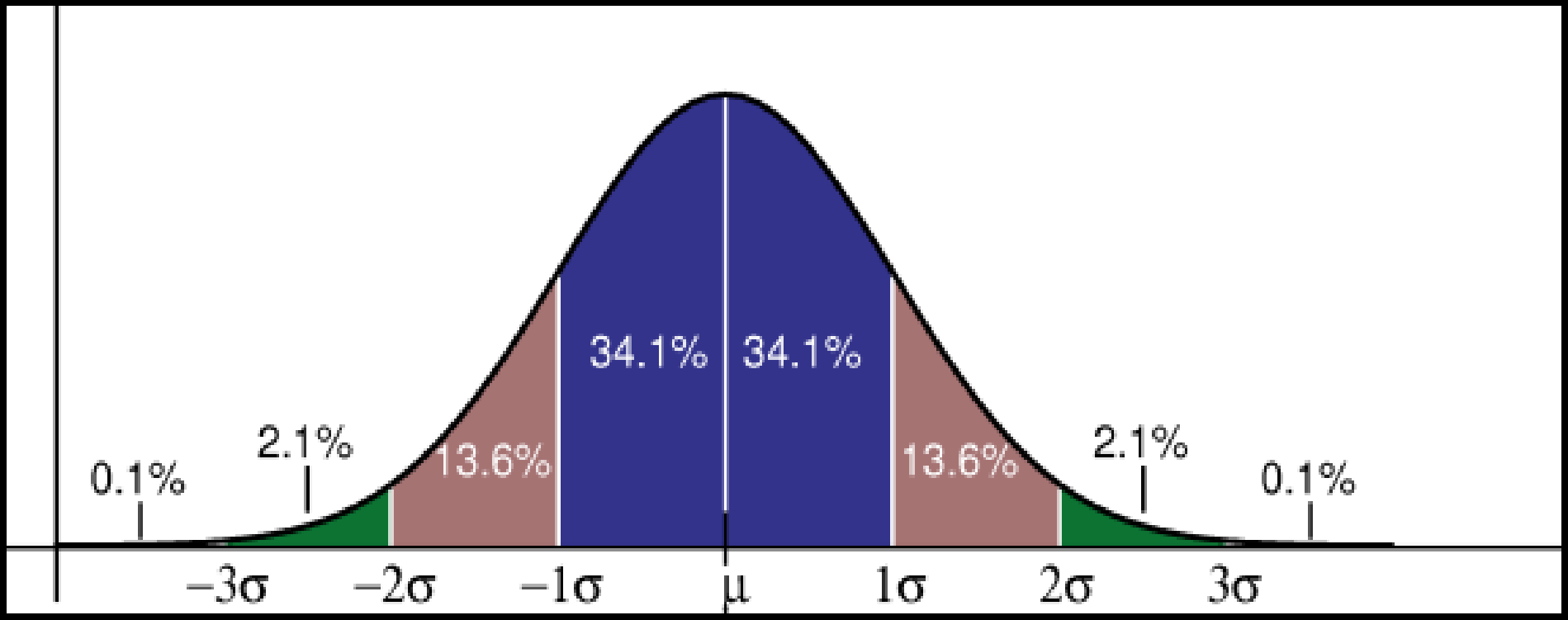
The Properties of the Gaussian Distribution



- **68% of the values lie within 1 standard deviation of the mean;**
- **95% lie within 2 standard deviations; and**
- **99.7% lie within 3 standard deviations.**

Three Coins Problem

Three coins problem: Solution

- List all possible outcomes (call that A).
- Then ask: In how many ways can three heads appear? (call that B)
- Probability of that outcome is B/A
- Likewise: What is the probability of obtaining a head and two tails?
- Ask In how many ways can a head and two tails appear? (call that C)
- Probability of that outcome is C/A

Three coins solution (cont'd)

- So : List all possible outcomes A = 8

  hhh, thh, hth, hht, tth, tht, htt, ttt

- Only one possible way in which we get 3 heads. So B=1
- So the probability that all three coins will come up heads is B/A = 1/8
- In how many ways can a head and two tails appear? So C=3
- So the probability of obtaining a head and two tails is C/A = 3/8

The Birthday problem

So…

- The probability of having a match with someone's birthday in a group of :
- just 23 people is over 50% !!!
- For 57 people it is 99%
- There are variants to this problem statement. Let's discuss those

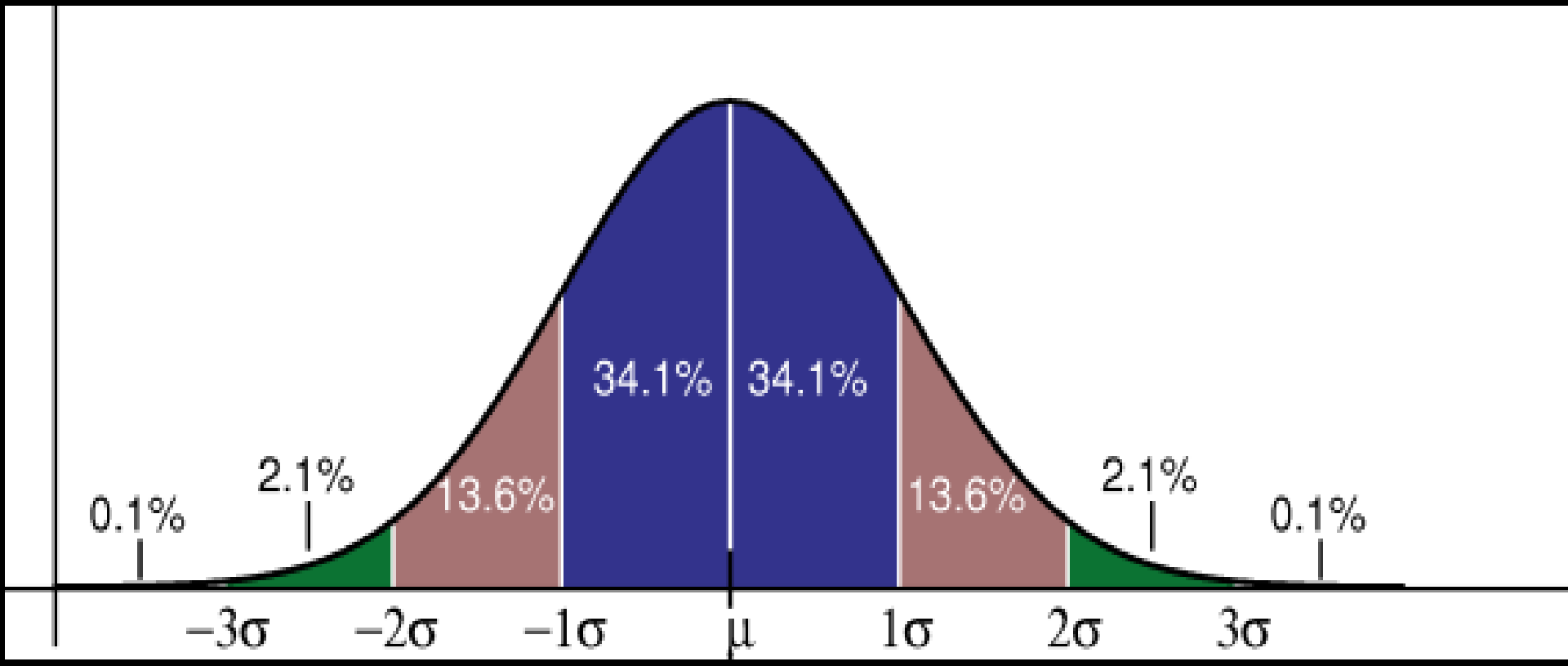
FYI

- The probability of large number of observations of independent events will generally map out as a normal distribution (the bell curve, the Gaussian distribution).

- The hump or high point will always be the mode

- If and only if the curve is symmetrical, that will also be the mean and the median.

The Gaussian Distribution



- **As the figure above illustrates, 68% of the values lie within 1 standard deviation of the mean; 95% lie within 2 standard deviations; and 99.7% lie within 3 standard deviations.**

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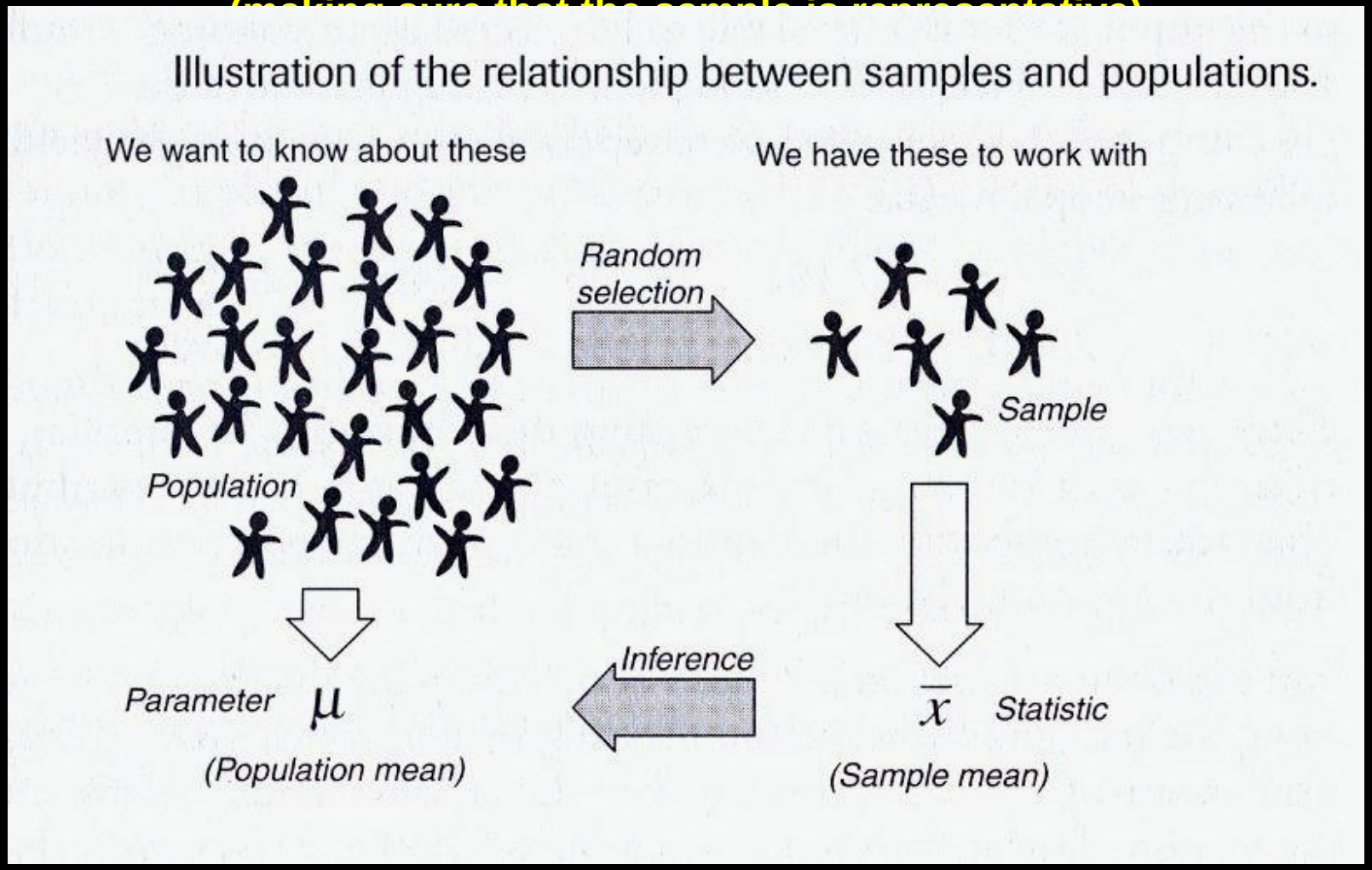
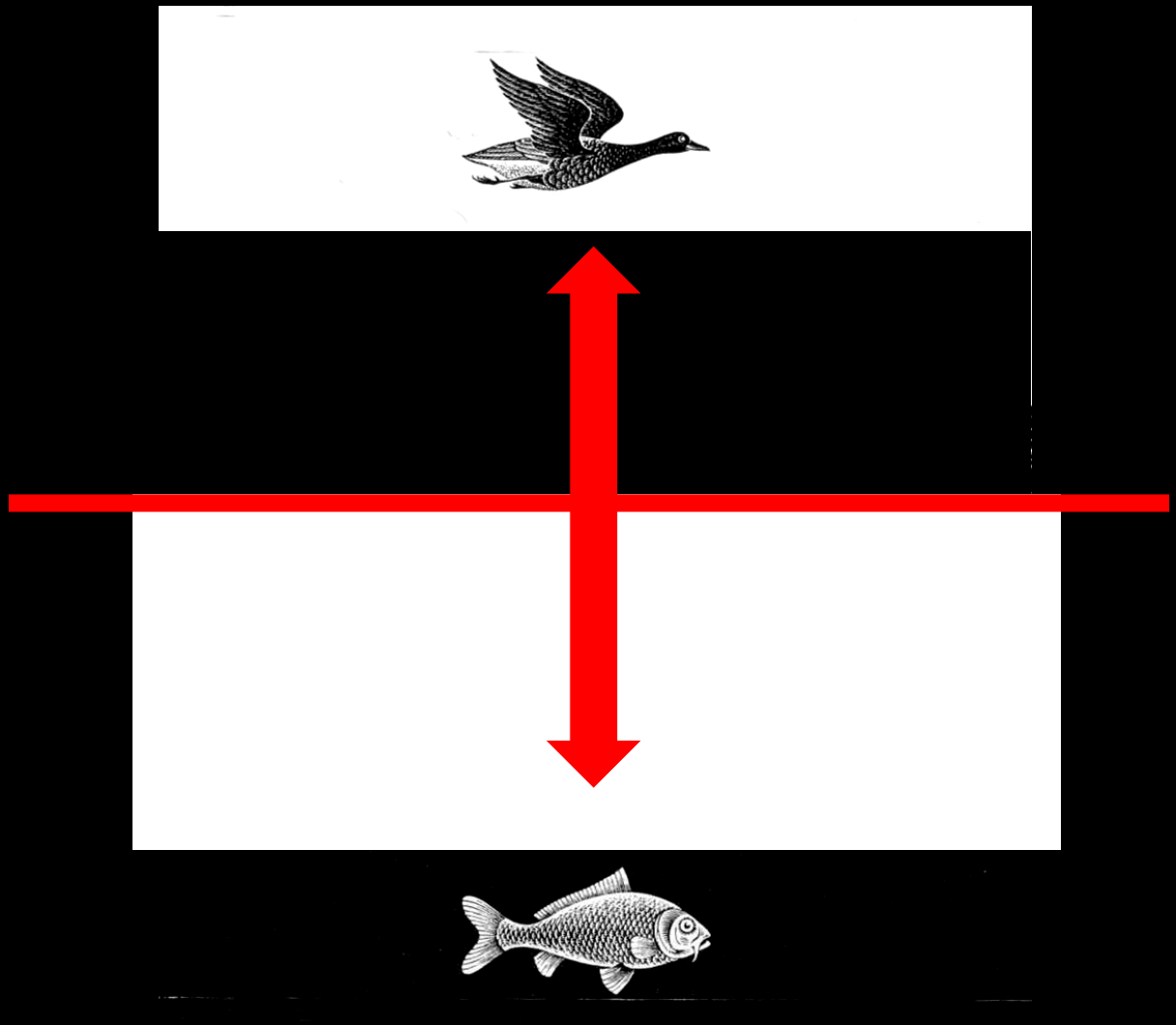
We want to know something about the Population so we study a small sample of the Population

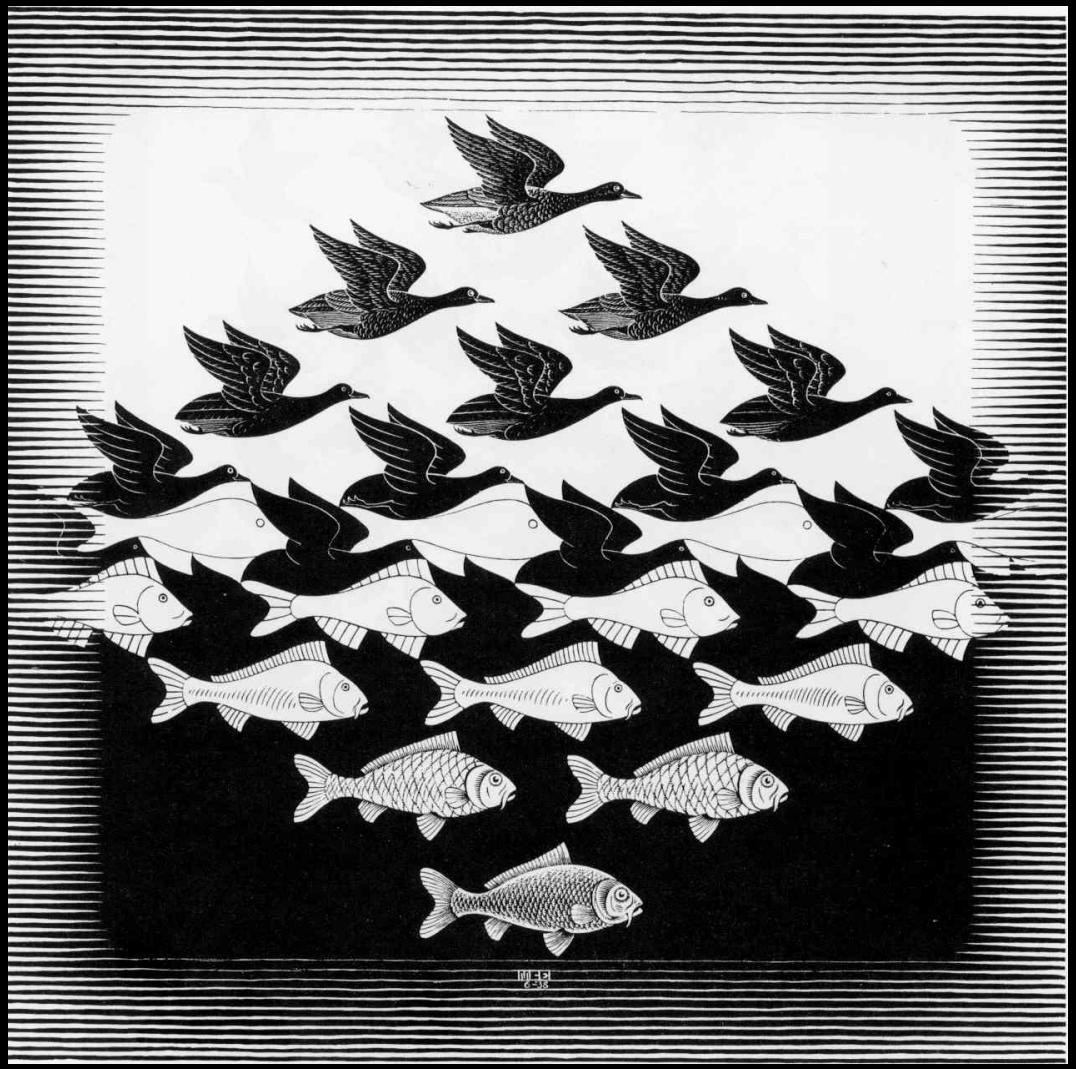
(making sure that the sample is representative)



Source: Statistics, Cliffs Quick Review, Wiley, NY, 2001



Transitions can be cut up in discrete states

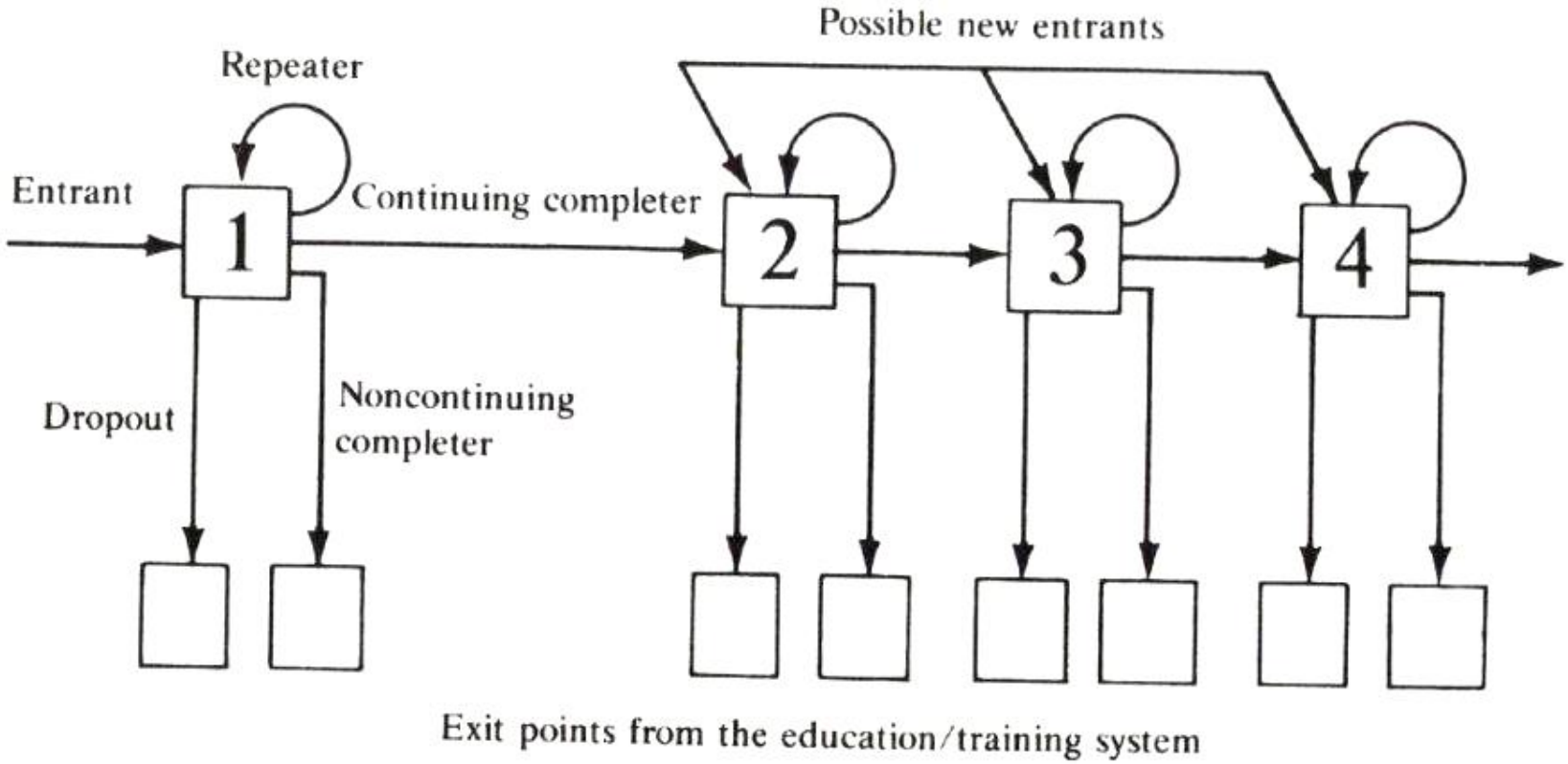


But many transitions are really continuous

Example:

Students leaving school and entering the Labor Market

Figure 3. The Markovian Basis of the Education Simulation Model



Note: Each student in any given course has one of four possible successor states: repeater in same course; completer continuing to successor course; noncontinuing completer; and noncompleting dropout. The last two constitute exit points from the education/training system.

Example Of Population Parameter vs. Sample Statistic

- **Example.** We want to know the percentage of voters that favor a new tax.
  - The actual percentage of all the voters is a population parameter.
  - The estimate of that percentage, based on sample data, is a sample statistic.
- **The quality of a sample statistic** (i.e., accuracy, precision, representativeness) is strongly affected by the way that sample observations are chosen; that is, by the **sampling method**.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Bad Surveys make for bad estimates

Estimates of the front runners in the Egyptian Presidential Election 2012

- Before the first Round:

1. Abdel Moneim Aboulfotouh
2. Amr Moussa
3. Mohamed Morsi
4. Hamdein Sabahi
5. Ahmed Shafik

- After the first Round:

1. Mohamed Morsi
2. Ahmed Shafik
3. Hamdein Sabahi
4. Abdel Moneim Aboulfotouh
5. Amr Moussa

The US 1948 Presidential Election: Truman vs. Dewey

Sampling Methods

- **Non-probability samples.** We do not know the probability that each population element will be chosen, and/or we cannot be sure that each population element has a non-zero chance of being chosen.

- **Probability samples.** Each population element has a known (non-zero) chance of being chosen for the sample.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Two of the main types of non-probability sampling methods

- **Voluntary sample.** People who self-select into the survey. Often, these folks have a strong interest in the main topic of the survey. E.g. those who call in to talk show, or participate in an on-line poll. This would be a volunteer sample.
- **Convenience sample.** A convenience sample is made up of people who are easy to reach. E.g. interviewing my students or my employees or shoppers at a local mall, If the group or the location was chosen because it was a convenient this would be a convenience sample.
- **Note**: Neither allows generalization to the population.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Non-probability Sample Surveys

- Surveys that are not based on probability sampling have no way of measuring their bias or sampling error.

- Surveys based on non-probability samples are not externally valid. You cannot generalize from them to the general population. They can only be said to be representative of the people that have actually completed the survey.

Non-Probability Samples

- The relationship between the target population and the survey sample is immeasurable and potential bias is unknowable.
- Sophisticated users of non-probability survey samples tend to view the survey as an experimental condition, rather than a tool for population measurement
- Analysts examine the results for internally consistent relationships.

Examples Of Non-Probability Samples

- **Judgment Samples:** A researcher decides which population members to include in the sample based on his or her judgment. The researcher may provide some alternative justification for the representativeness of the sample.
- **Snowball Samples:** Often used when a target population is rare, members of the target population recruit other members of the population for the survey.

Examples Of Non-Probability Samples

- **Quota Samples:** The sample is designed to include a designated number of people with certain specified characteristics. For example, 100 coffee drinkers. This type of sampling is common in non-probability market research surveys.
- **Convenience Samples:** The sample is composed of whatever persons can be most easily accessed to fill out the survey.

Random Samples

Probability Samples are representative

- The key benefit of all these probability sampling methods is that they guarantee that the sample chosen is representative of the population. This ensures that the statistical conclusions will be valid.

Hence the conclusions are generalizable

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Simple Random sampling

- The population consists of N objects.
- The sample consists of n objects.
- If all possible samples of n objects are equally likely to occur, the sampling method is called simple random sampling.

- Selection is done by a lottery method or using a table of random number or a computerized random number generator.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Stratified Sampling

- Stratified sampling. The population is divided into groups, based on some characteristic.
- The groups are called strata.
- Then, within each group, a probability sample (often a simple random sample) is selected.

- As a example, suppose we conduct a national survey. We might divide the population into groups or strata, based on geography - north, east, south, and west. Then, within each stratum, we might randomly select survey respondents.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Cluster sampling

- **Cluster sampling.** With cluster sampling, every member of the population is assigned to one, and only one, group. Each group is called a cluster.
- A sample of clusters is chosen, using a probability method (often simple random sampling).
- Only individuals within sampled clusters are surveyed.
- E.g. select a sample of BA units, survey all the staff in these units.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Multistage sampling.

- **Multistage sampling.** With multistage sampling, we select a sample by using combinations of different sampling methods.

- For example, in Stage 1, we might use cluster sampling to choose clusters from a population. Then, in Stage 2, we might use simple random sampling to select a subset of elements from each chosen cluster for the final sample.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Systematic random sampling.

- **Systematic random sampling. With systematic random sampling, we create a list of every member of the population. From the list, we randomly select the first sample element from the first k elements on the population list. Thereafter, we select every kth element on the list.**

- **This method is different from simple random sampling since every possible sample of n elements is not equally likely.**

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

How to select a probability sample

Probability Sampling

- A probability-based survey sample is created by constructing a list of the target population, called the sample frame, a randomized process for selecting units from the sample frame, called a selection procedure, and a method of contacting selected units to and enabling them complete the survey, called a data collection method or mode.

Probability Sampling: Step 1

- **Construct a Sample frame: A probability-based survey sample is created by constructing a list of the target population, called the sample frame.**

- **For some target populations this process may be easy, for example, sampling the employees of a company by using payroll list.**

- **However, in large, disorganized populations simply constructing a suitable sample frame is often a complex and expensive task.**

Probability Sampling: Step 2

- **Selecting a sample from within the Sample frame:**
- **a randomized process for selecting units from the sample frame, called a selection procedure.**

- **Common methods of conducting a probability sample of the household population in the United States are Area Probability Sampling, Random Digit Dial telephone sampling, and more recently Address-Based Sampling.**

Specialized Techniques Of Probability Sampling

- Within probability sampling there are specialized techniques such as:
  - stratified sampling &
  - cluster sampling
- These techniques improve the precision or efficiency of the sampling process without altering the fundamental principles of probability sampling.

Probability Sampling: Step 3

- **Collecting the Data:**
- **There must be a method of contacting selected units to and enabling them complete the survey, called a data collection method or mode.**

Major Types of Bias In Surveys

- Non-response bias
- Coverage bias
- Selection bias

But how you select your sample is only one of the issues in doing survey research

Bias Due to Measurement Error

- In survey research, the measurement process includes the environment in which the survey is conducted, the way that questions are asked, and the state of the survey respondent.

- Response bias refers to the bias that results from problems in the measurement process. Some examples of response bias:

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Examples of Response Bias

(Due to error in the Measurement process)

- Leading questions. The wording of the question may be loaded in some way to unduly favor one response over another. For example, a satisfaction survey may ask the respondent to indicate where she is satisfied, dissatisfied, or very dissatisfied.
- By giving the respondent one response option to express satisfaction and two response options to express dissatisfaction, this survey question is biased toward getting a dissatisfied response.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Examples of Response Bias – Cont'd

(Due to error in the Measurement process)

- **Social desirability. Most people like to present themselves in a favorable light, so they will be reluctant to admit to unsavory attitudes or illegal activities in a survey, particularly if survey results are not confidential. Instead, their responses may be biased toward what they believe is socially desirable.**

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Sampling Statistic and Sampling Error

- A survey produces a sample statistic, which is used to estimate a population parameter. If you repeated a survey many times, using different samples each time, you might get a different sample statistic with each replication. And each of the different sample statistics would be an estimate for the same population parameter.

- If the statistic is unbiased, the average of all the statistics from all possible samples will equal the true population parameter; even though any individual statistic may differ from the population parameter. The variability among statistics from different samples is called sampling error.

Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

Increasing The Sample size: Reduces Sampling Error but NOT Survey Bias

- Increasing the sample size tends to reduce the sampling error; that is, it makes the sample statistic less variable. However, increasing sample size does not affect survey bias.

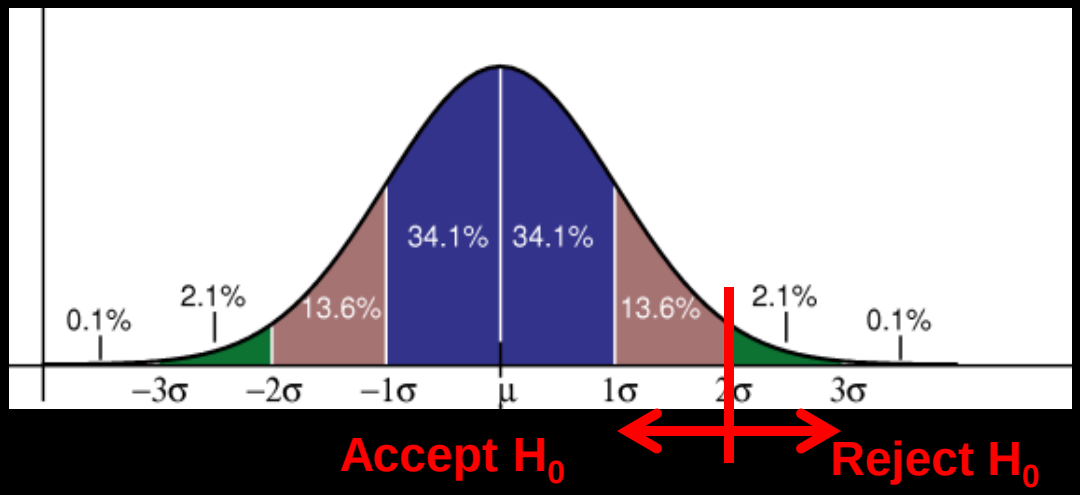
- A large sample size cannot correct for the methodological problems (undercoverage, nonresponse bias, etc.) that produce survey bias.

- Example: The Literary Digest Survey sample size was very large - over 2 million surveys were completed; but the large sample size could not overcome problems with the sample - undercoverage and nonresponse bias.

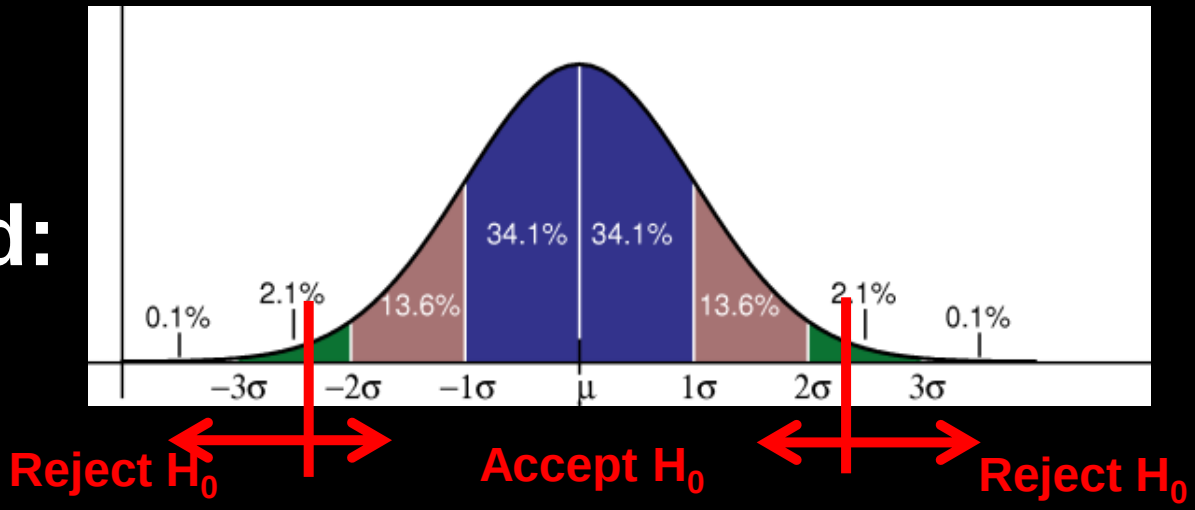
Source: http://stattrek.com/statistics/data-collection-methods.aspx?Tutorial=AP

One-tailed or Two-tailed Tests

- **One-Tailed :**



- **Two Tailed:**



Usually:

No directionality: use two-tailed test

Directionality: use one-tailed test

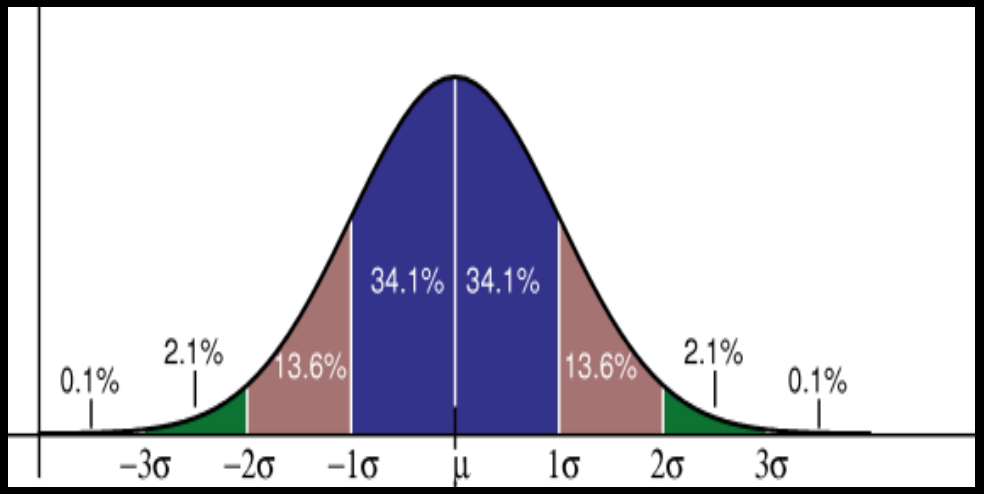
Type I & Type II Error

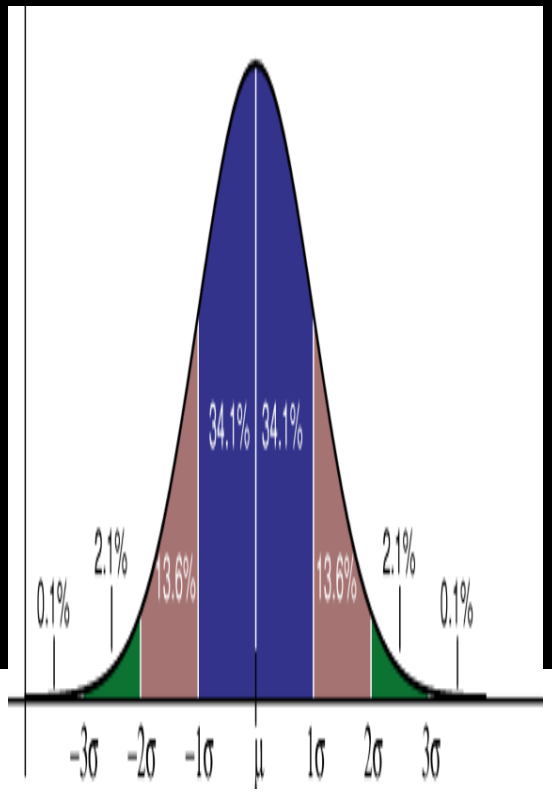
Types of Statistical Errors

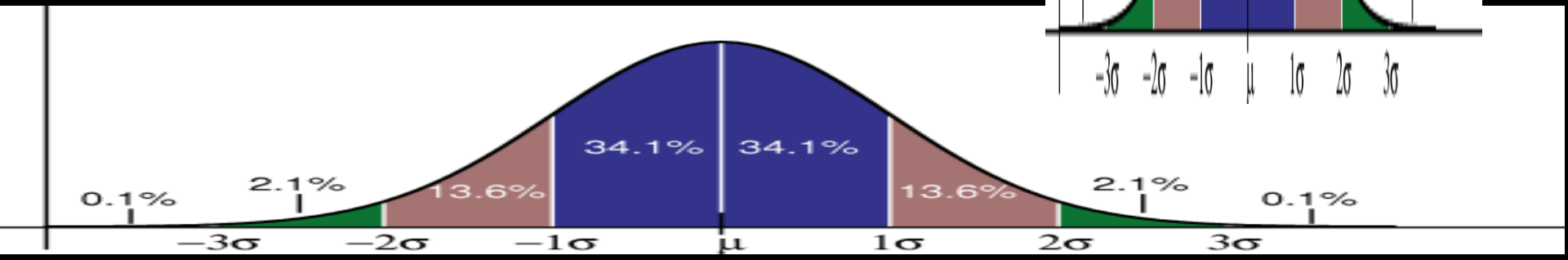
		H_0 is actually:	
		True	***False***
Test	reject H_0	Type I error	correct
Decision	accept H_0	correct	Type II error

Source: Statistics, Cliffs Quick Review, Wiley, NY, 2001

The standard deviation defines how "spread out" the distribution is:







Outline

1. Science, Method & Measurement
2. On Building An Index
3. Correlation & Causality
4. Probability & Statistics
5. Samples & Surveys
6. **Experimental & Quasi-experimental Designs**
7. Conceptual Models
8. Quantitative Models
9. Complexity & Chaos
10. Recapitulation - Envoi

Internal & External Validity

- **Internal Validity question:** Is the data I have collected interpretable? Can I say what I want to say about this data and my statement would be valid?
- **External Validity question:** Are these (valid) findings generalizable beyond this experiment? To what populations, settings, treatments, and measurable variables can the recorded effect be generalized?

So what affects
Internal Validity?

Internal Sources of Invalidity

- History
- Maturation
- Testing
- Instrumentation
- Regression
- Selection
- Mortality
- Interaction of selection and others

Source: Donald Campbell and Julian Stanley, *Experimental and quasi-experimental designs for Research*, Wadsworth Publishing; 1 edition (July 13, 1963)

And what affects
External Validity?

External Sources of Invalidity

- Interaction of Testing and X
- Interaction of selection and X
- Reactive arrangements
- Multiple X interference

Source: Donald Campbell and Julian Stanley, *Experimental and quasi-experimental designs for Research*, Wadsworth Publishing; 1 edition (July 13, 1963)

TABLE 1

SOURCES OF INVALIDITY FOR DESIGNS 1 THROUGH 6

	Sources of Invalidity											
	Internal								External			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of Selection and Maturation, etc.	Interaction of Testing and X	Interaction of Selection and X	Reactive Arrangements	Multiple-X Interference
Pre-Experimental Designs:												
1. One-Shot Case Study *X O*	−	−				−	−			−		
2. One-Group Pretest-Posttest Design *O X O*	−	−	−	−	?	+	+	−	−	−	?	
3. Static-Group Comparison *X O* --------- *O*	+	?	+	+	+	−	−	−		−		
True Experimental Designs:												
4. Pretest-Posttest Control Group Design *R O X O* *R O O*	+	+	+	+	+	+	+	+	−	?	?	
5. Solomon Four-Group Design *R O X O* *R O O* *R X O* *R O*	+	+	+	+	+	+	+	+	+	?	?	
6. Posttest-Only Control Group Design *R X O* *R O*	+	+	+	+	+	+	+	+	+	?	?	

Note: In the tables, a minus indicates a definite weakness, a plus indicates that the factor is controlled, a question mark indicates a possible source of concern, and a blank indicates that the factor is not relevant.

It is with extreme reluctance that these summary tables are presented because they are apt to be "too helpful," and to be depended upon in place of the more complex and qualified presentation in the text. No + or − indicator should be respected unless the reader comprehends why it is placed there. In particular, it is against the spirit of this presentation to create uncomprehended fears of, or confidence in, specific designs.

TABLE 2

SOURCES OF INVALIDITY FOR QUASI-EXPERIMENTAL DESIGNS 7 THROUGH 12

	Sources of Invalidity											
	Internal								External			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of Selection and Maturation, etc.	Interaction of Testing and X	Interaction of Selection and X	Reactive Arrangements	Multiple-X Interference
Quasi-Experimental Designs:												
7. Time Series *O O O OXO O O O*	−	+	+	?	+	+	+	+	−	?	?	
8. Equivalent Time Samples Design X_1O X_0O X_1O X_0O, etc.	+	+	+	+	+	+	+	+	−	?	−	−
9. Equivalent Materials Samples Design M_aX_1O M_bX_0O M_cX_1O M_dX_0O, etc.	+	+	+	+	+	+	+	+	−	?	?	−
10. Nonequivalent Control Group Design *O X O* *O O*	+	+	+	+	?	+	+	−	−	?	?	
11. Counterbalanced Designs X_1O X_2O X_3O X_4O X_2O X_4O X_1O X_3O X_3O X_1O X_4O X_2O X_4O X_3O X_2O X_1O	+	+	+	+	+	+	+	?	?	?	?	−
12. Separate-Sample Pretest-Posttest Design *R O (X)* *R X O*	−	−	+	?	+	+	−	−	+	+	+	
12*a*. *R O (X)* *R X O* *R O (X)* *R X O*	+	−	+	?	+	+	−	+	+	+	+	
12*b*. *R* O_1 *(X)* *R* O_2 *(X)* *R X* O_3	−	+	+	?	+	+	−	?	+	+	+	
12*c*. *R* O_1 *X* O_2 *R X* O_3	−	−	+	?	+	+	+	−	+	+	+	

TABLE 3
SOURCES OF INVALIDITY FOR QUASI-EXPERIMENTAL DESIGNS 13 THROUGH 16

	Sources of Invalidity											
	Internal								External			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of Selection and Maturation, etc.	Interaction of Testing and X	Interaction of Selection and X	Reactive Arrangements	Multiple-X Interference
Quasi-Experimental Designs Continued:												
13. Separate-Sample Pretest-Posttest Control Group Design R O (X) R X O R O R O	+	+	+	+	+	+	+	−	+	+	+	
13a. R O (X) R X O R′ R O (X) R X O R O (X) R X O R′ R O R O R′ R O R O R O R O	+	+	+	+	+	+	+	+	+	+	+	
14. Multiple Time-Series O O OXO O O O O O O O O	+	+	+	+	+	+	+	+	−	−	?	
15. Institutional Cycle Design Class A X O_1 Class B_1 RO_2 X O_3 Class B_2 R X O_4 Class C O_5 X [a]Gen. Pop. Con. Cl. B O_6 [a]Gen. Pop. Con. Cl. C O_7												
$O_2 < O_1$, $O_5 < O_4$	+	−	+	+	?	−	?		+	?	+	
$O_2 < O_3$	−	−	−	?	?	+	+		−	?	+	
$O_2 < O_4$	−	−	+	?	?	+	?		+	?	?	
$O_6 = O_7$, $O_{2y} = O_{2o}$		+						−				
16. Regression Discontinuity	+	+	+	?	+	+	?	+	+	−	+	+

1. One Shot Case Study

X O

2. One-Group Pretest-Posttest Design

O X O

This is a really BAD design

- Internal invalidity that can explain $O_1 – O_2$ difference:
  - History: many other things could have happened between O_1 & O_2 . In social science you cannot have experimental isolation as in the natural sciences labs.
  - Maturation: between O_1 & O_2 students could have grown older, hungrier, more tired, etc.
  - Testing: that is the effect is the effect of the pretest O_1 not the treatment X
  - Instrumentation (decay) The observers themselves can get tired, etc. accounting for a part if not all of the $O_1 – O_2$ change

Further problems with design 2

- Again applies only to the group being tested (no generalizability), plus

There is also regression towards the mean…

Regression towards the mean

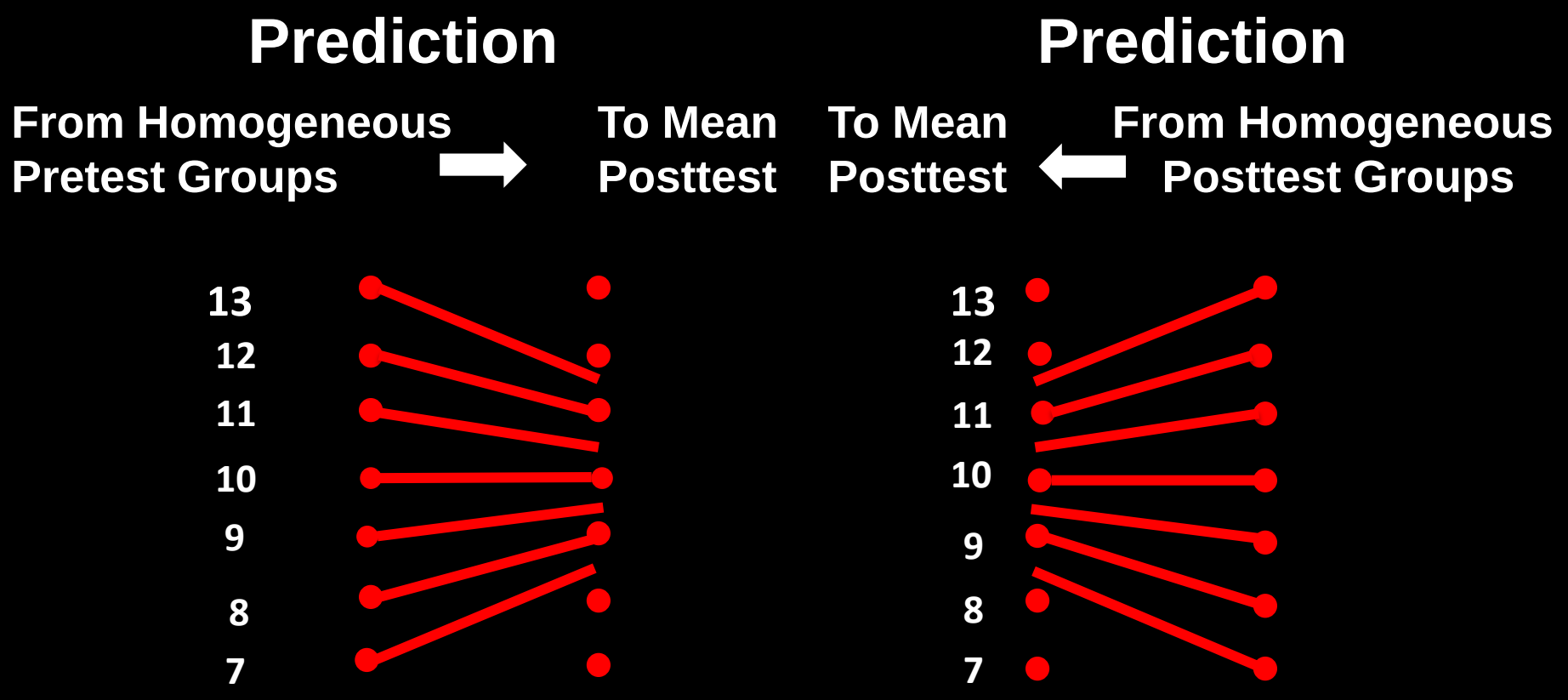


Fig. 1*b*. **Fig. 1*c*.**

Fig. 1. Regression in the Prediction of Posttest Scores from Pretest, and Vice Versa

3. Static group Comparison

X O

O

4. Pretest-Posttest Control Group Design

R	O	X	O
R	O		O

5. Solomon Four-Group Design

R	O_1	X	O_2
R	O_3		O_4
R		X	O_5
R			O_6

6. Posttest-Only Control Group Design

R	X	O
R		O

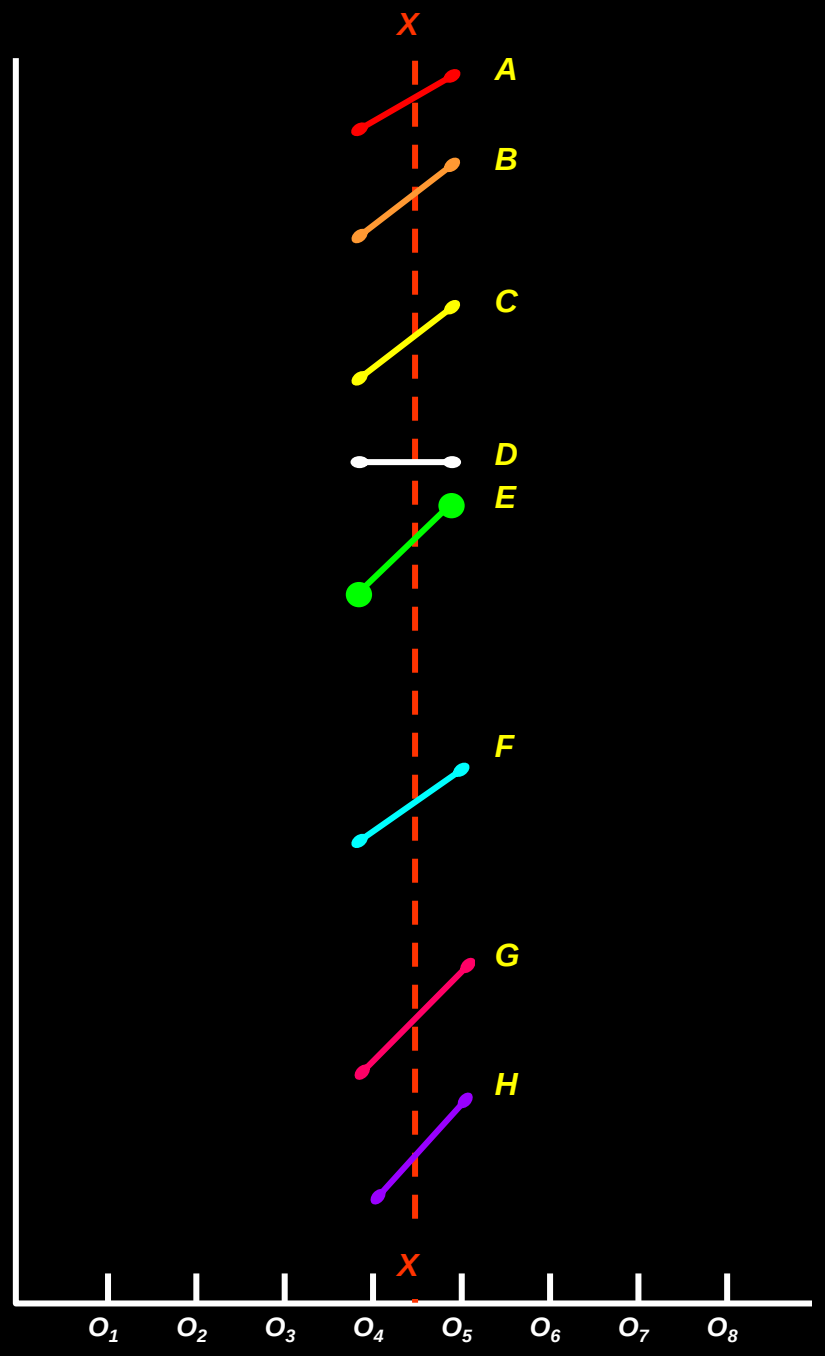
7. Time Series

O O O O X O O O O

Introduction of an experimental variable at point X into a time series of measurements, O_1 – O_8

Some possible outcome patterns

- Except for D , which is flat, the gain O_4 – O_5 is the same in all the time series

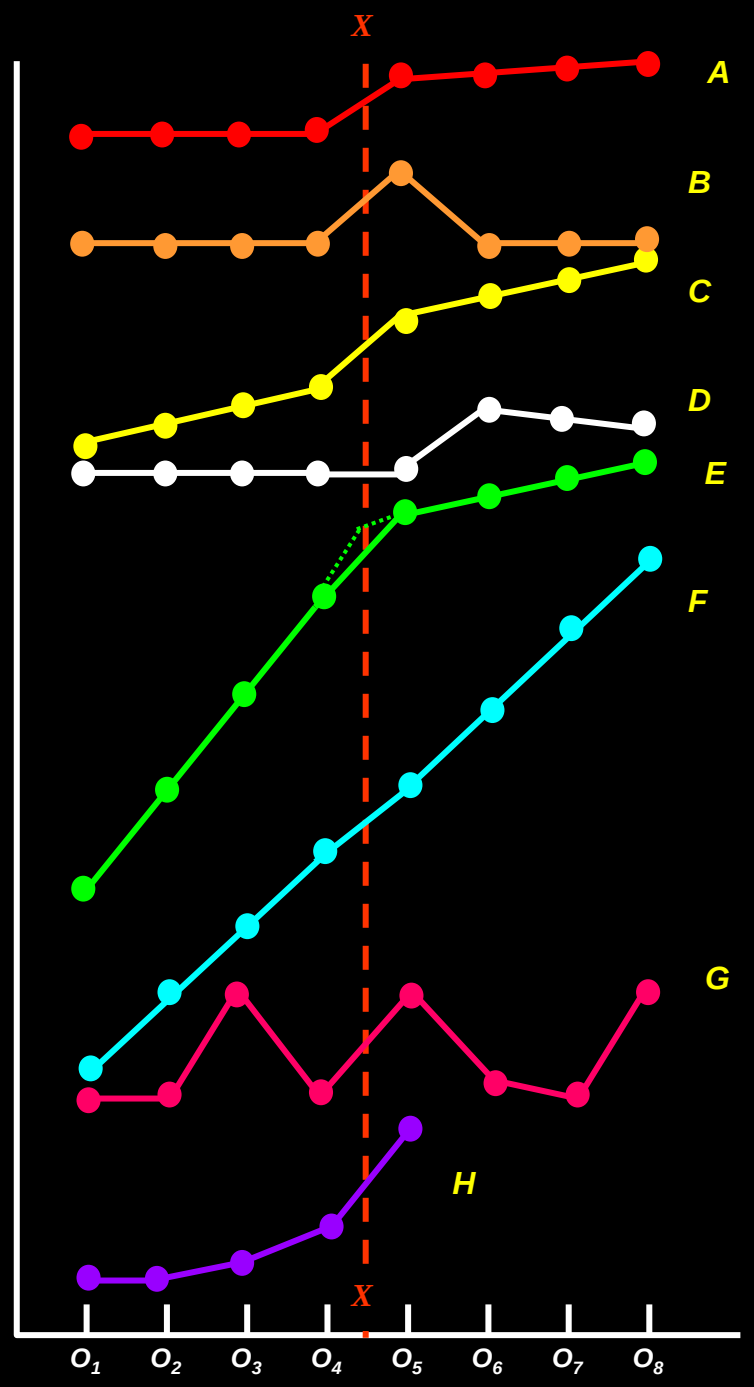


Source: Donald Campbell and Julian Stanley, *Experimental and quasi-experimental designs for Research*, Wadsworth Publishing; 1 edition (July 13, 1963)

Introduction of an experimental variable at point X into a time series of measurements, O_1 – O_8

Some possible outcome patterns

- Now Add Context:
- The legitimacy of inferring an effect varies widely:
  - Strongest in A and B
  - Possible in C, D and E
  - Totally unjustified in F, G and H.



Source: Donald Campbell and Julian Stanley, *Experimental and quasi-experimental designs for Research*, Wadsworth Publishing; 1 edition (July 13, 1963)

8. Equivalent Time Samples Design

X_1O X_0O X_1O X_0O, etc.

What is happening here…

- This is repeated testing and observation of a group
- The real test X_1 is introduced intermittently followed by an observation, with other (non) tests X_0 being introduced before other observations
- This can work if the effect of the X is transient
- Example telling students that "this is a test" and then doing it every week, but not telling them which ones of these tests will count for the final grade! Controls factors such as anxiety of respondents (students).

9. Equivalent Materials Samples Design

M_aX_1O M_bX_0O M_cX_1O M_dX_0O, etc.

This design changes some things in the materials used for the test itself in addition to the previous design which is interwoven with it. Internally valid, but again externally not valid

10. Nonequivalent Control Group Design

O X O

O O

Why would we use this design?

- Because you frequently cannot randomize, and have to use equivalent convenience samples, e.g. class rooms in schools or schools in a district, or production units in an institution and test all the people in that class, school or production unit.
- Accordingly, we cannot control interaction of selection and maturation etc.
- Again, external validity (i.e. generalizability) is questionable.

11. Counterbalanced Designs

X_1O X_2O X_3O X_4O

X_2O X_4O X_1O X_3O

X_3O X_1O X_4O X_2O

X_4O X_3O X_2O X_1O

Why this complicated design?

- To enter each respondent (or respondent group) into each type of treatment once.
- The design is orthogonal (each combination of X_i and O_t occurs once).
- Good for multiple treatment testing.

- PS: the design is also called a Latin-square design.

Orthogonal:
you can change the columns and /or rows in the table(s)

	T_1	T_2	T_3	T_4	X_1	X_2	X_3	X_4
A	X_1O	X_2O	X_3O	X_4O	T_1O	T_2O	T_3O	T_4O
B	X_2O	X_4O	X_1O	X_3O	T_2O	T_4O	T_1O	T_3O
C	X_3O	X_1O	X_4O	X_2O	T_3O	T_1O	T_4O	T_2O
D	X_4O	X_3O	X_2O	X_1O	T_4O	T_3O	T_2O	T_1O

Which of these medicines is most effective?

12. Separate-Sample Pretest-Posttest Design

R	O	(X)	
R		X	O

When to use this Design?

- When the X has to be administered to all, and we cannot control who gets it and who does not, but we want to test for its effect
- Thus we rely on the randomization to establish the representativity of the pre-test and the post-test.
- It is much stronger than Design 2 and should not be confused with it.

12a. Separate-Sample Pretest-Posttest Design

```
R    O    (X)
R         X    O
-------------------------------------
R              O    (X)
R                   X    O
```

12b. Separate-Sample Pretest-Posttest Design

R	O_1		(X)	
R		O_2	(X)	
R			X	O_3

12c. Separate-Sample Pretest-Posttest Design

R	O_1	X	O_2
R		X	O_3

13. Separate-Sample Pretest-Posttest Control Group Design

```
R     O     (X)
R           X    O
-------------------------
R     O
R                O
```

If we can add a control group where X is not given, then we can transform design 12 to Design 13.

```
R′ { R O   (X)
     R      X     O
     ---------------------------
     R O   (X)
     R      X     O
     ---------------------------
     R O   (X)
     R      X     O

R′ { R O
     R            O
     ------------------------
     R O
     R            O
     ------------------------
     R O
     R            O
```

13a. Separate-Sample Pretest-Posttest Control Group Design

14. Multiple Time-Series

O O O X O O O

O O O X O O O

15. Institutional Cycle Design

Class A	X	O_1			
Class B_1	R	O_2	X	O_3	
Class B_2	R		X)		O_4
Class C		R			O_5
X					

$O_2 < O_1$
$O_5 < O_4$
$O_2 < O_3$
$O_2 < O_4$
$O_6 = O_7$
$O_{2y} = O_{2o}$

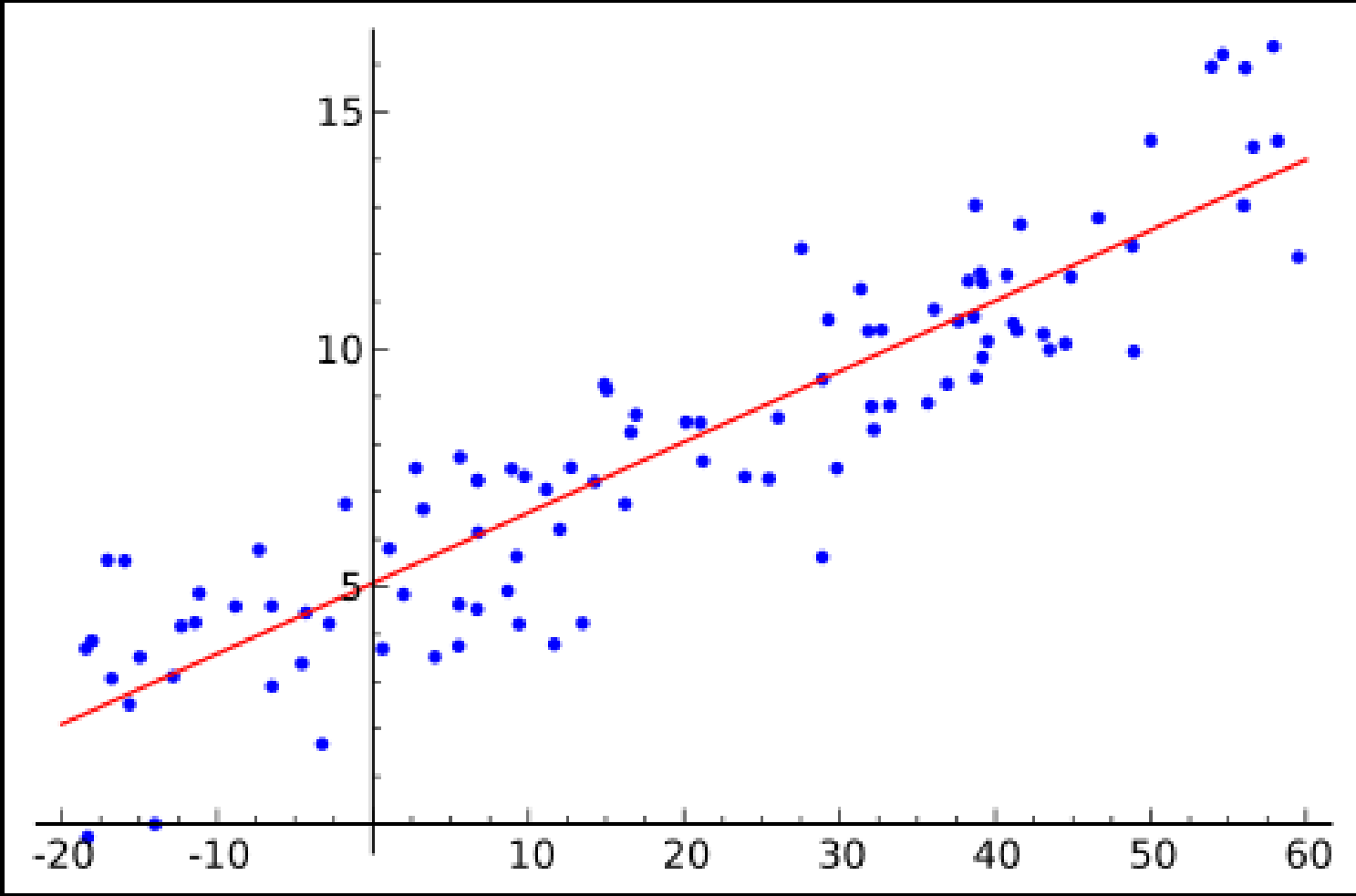
A complicated patch-up ex-post design. Let's just ignore it for now.

A complicated patch-up ex-post design.
Let’s just ignore it for now.

16. Regression

- It is used when experimental studies are impossible and only pre-existing data are available, (usually the case in economics).
- It relates independent variable(s) to a dependent variable and usually assumes causation by the independent variable(s).
- Regression analysis is widely used for prediction and forecasting, and fits in our discussion under quantitative models rather than here.

Typical linear regression



A famous Case Study:
Hormone Replacement Therapy (HRT) and Heart Attacks in Women

Hormone Therapy and Heart Attacks

- In a widely studied example, numerous epidemiological studies showed that women who were taking combined hormone replacement therapy (HRT) also had a lower-than-average incidence of coronary heart disease (CHD), leading doctors to propose that **HRT was protective against CHD**.

Source: Lawlor DA, Davey Smith G, Ebrahim S (June 2004). "Commentary: the hormone replacement-coronary heart disease conundrum: is this the death of observational epidemiology?". Int J Epidemiol 33 (3): 464–7. doi:10.1093/ije/dyh124. PMID 15166201.

So, Should I take HRT as a preventative against Heart Attacks?

BUT….

Hormone Therapy and Heart Attacks

- But randomized controlled trials showed that HRT caused a small but statistically significant increase in risk of CHD.
- So: How come?

Source: Lawlor DA, Davey Smith G, Ebrahim S (June 2004). "Commentary: the hormone replacement-coronary heart disease conundrum: is this the death of observational epidemiology?". Int J Epidemiol 33 (3): 464–7. doi:10.1093/ije/dyh124. PMID 15166201.

Hormone Therapy and Heart Attacks

- Re-analysis of the data from the epidemiological studies showed that women undertaking HRT were more likely to be from higher socio-economic groups.
- These wealthier women also had better than average diet and exercise regimens.
- The use of HRT and decreased incidence of coronary heart disease were coincident effects of a third and separate cause (i.e. the benefits associated with a higher socioeconomic status).
- They were not cause and effect, as had been supposed.

Source: Lawlor DA, Davey Smith G, Ebrahim S (June 2004). "Commentary: the hormone replacement-coronary heart disease conundrum: is this the death of observational epidemiology?". Int J Epidemiol 33 (3): 464–7. doi:10.1093/ije/dyh124. PMID 15166201.

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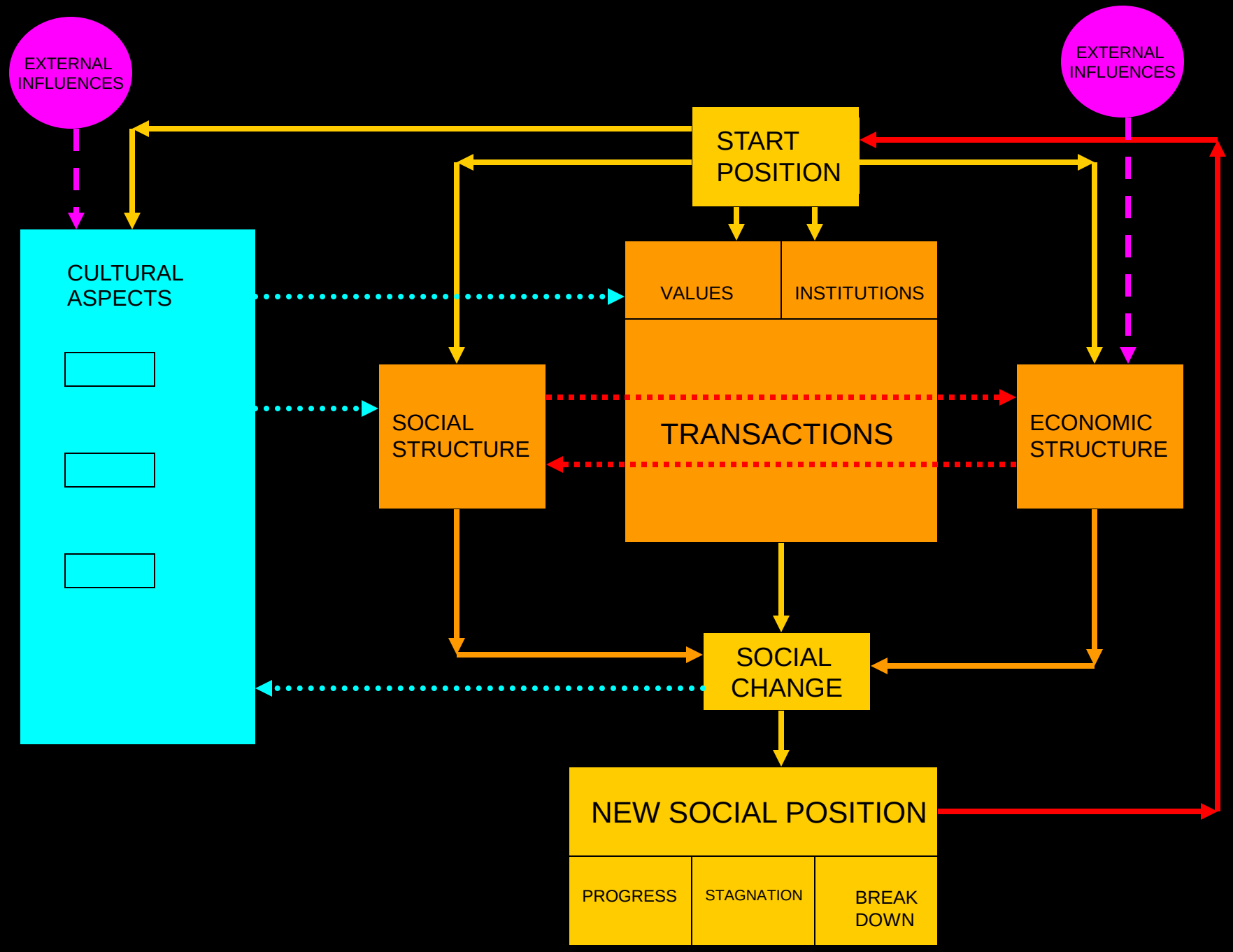
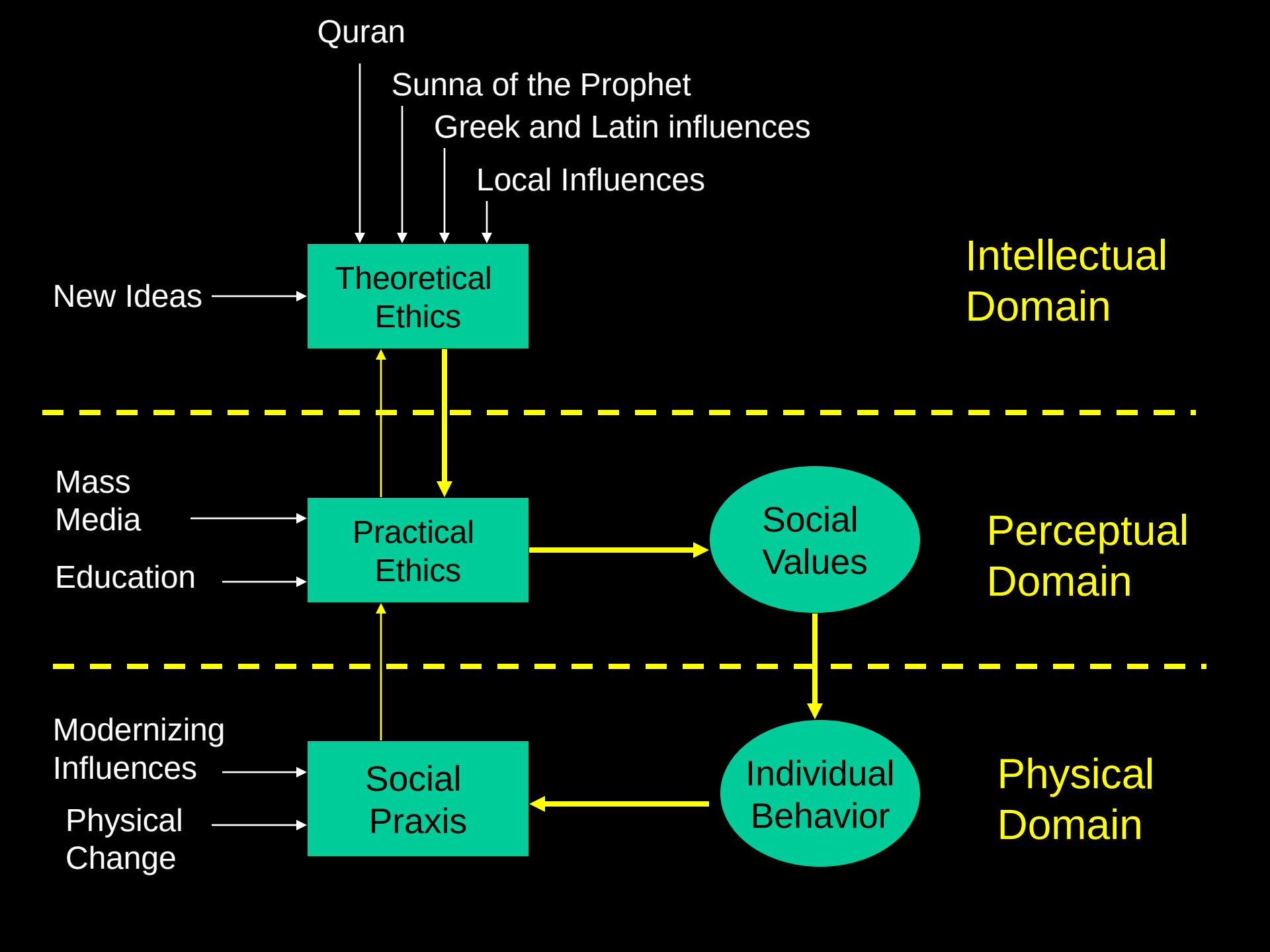
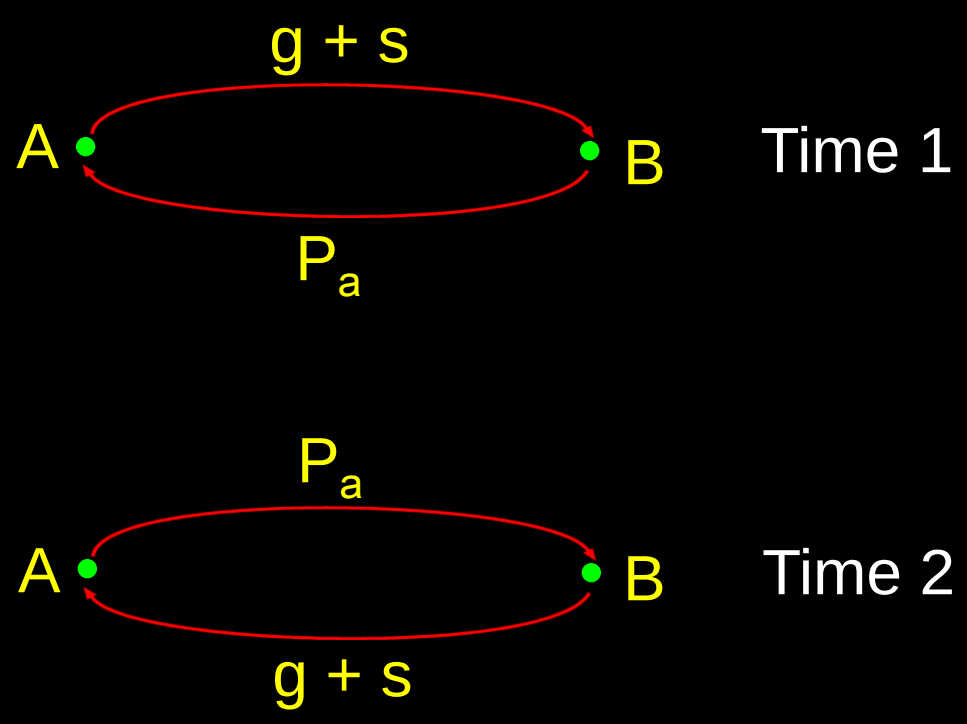
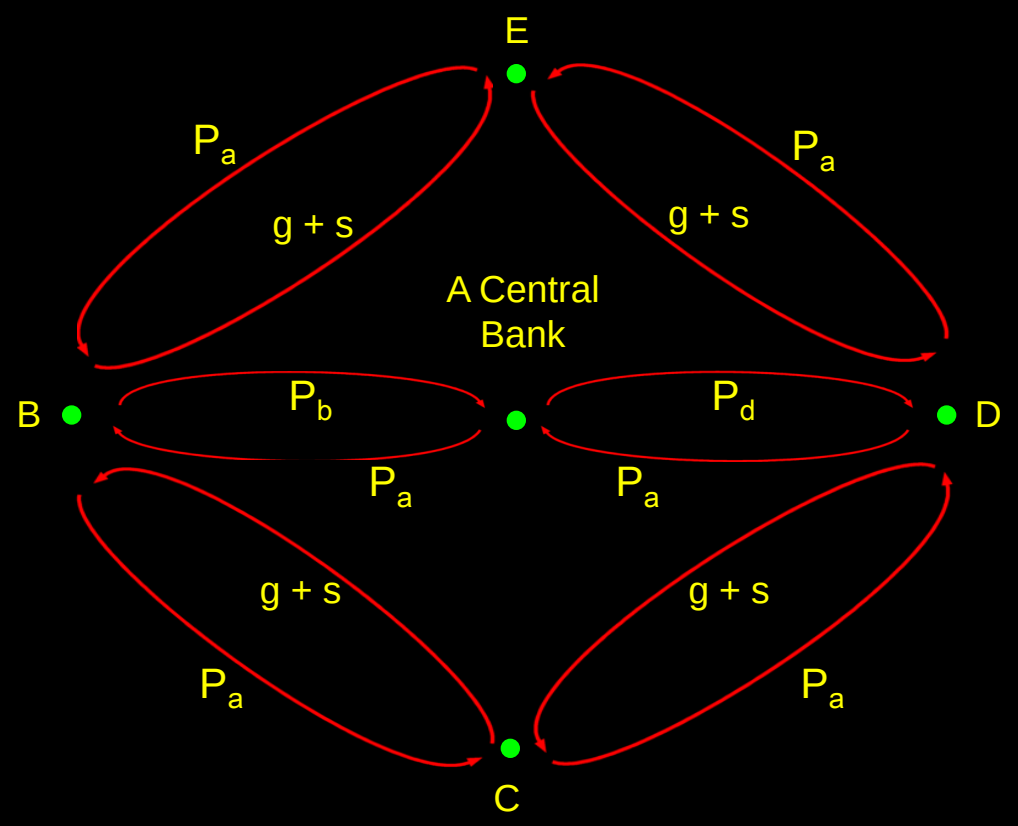

EXTERNAL INFLUENCES
EXTERNAL INFLUENCES
START POSITION
CULTURAL ASPECTS
VALUES
INSTITUTIONS
SOCIAL STRUCTURE
TRANSACTIONS
ECONOMIC STRUCTURE
SOCIAL CHANGE
NEW SOCIAL POSITION
PROGRESS
STAGNATION
BREAK DOWN


Quran
Sunna of the Prophet
Greek and Latin influences
Local Influences
New Ideas
Theoretical Ethics
Intellectual Domain
Mass Media
Education
Practical Ethics
Social Values
Perceptual Domain
Modernizing Influences
Physical Change
Social Praxis
Individual Behavior
Physical Domain

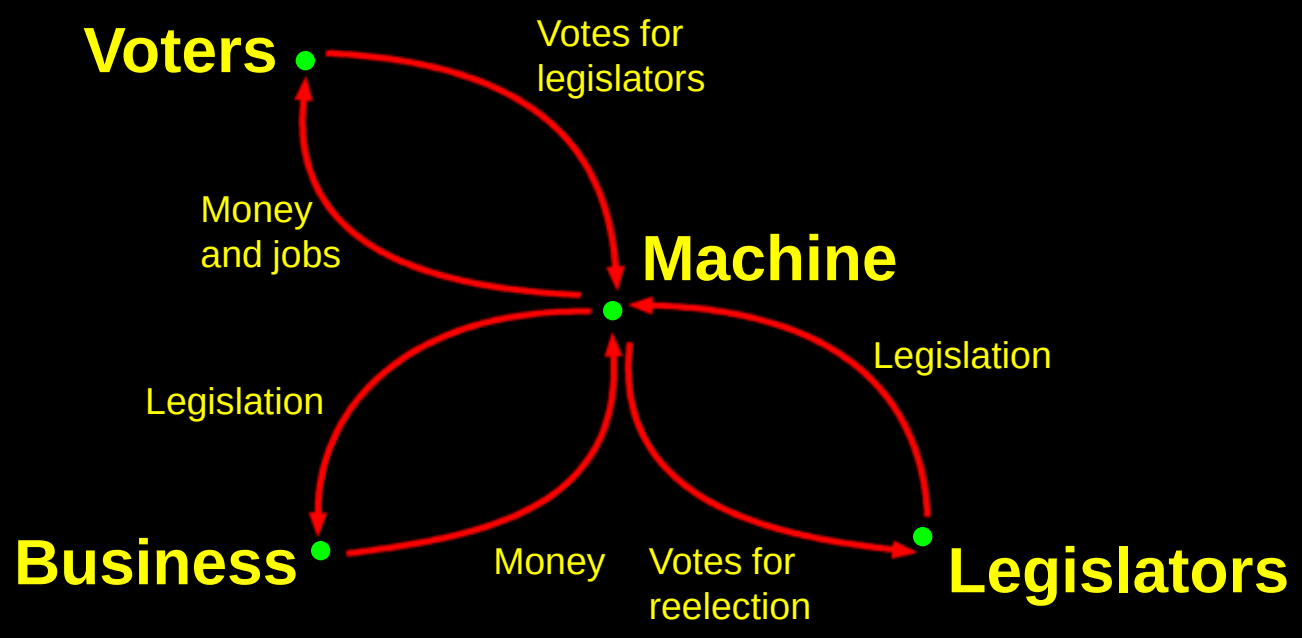
Exchange with Promise to Pay



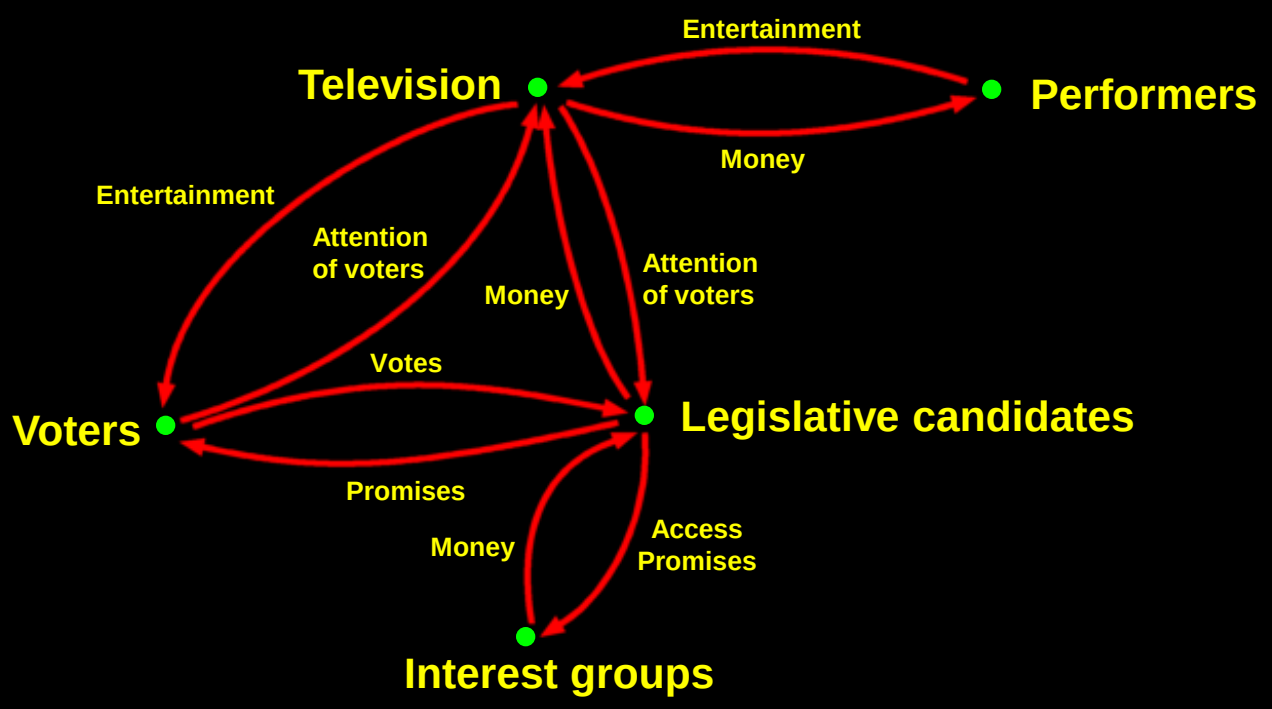
Exchange with promise of a Central Bank



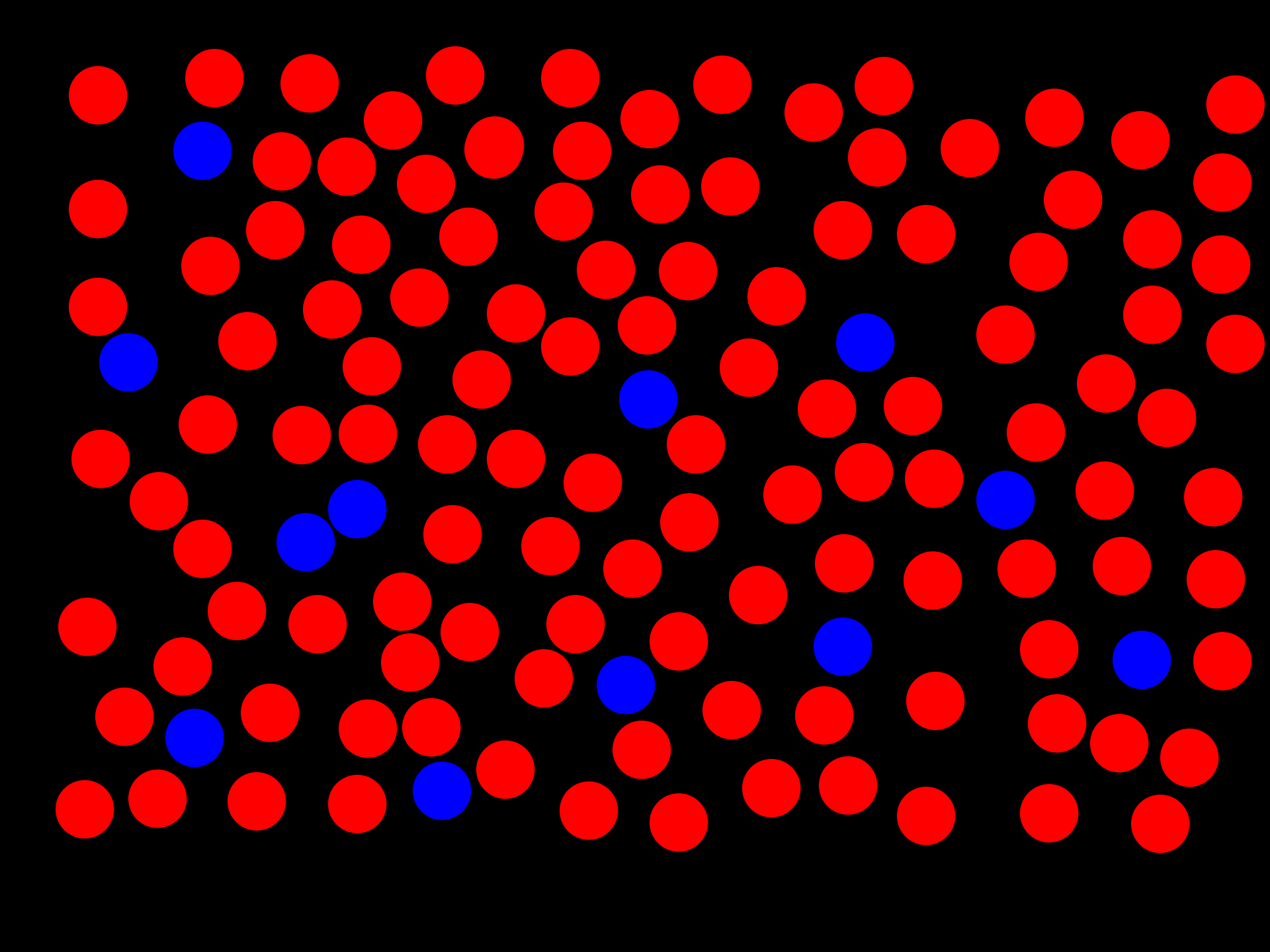
Role of Party Machine in Political Exchange



Transaction involving voters, TV, interest groups and legislative candidates



Cultural Transactions

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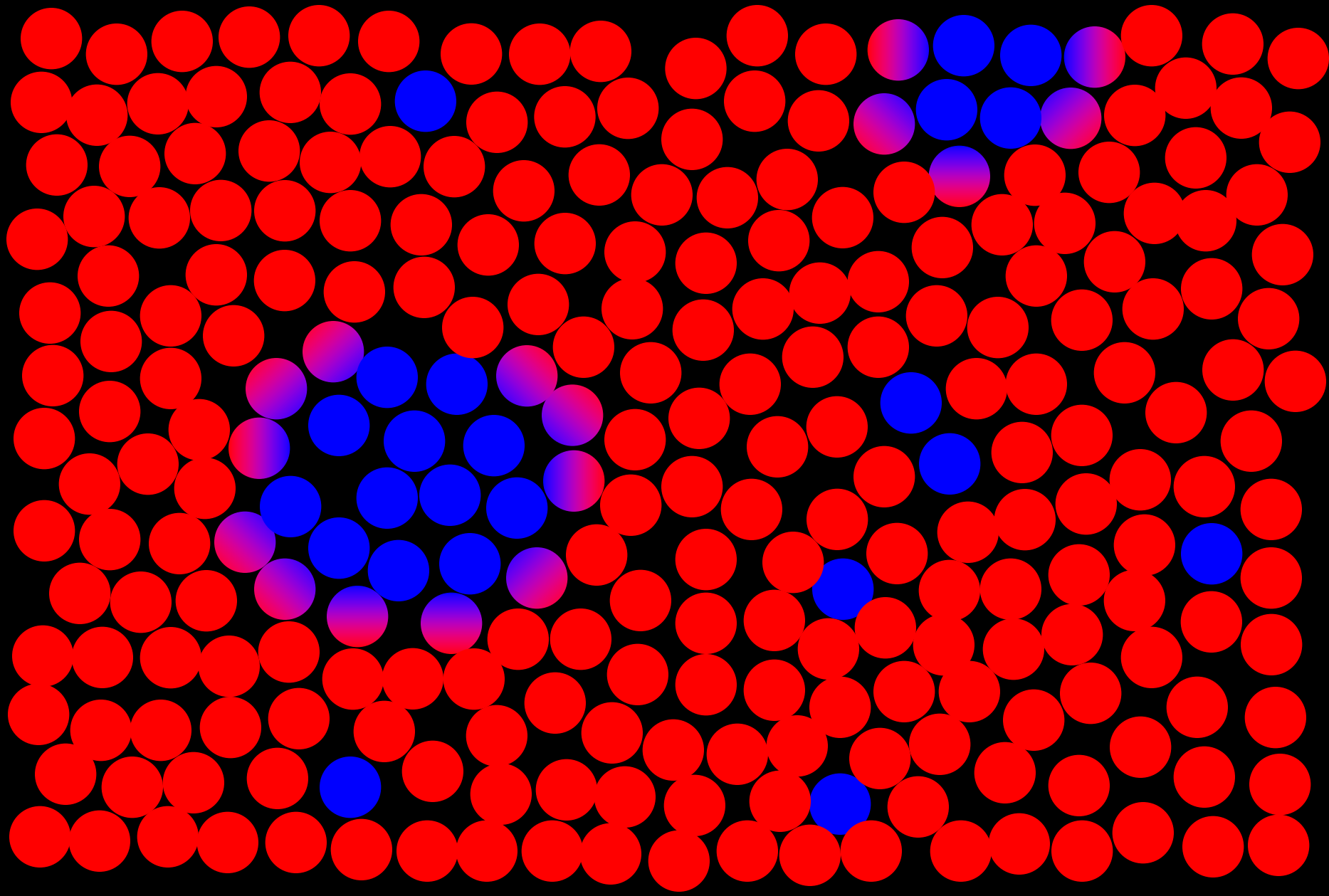


NATIONAL BESTSELLER

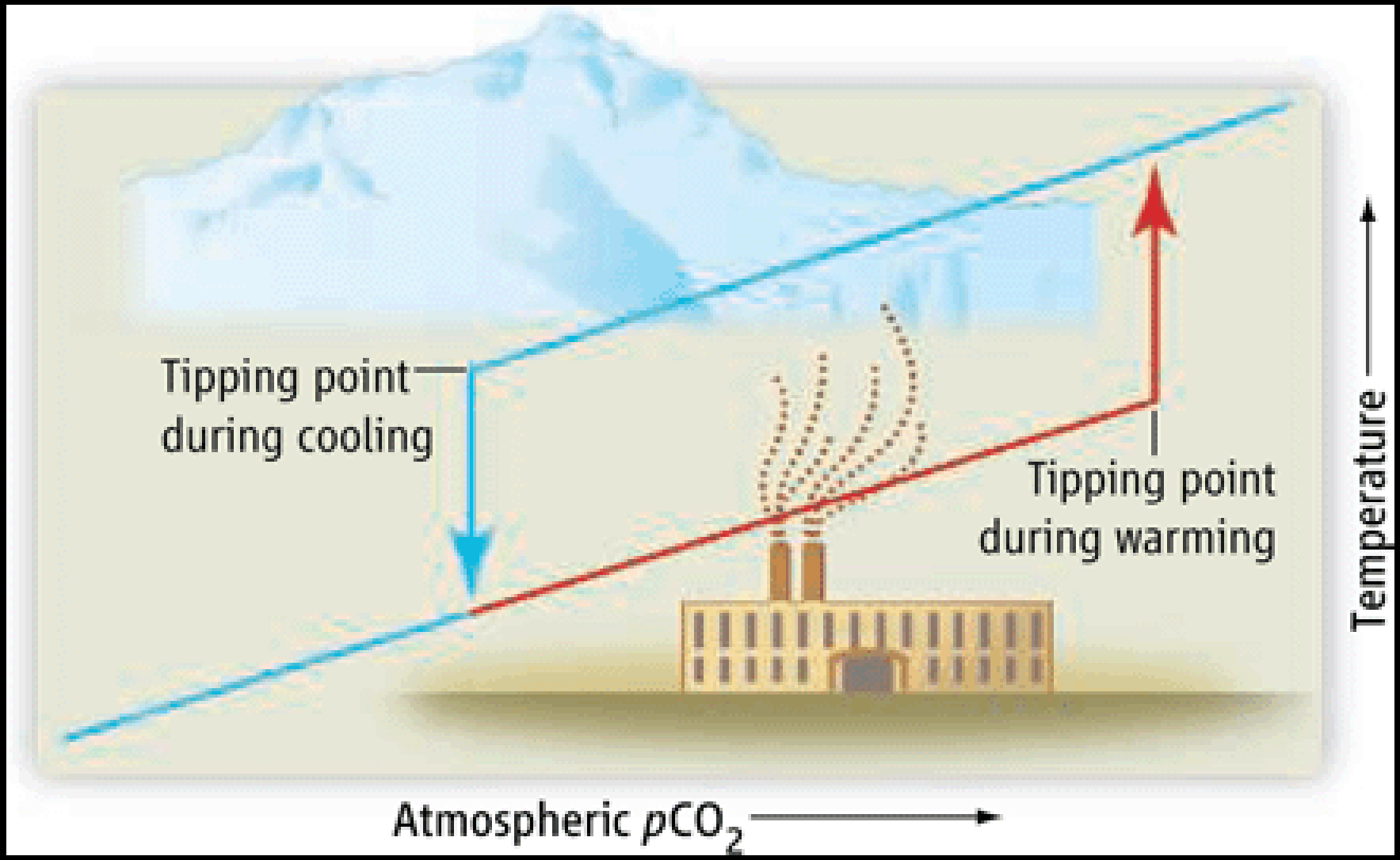
WITH A NEW INTRODUCTION BY THE AUTHOR

The TIPPING POINT

How Little Things Can Make a Big Difference

MALCOLM GLADWELL

"A fascinating book that makes you see the world in a different way." —FORTUNE


Tipping point
during cooling
Tipping point
during warming
Temperature
Atmospheric pCO_2

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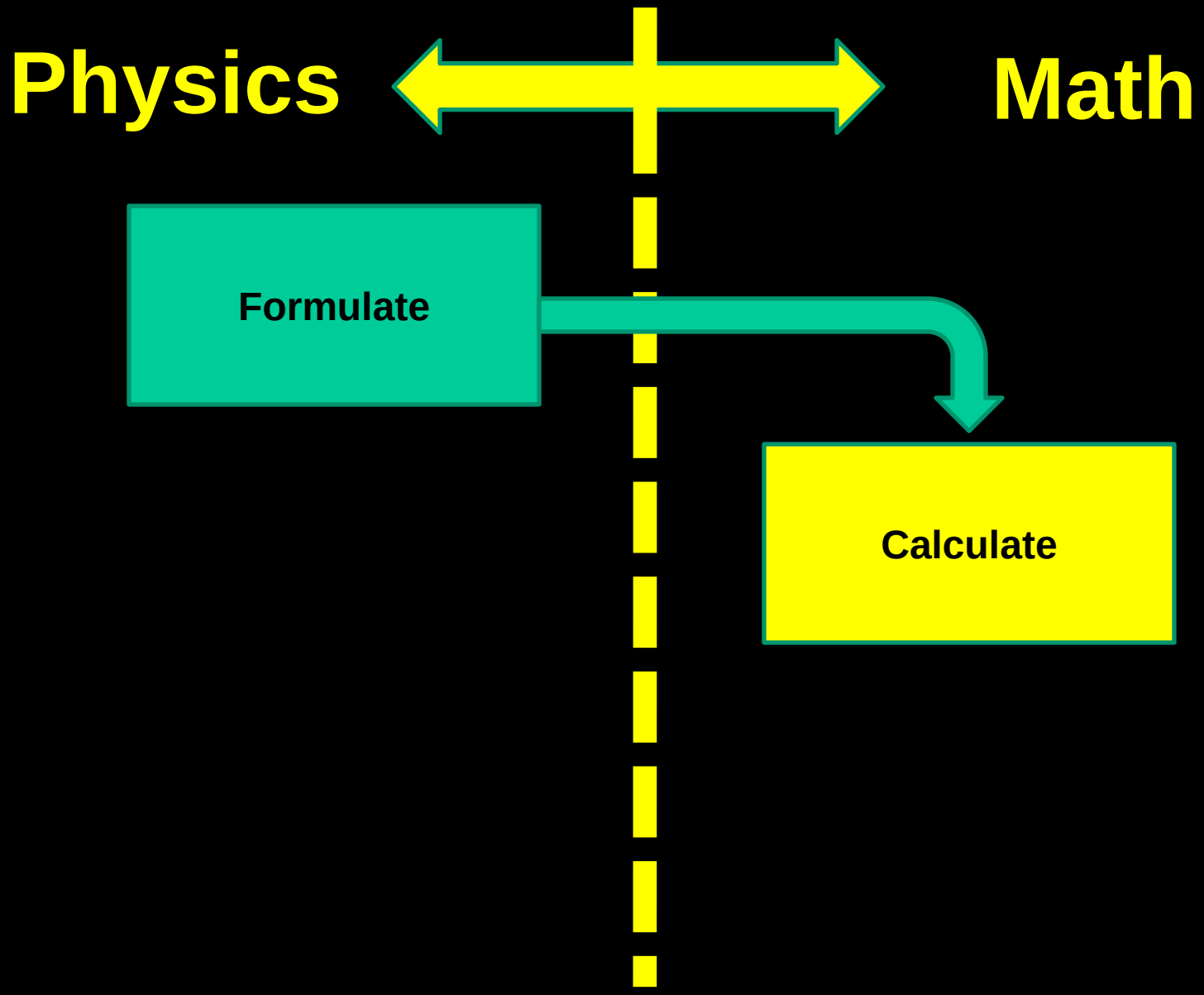
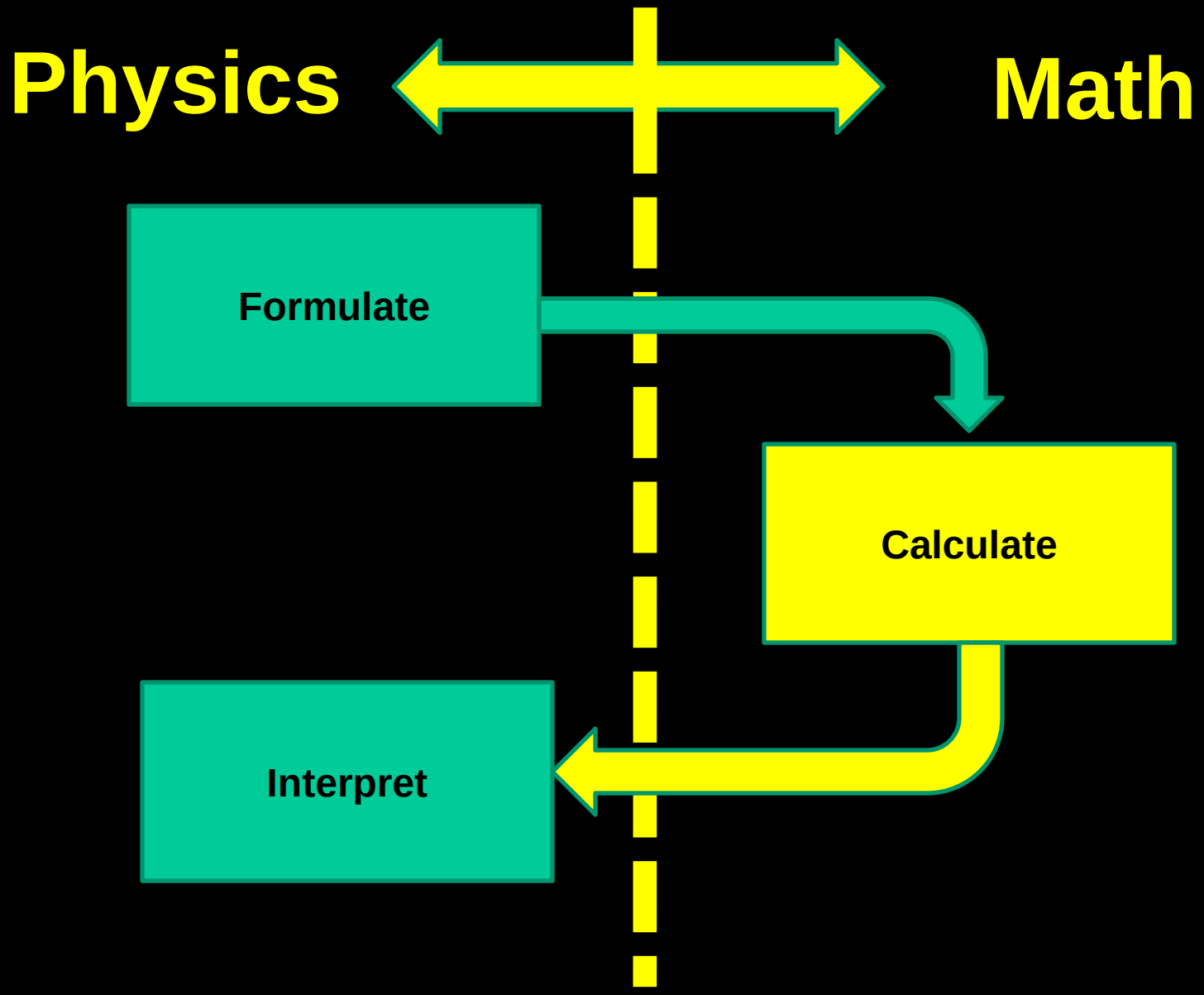
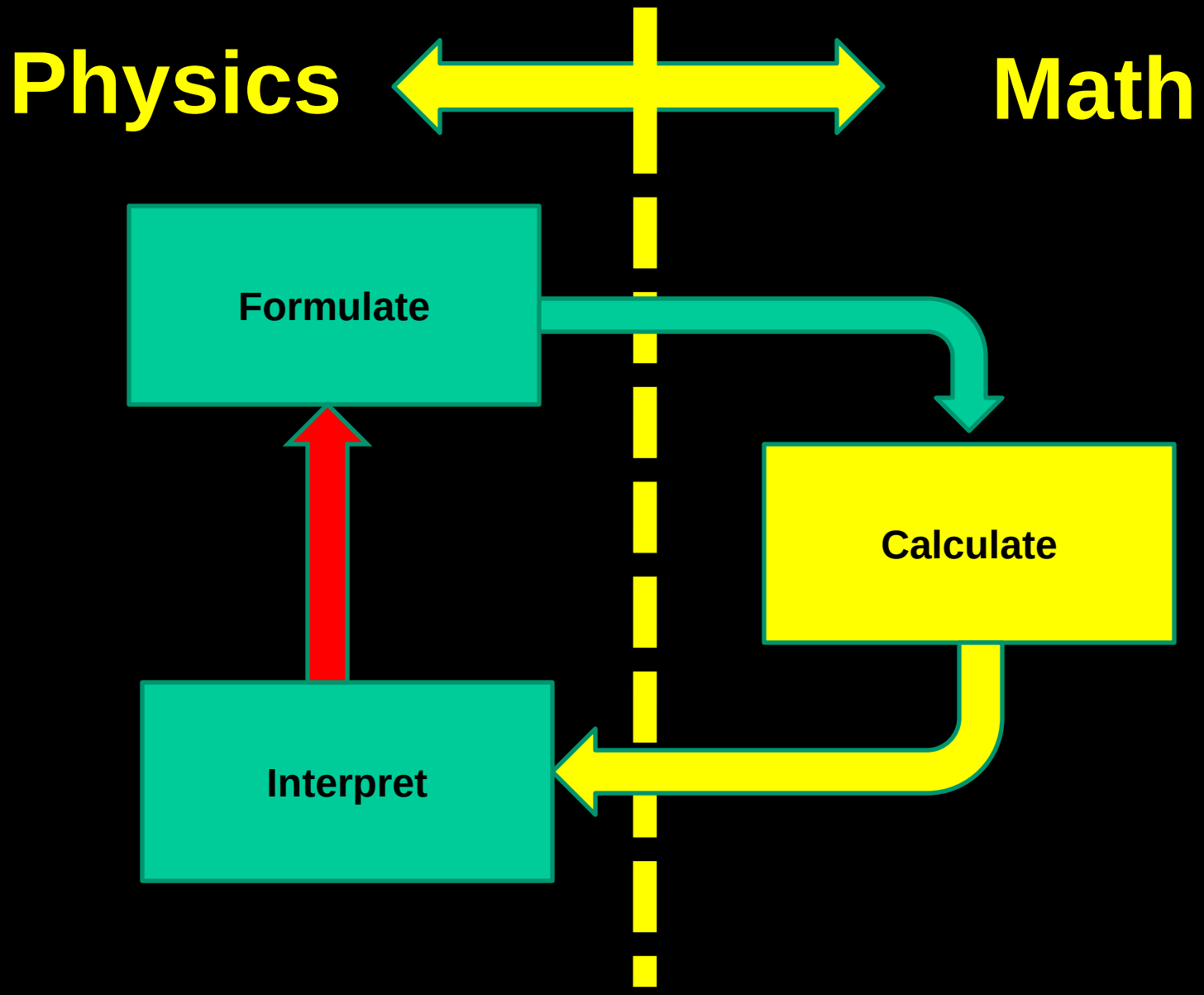

Physics
Math
Formulate
Calculate


Physics
Math
Formulate
Calculate
Interpret


Physics
Math
Formulate
Calculate
Interpret

Example (Cont'd)

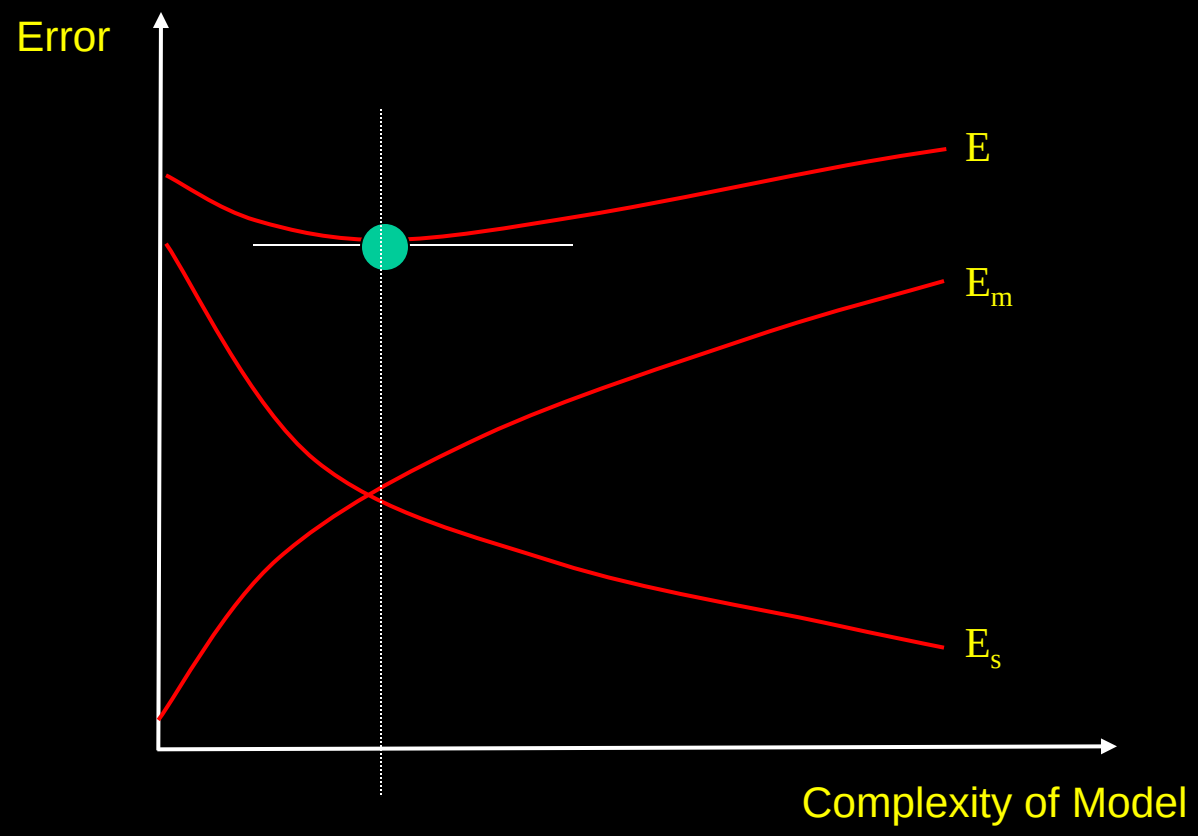
$P_1 = 100 \pm 2$ (error term = 2%)

$P_2 = 102 \pm 2$ (error term = 2%)

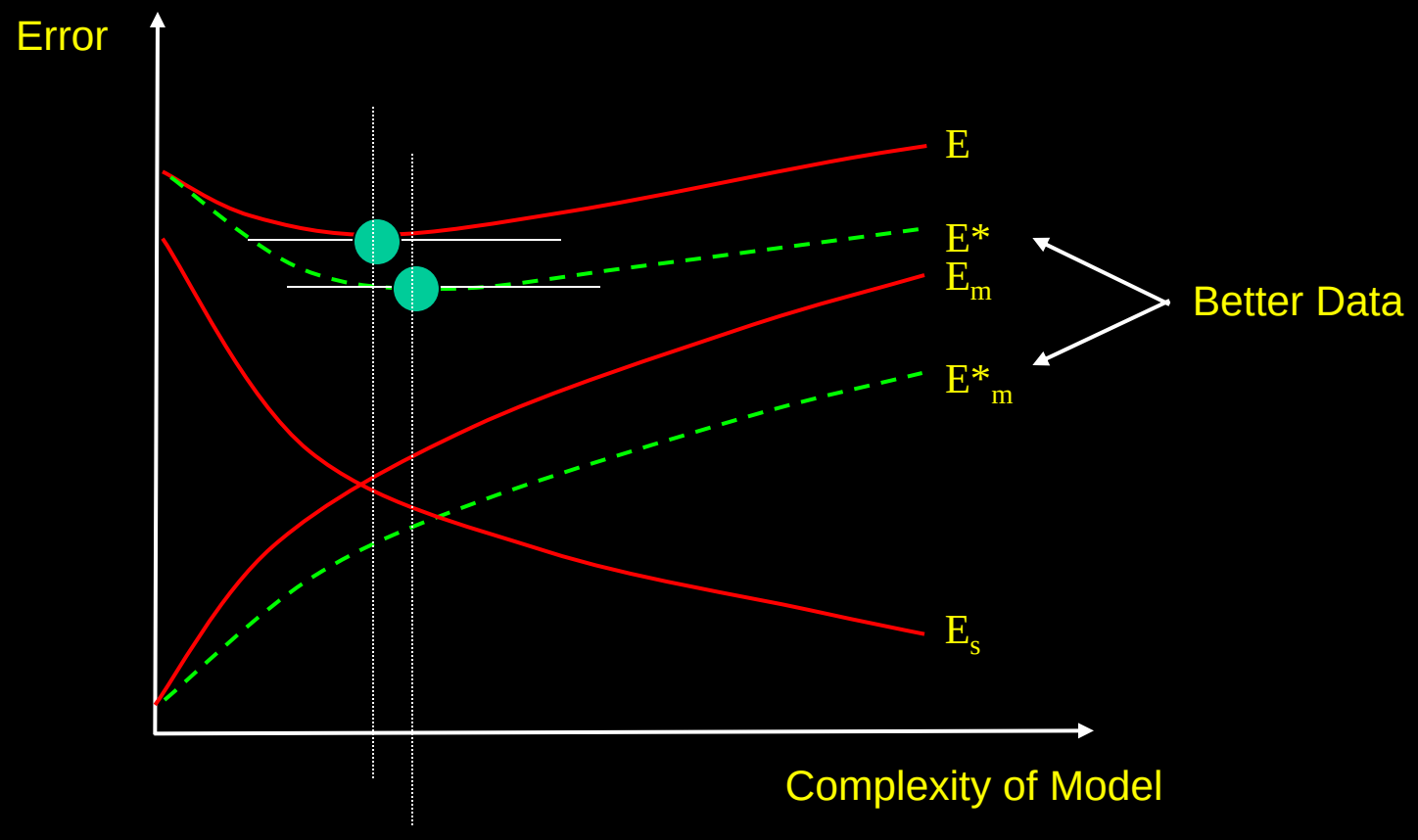
$P_2 + P_1 = 202 \pm 4$ (error term $\approx$ 2%)

$P_2 - P_1 = 2 \pm 2$ (error term $\approx$ 100%)

Errors in Models



Errors in Models



Seven Rules for Building Models

- Avoid inter-correlated variables
- Add whenever possible
- If not possible then multiply or divide
- Avoid subtraction and exponentials
- Avoid models that proceed in chains
- Simpler partial models can be more robust than one complex models
- Always report predictable error (essential for cases of asymmetrical costs)

The steps to building a model:

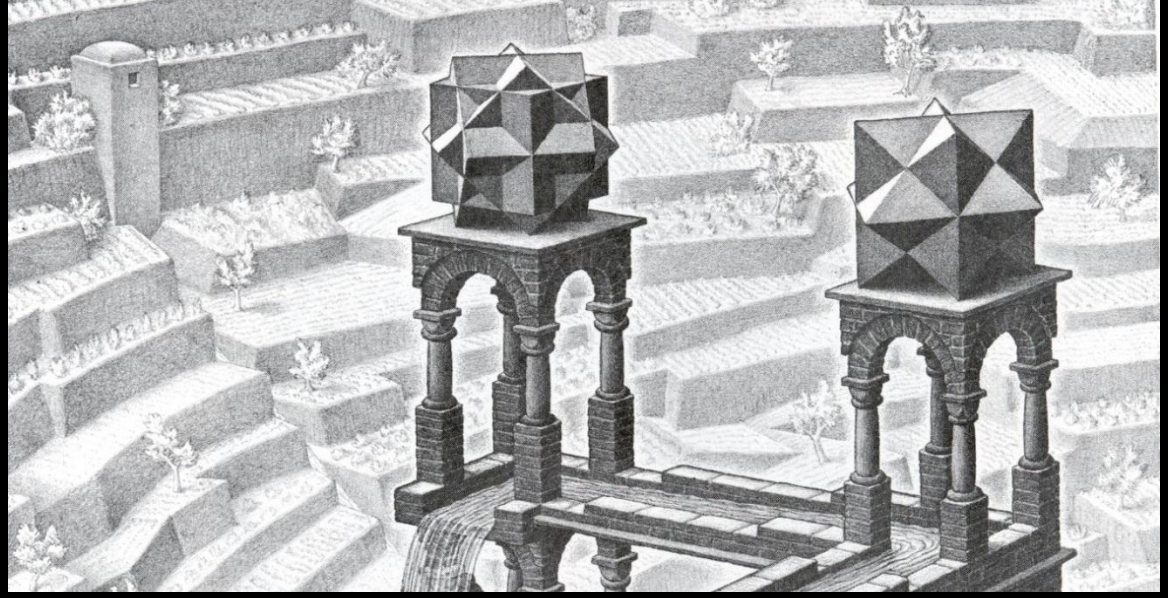
- Simplification
- Building a decision model
- Testing the model (calibration on historical data)
- Using the model to find the solution:
- A good Model can be used again and again for similar problems or can be modified.

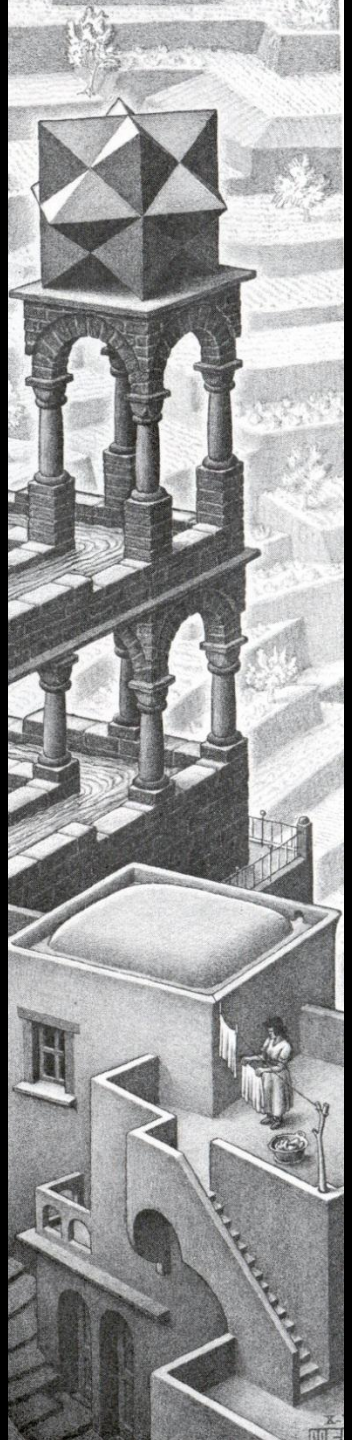
Why the Modeling exercise is useful

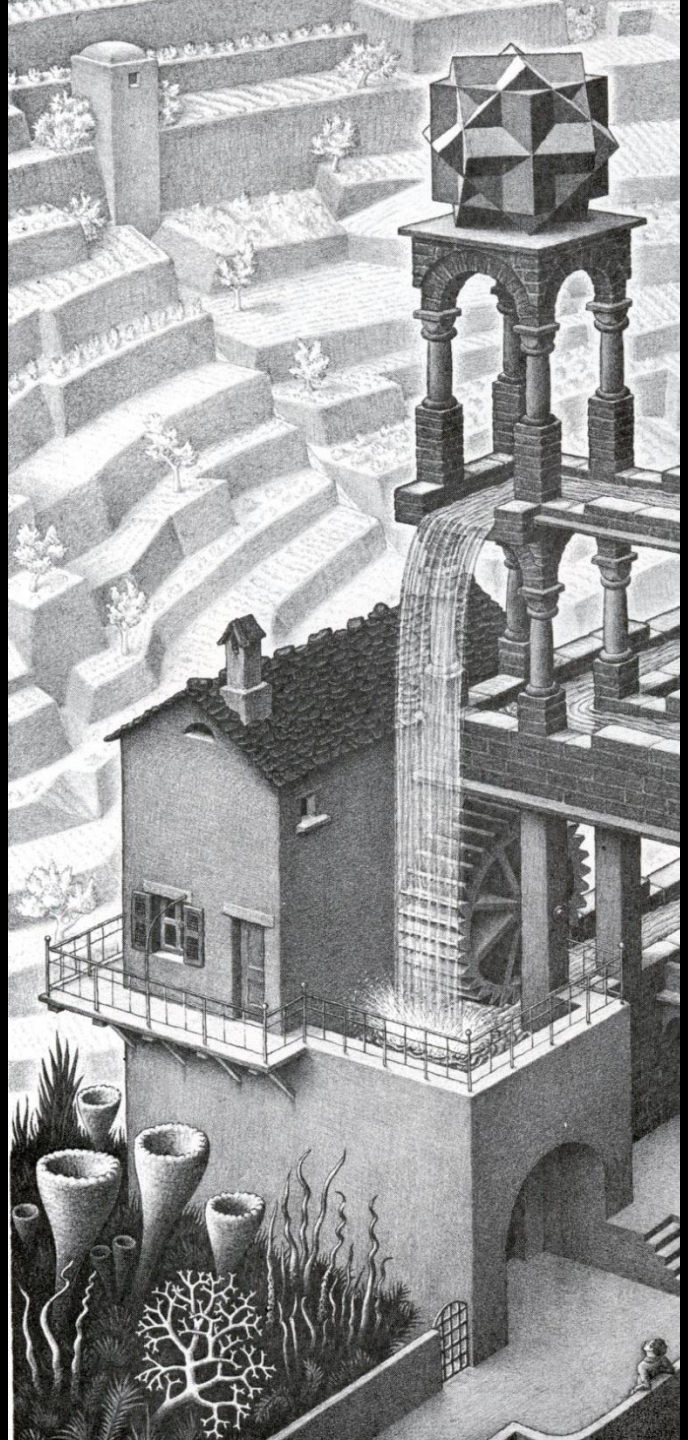
- It is a simplified representation of the actual situation
- It need not be complete or exact in all respects
- It concentrates on the most essential relationships and ignores the less essential ones.
- It is more easily understood than the empirical (i.e., observed) situation, and hence permits the problem to be solved more readily with minimum time and effort.

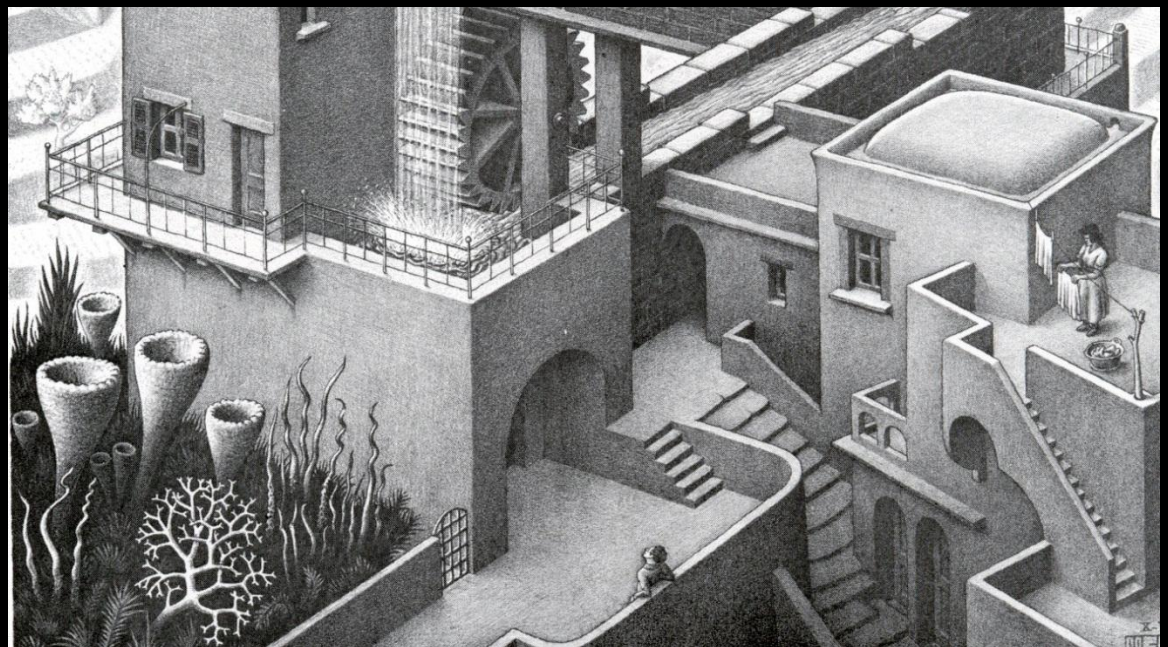
Examples of Applications of Modeling in Business & Management

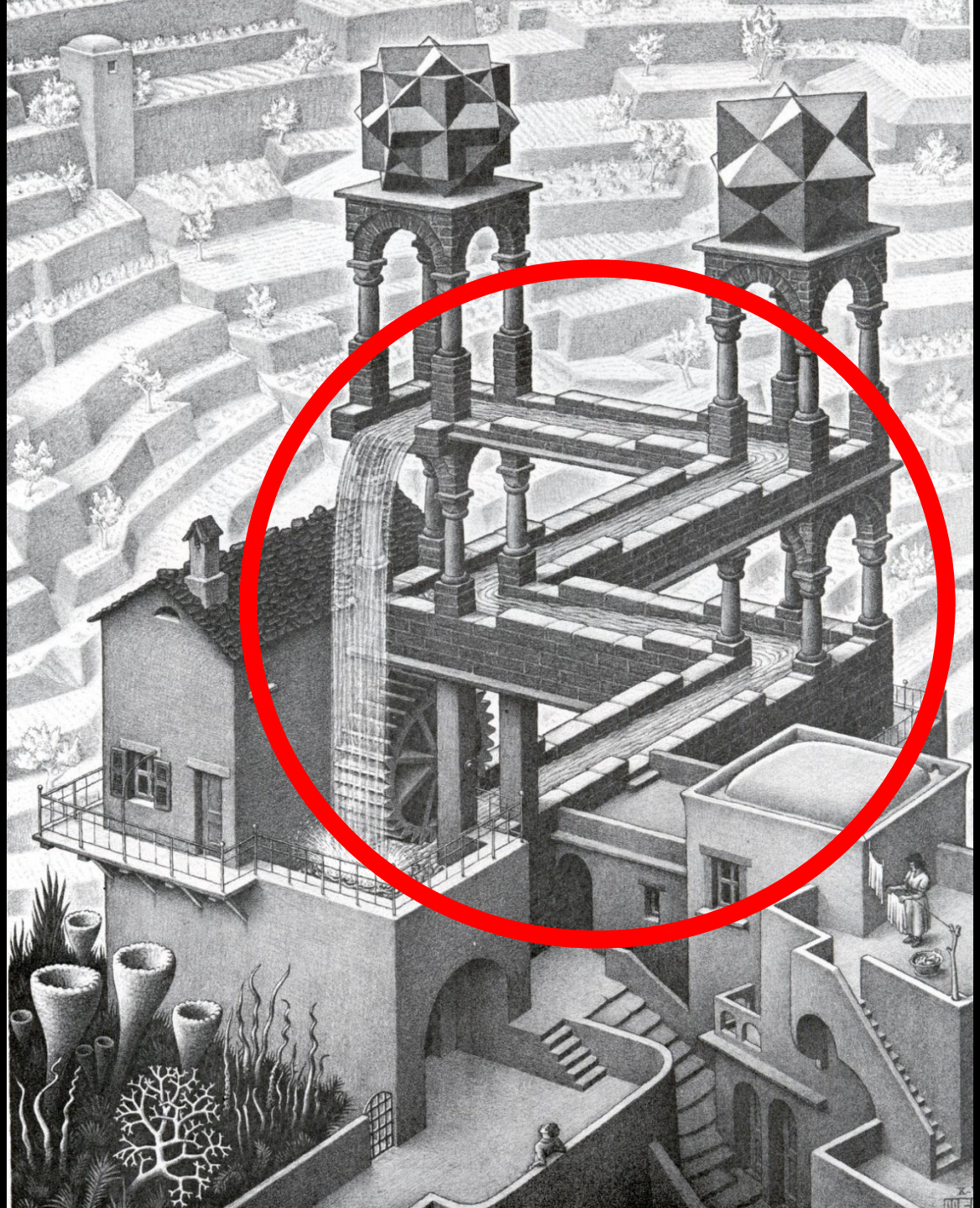
- An auditor can use random sampling techniques to audit the accounts receivable for clients.
- A plant manager can use statistical quality control techniques to assure the quality of his production with a minimum of testing or inspection.
- A financial analyst may use regression and correlation to help understand the relationship of a financial ratio to a set of other variables in business.
- A market researcher may use test of significance to accept or reject the hypotheses about a group of buyers to which the firm wishes to sell a particular product.
- A sales manager may use statistical techniques to forecast sales for the coming year.



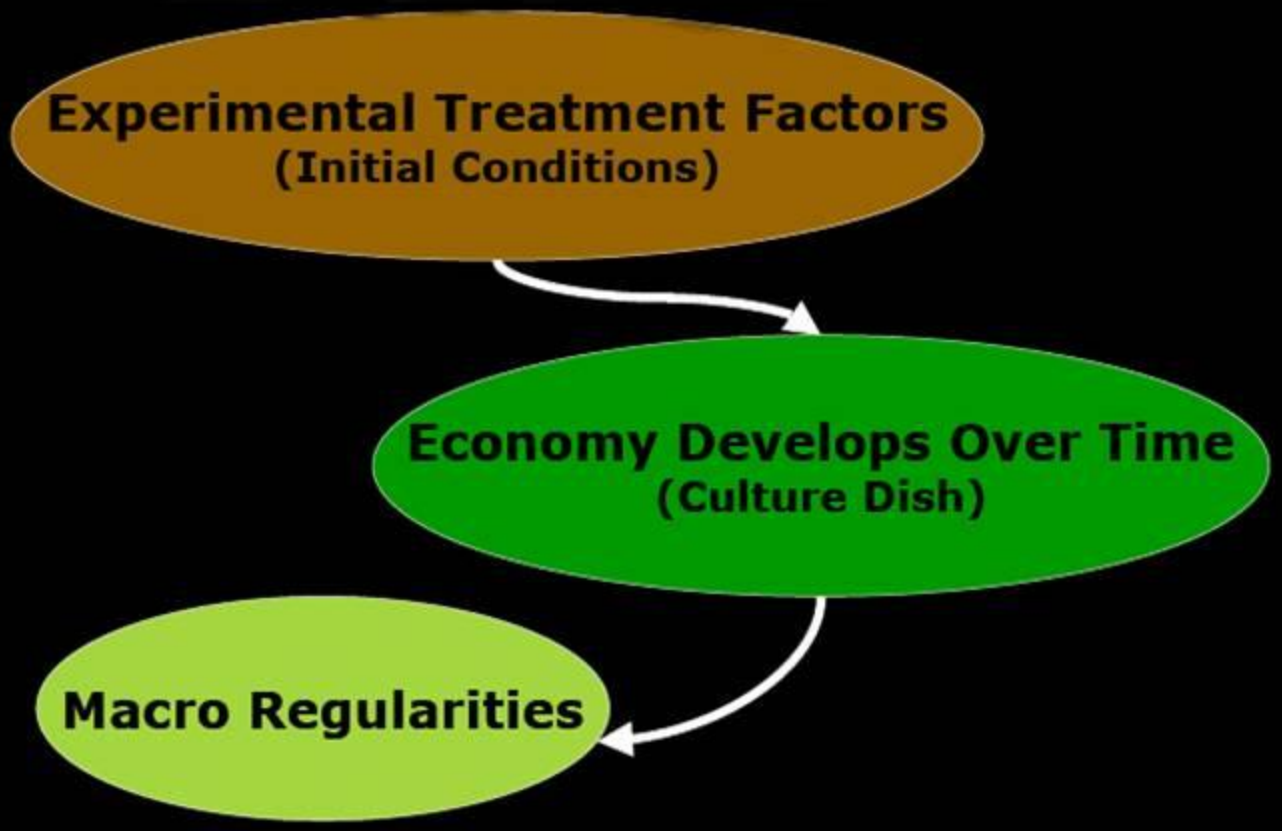








ACE Modeling:
The Culture Dish Analogy



Source: http://www.econ.iastate.edu/tesfatsi/aceconstruct.pdf

Conventional (von Neumann) Computers are

- Good at:
  - Fast arithmetic
  - Doing precisely what the programmer programs them to do
- Not so good at:
  - Interacting with noisy data or data from the environment
  - Massive parallelism
  - Fault tolerance
  - Adapting to circumstances

Neural Networks

- Based on the parallel architecture of animal brains.
- A form of multiprocessor computer system, with
  - Simple processing elements
  - A high degree of interconnection
  - Simple (scalar) messages
  - Adaptive interaction between elements

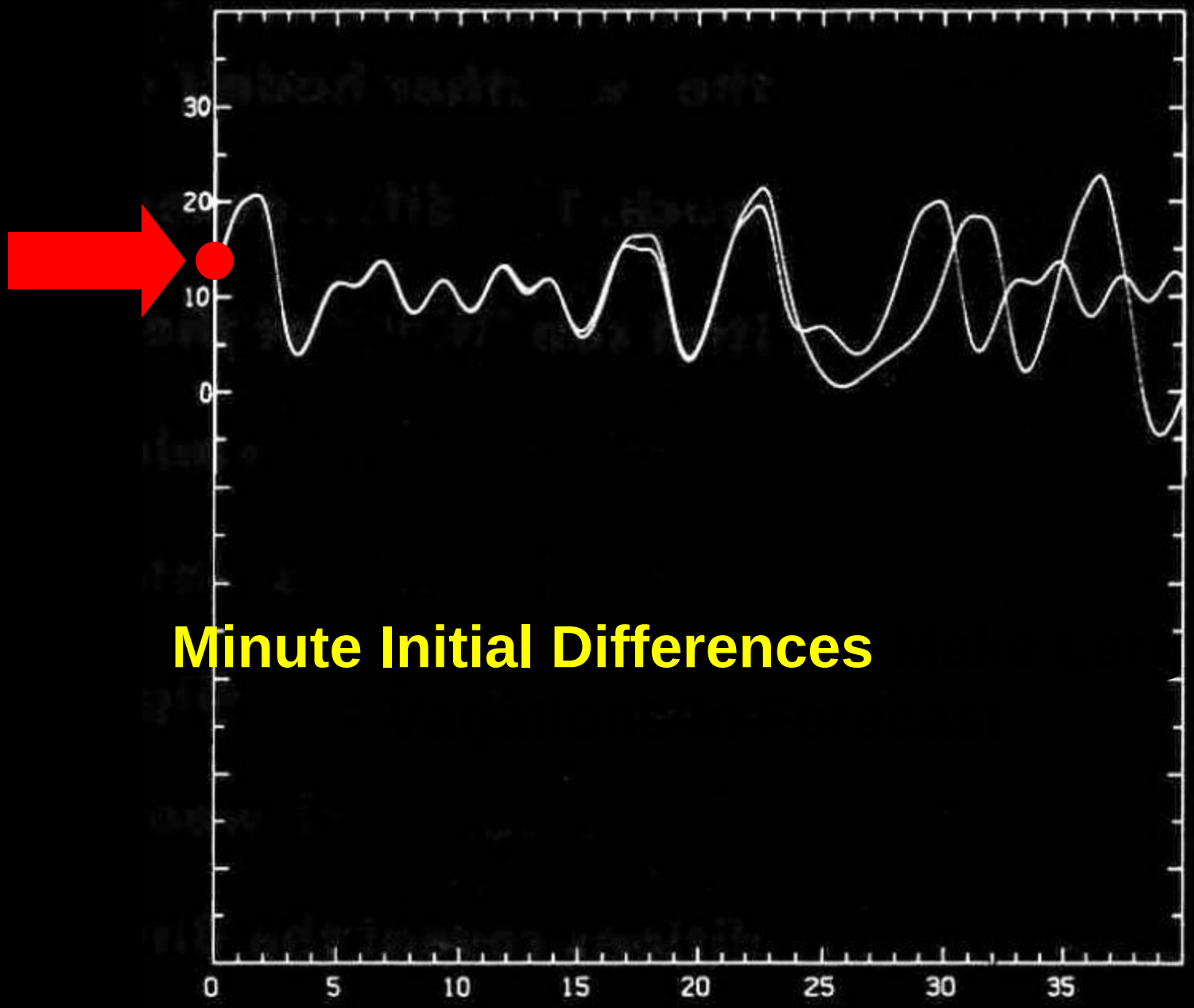
Neurons can have 10,000 connections providing inputs and send signals to 1000s of other neurons. Neurons are wired up in a 3-dimensional pattern.

Outline

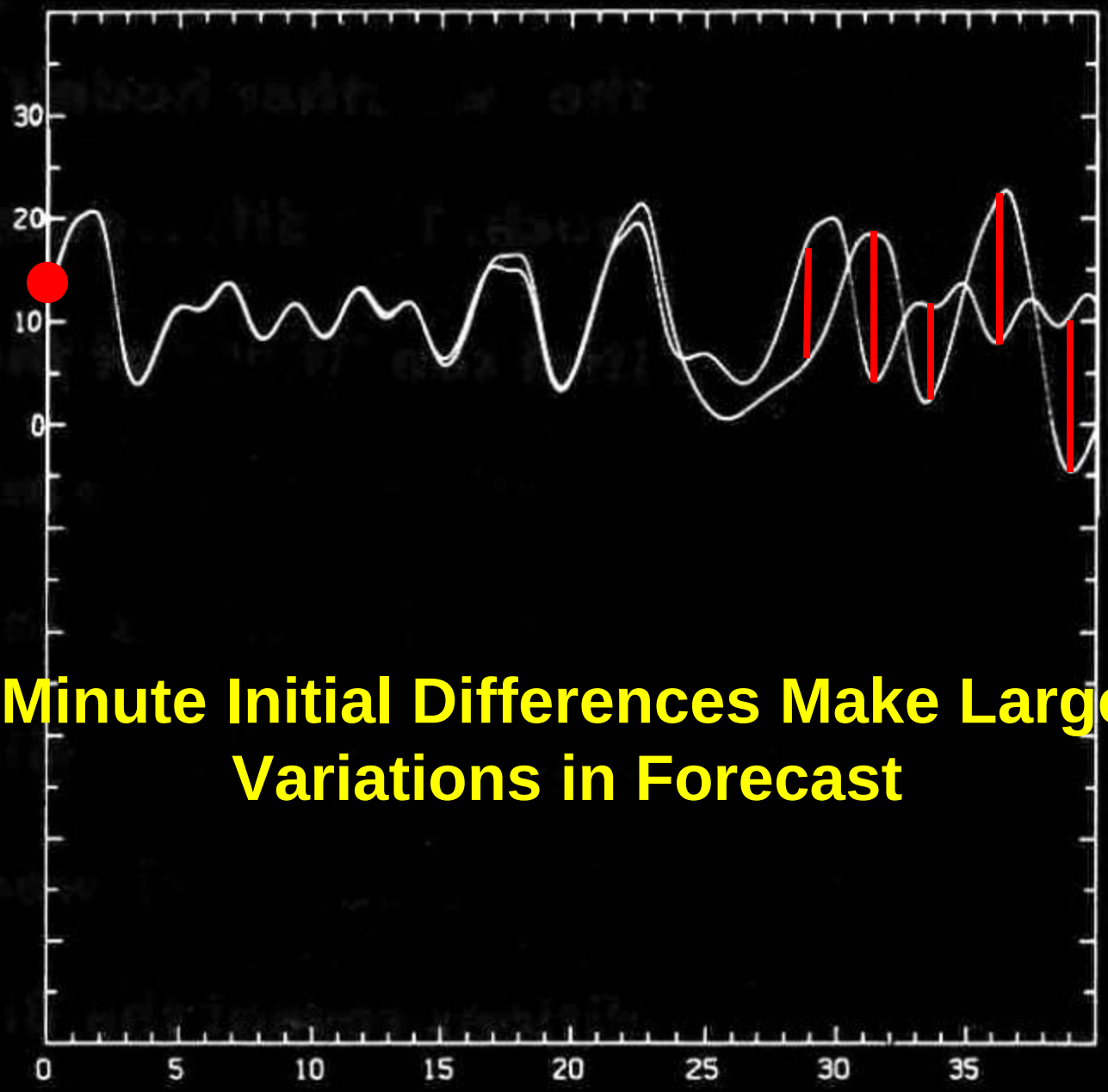
1. Science, Method & Measurement
2. On Building An Index
3. Correlation & Causality
4. Probability & Statistics
5. Samples & Surveys
6. Experimental & Quasi-experimental Designs
7. Conceptual Models
8. Quantitative Models
9. **Complexity & Chaos**
10. Recapitulation - Envoi

Weather Phenomena

Does the Flutter of a Butterfly’s Wings in Rio Cause a Hurricane in Texas?

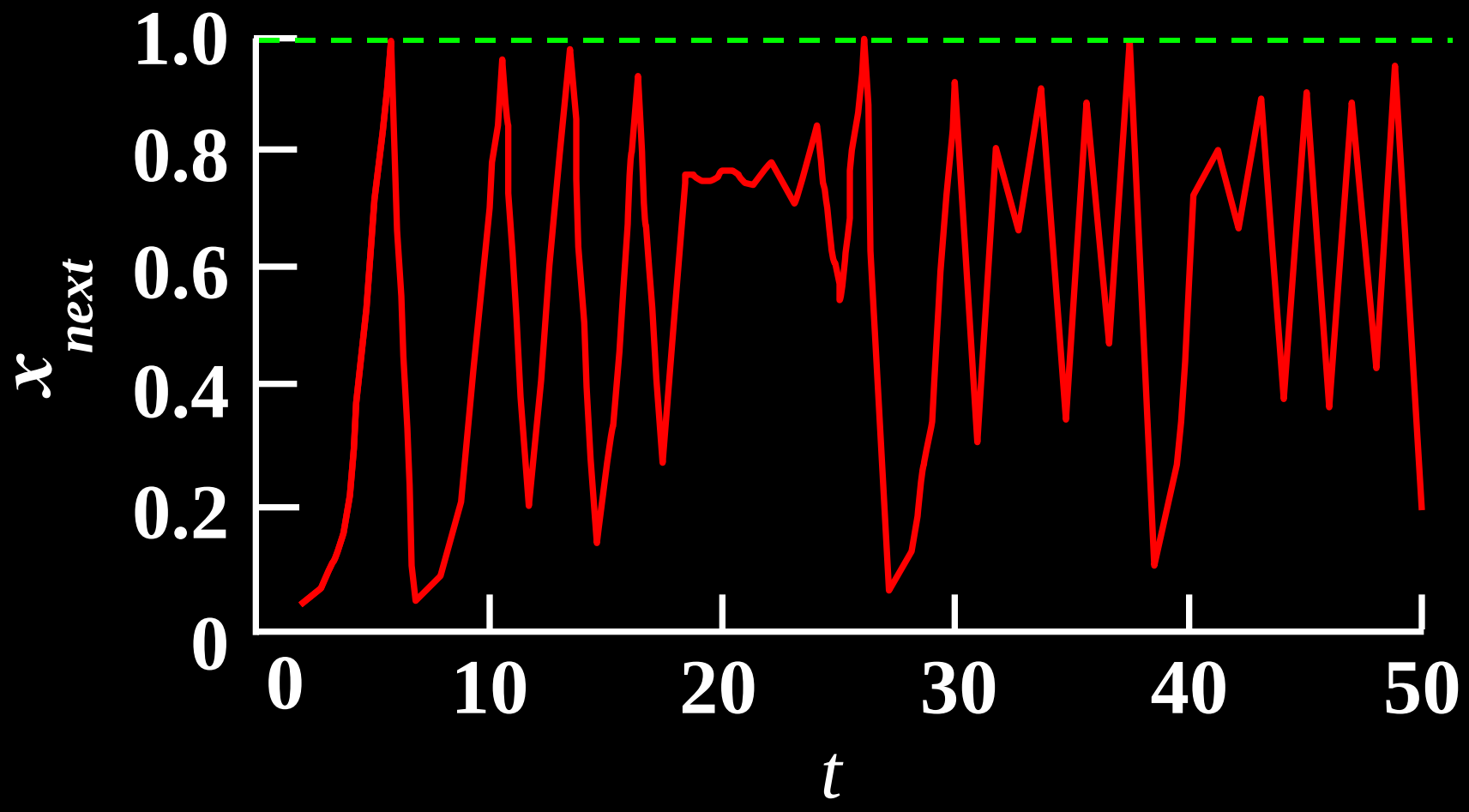


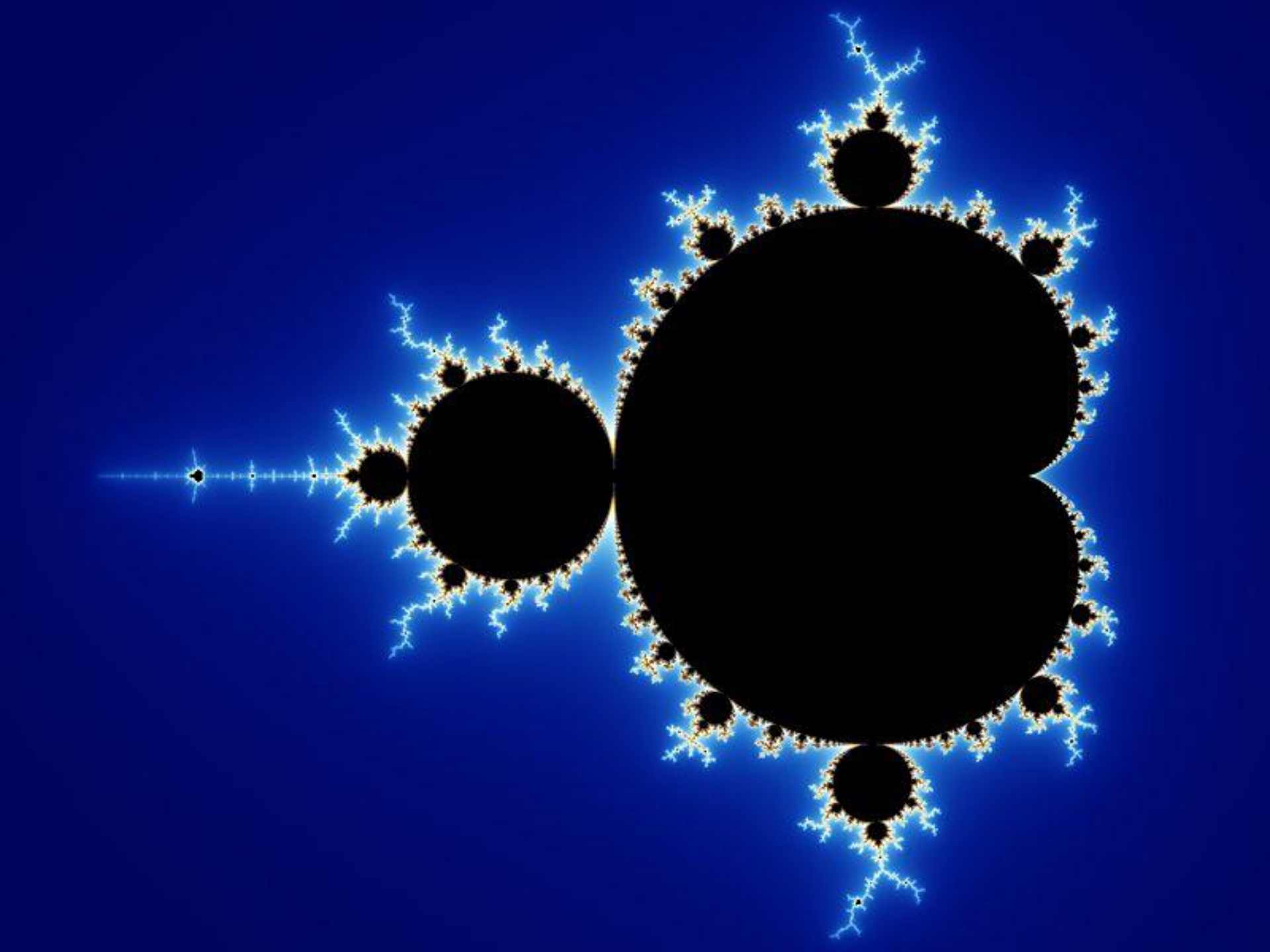
Minute Initial Differences



Minute Initial Differences Make Large Variations in Forecast

For a = 3.99





Outline

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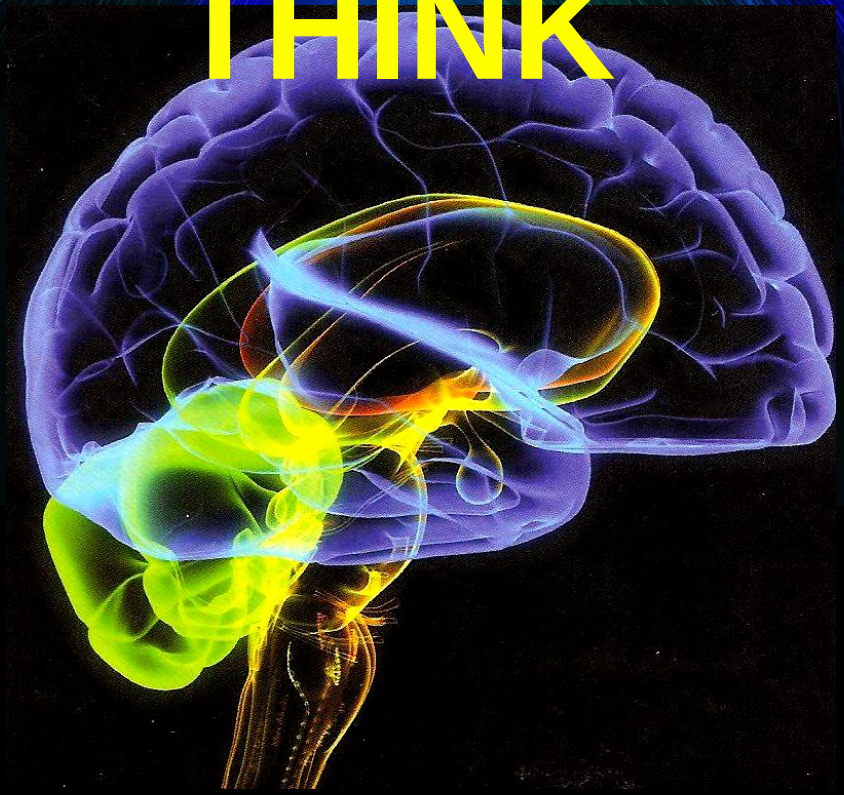
9. Complexity & Chaos
10. **Recapitulation - Envoi**

Which is where we now are…

I hope that this course made you

THINK



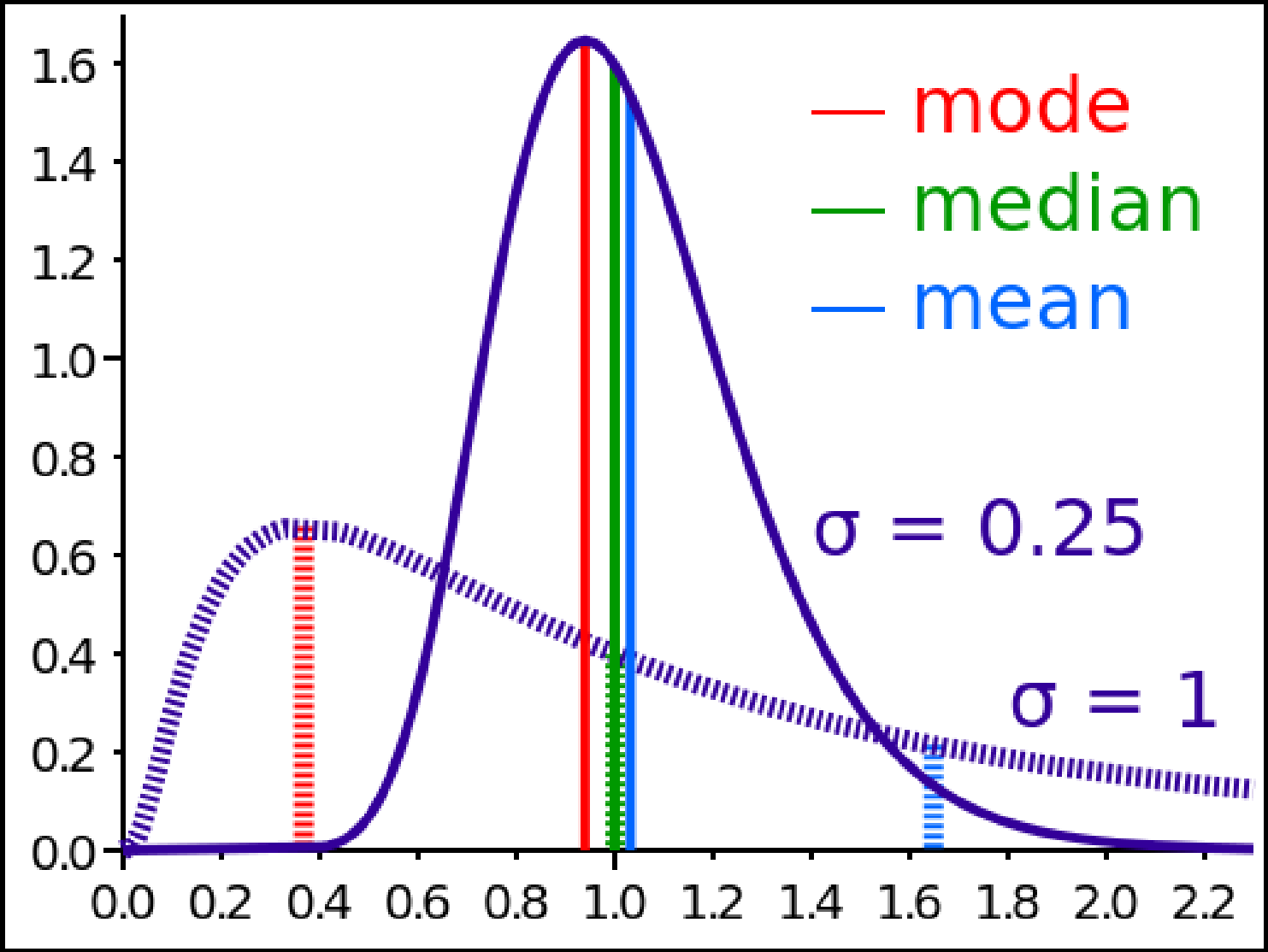
Now let’s see how we present findings to the public…

Table

Chi-Square Distribution

Source: R.A. Fisher and F. Yates, Statistical Tables for Biological Agricultural and Medical Research, 6th ed., Table IV, Oliver & Boyd, Ltd., Edinburgh

Degrees of Freedom (df)	Probability (p)										
	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59
	Nonsignificant								Significant		



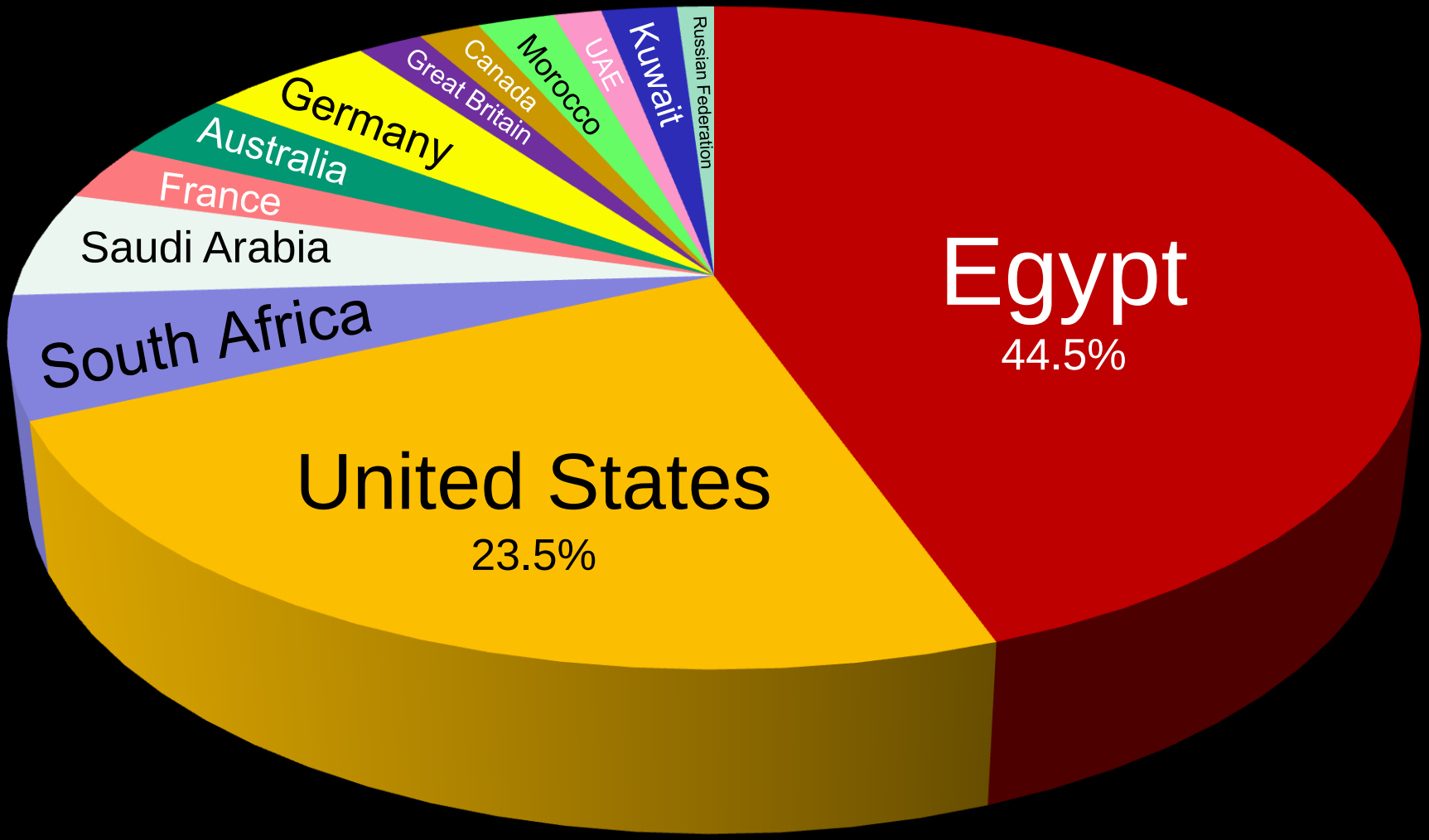
Mean, Median, Mode

Equations

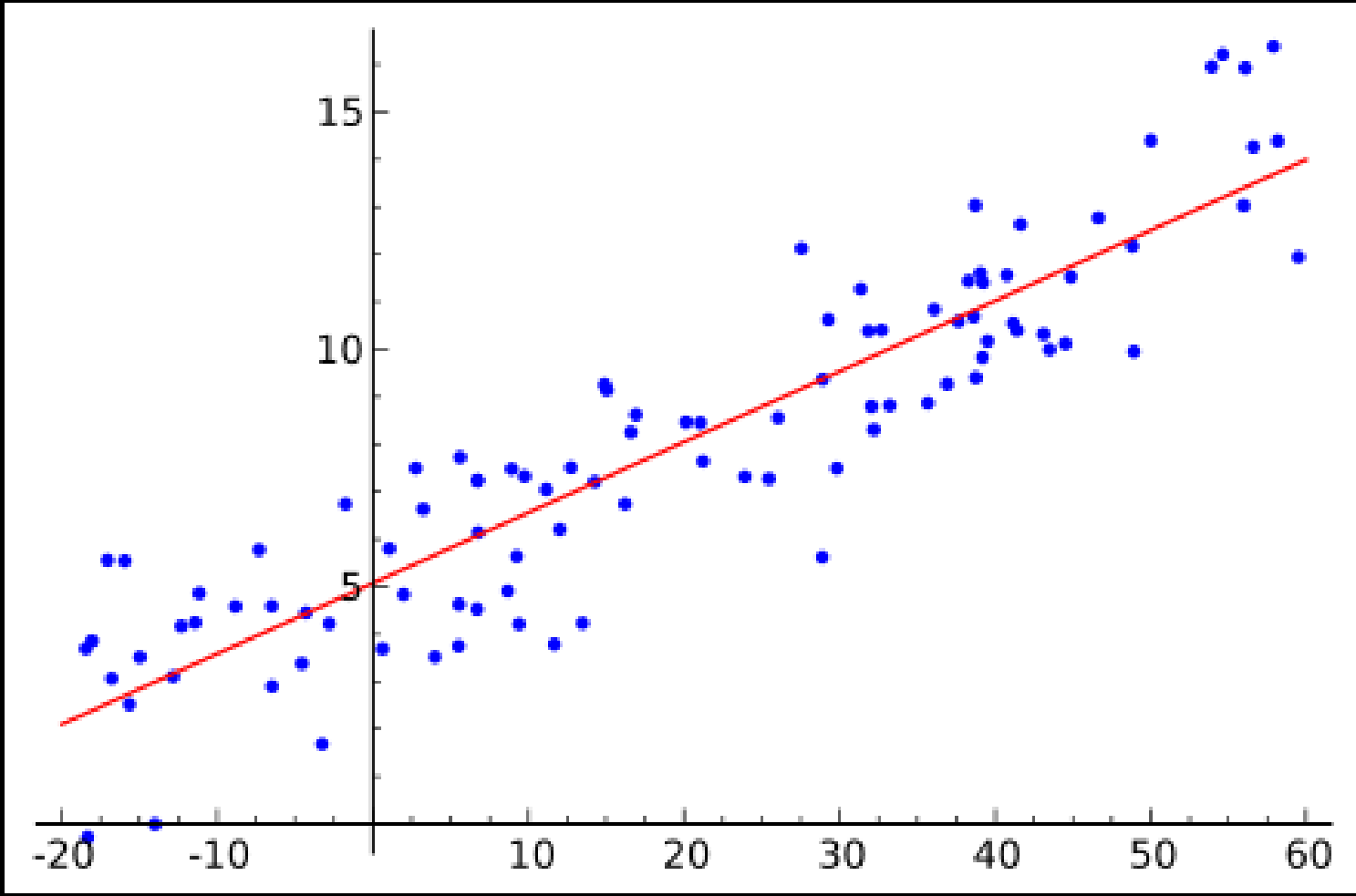
$$S^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2$$

Pie Charts

Usage of BA websites by Country
April 2010 – March 2011



Graphs



Now get set to fly with the masters

Start Gapminder 1

Start Gapminder 2

That was just great…

Now, you too shall go and do quantitative research

AND

present your findings as beautifully as that…

Go… Soar Like An Eagle…

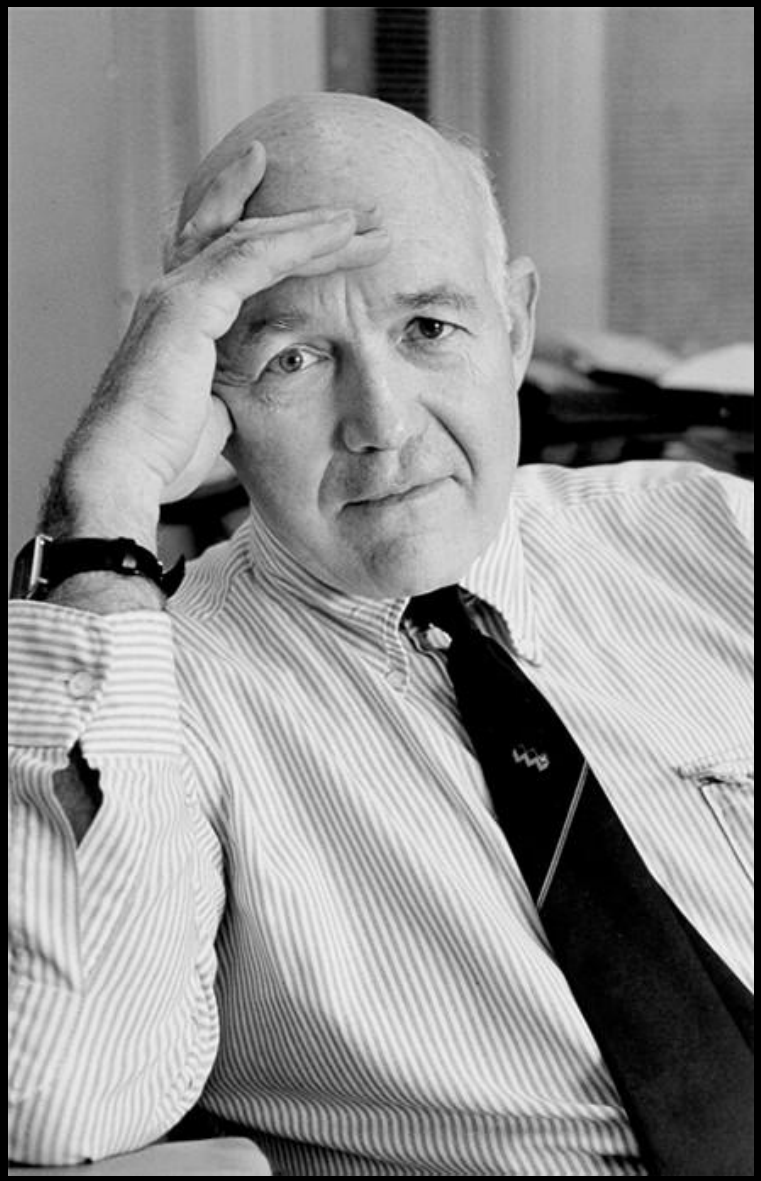
Envoi

Research Studies can have major impacts on the life of a nation and a society

Example:

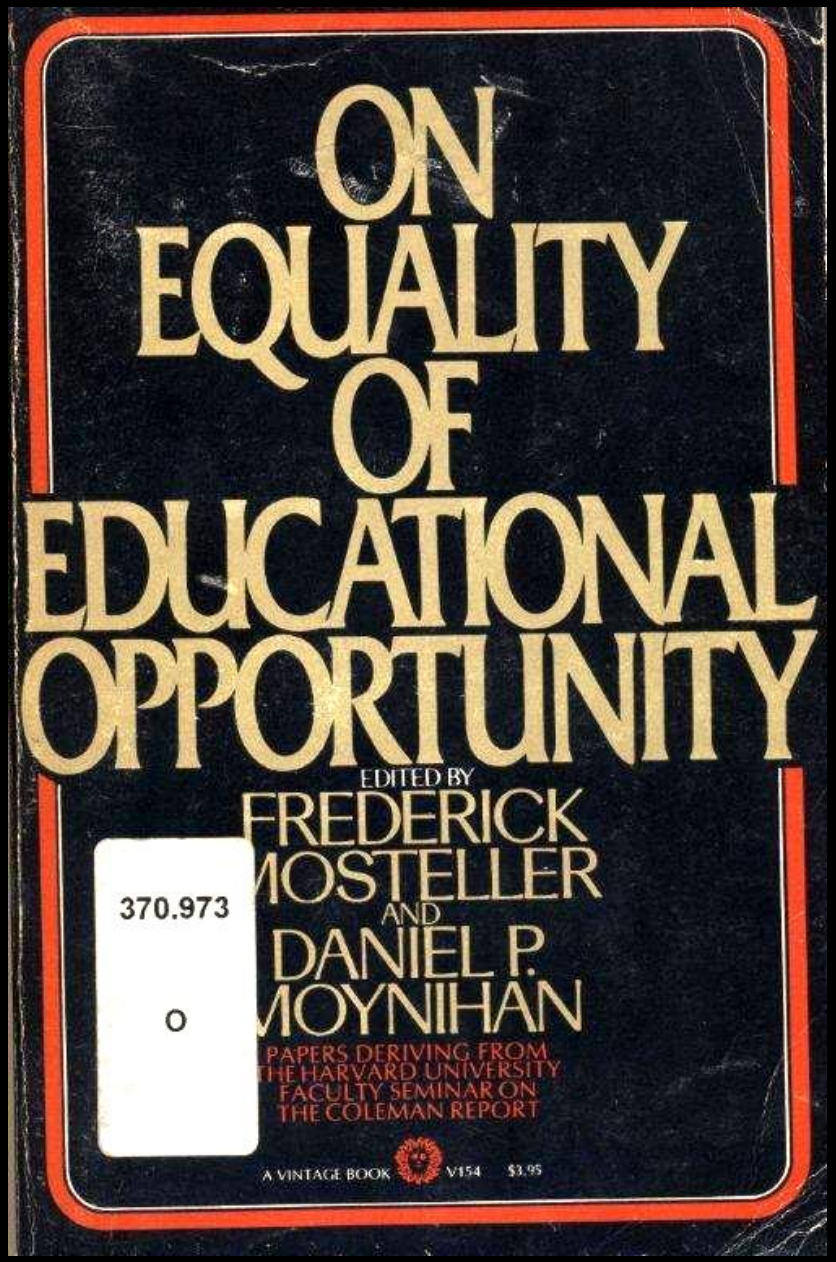
Race, Education and the USA:

The Coleman Report and its aftermath



James Samuel Coleman

(May 12, 1926 – March 25, 1995)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EDITED BY
FREDERICK MOSTELLER
AND
DANIEL P. MOYNIHAN
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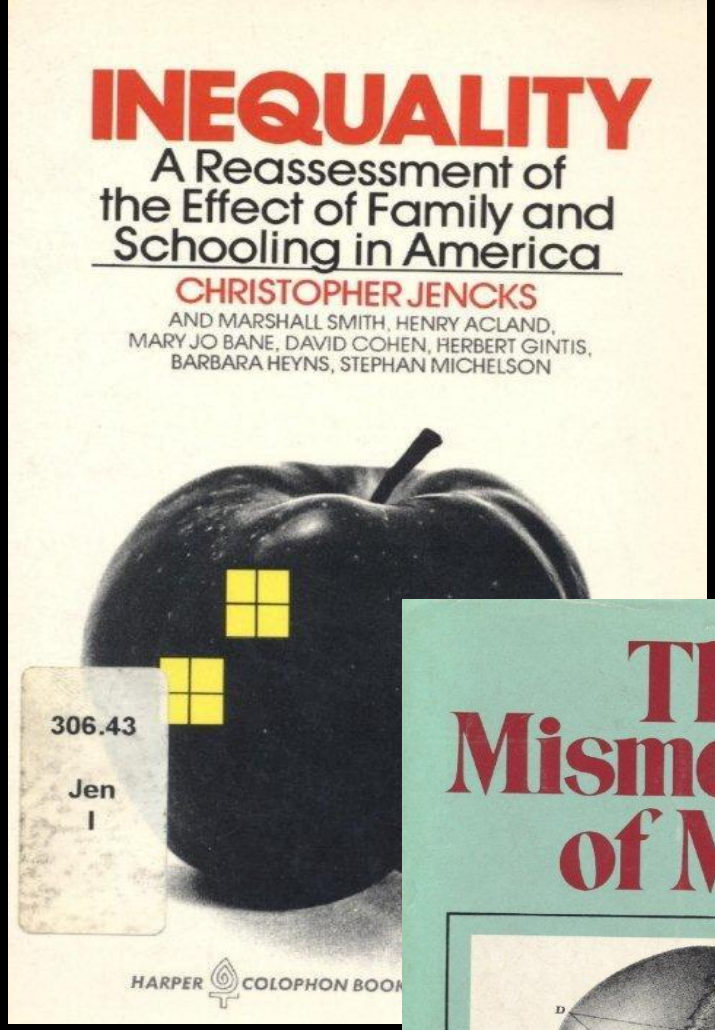
INEQUALITY
A Reassessment of the Effect of Family and Schooling in America
CHRISTOPHER JENCKS
AND MARSHALL SMITH, HENRY ACLAND, MARY JO BANE, DAVID COHEN, HERBERT GINTIS, BARBARA HEYNS, STEPHAN MICHELSON
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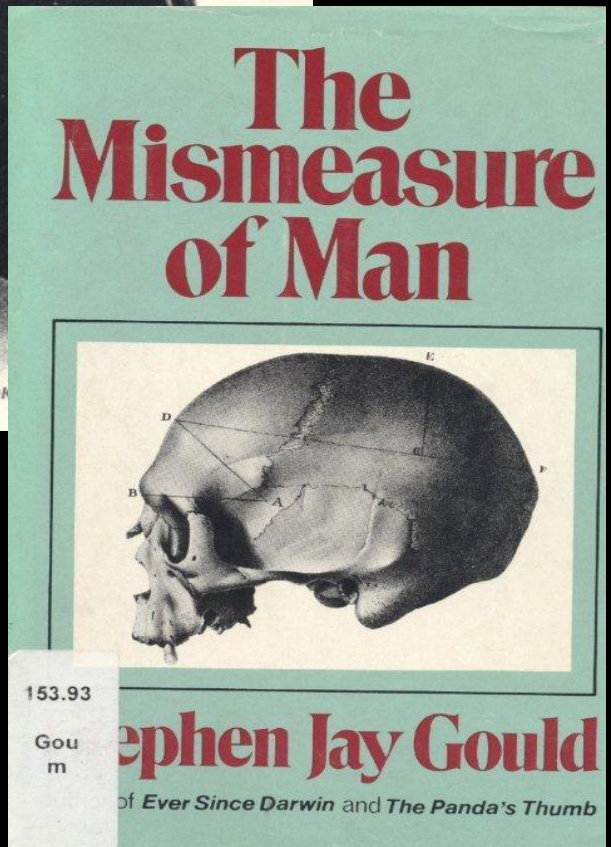
The Mismeasure of Man
ephen Jay Gould
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m

So, your studies could one day have a major impact…

Now think:
whether it is through modeling, or surveys, or through experimental designs to test new treatments…

What could you do to make this a better world?

Now each group shall prepare a study proposal and submit it in one week.

How can you produce useful, international publication-level studies?

Questions you must ask as you start preparing for a study

- **What?** (subject matter)
- **Where?** (location, scale in both space and time)
- **Why?** (purpose of the study: establish, explain, refute…)
- **For Whom?** (decision-maker, scientists)
- **How?** (methodology)
- **How much?** (effort, money, time, detail, etc.)
- **When? How much time?** (when start, when end?)
- **How?** (presentation of findings: book, report, article, presentation at seminar, etc.)
- **So What?**

Let’s review the steps for a Study

1. Objectives or Hypotheses:

- **What are the objectives of the study or the questions to be answered?**

- **What is the population to which the investigators intend to refer their findings?**

2. Research Design:

- Is the study a planned experiment (i.e., primary data), or an analysis of records (i.e., secondary data)?
- How is the sample to be selected?
- Are there possible sources of selection, which would make the sample atypical or non-representative?
- If so, what provision is to be made to deal with this bias?
- What is the nature of the control group, standard of comparison, or cost?
- Remember that research design or statistical modeling means thinking first: reflections before actions.

3. Observations:

- Are there clear definitions of variables, including classifications, measurements (and/or counting), and the outcomes?
- Is the method of classification or of measurement consistent for all the subjects and relevant to the problem being studied?
- Are there possible biases in measurement (and/or counting)?
- If so, what provisions must be made to deal with them?
- Are the observations reliable and replicable (to defend your finding)?

4. Analysis & Conclusions:

- Are the data sufficient and worthy of statistical analysis?
- If so, are the necessary conditions of the methods of statistical analysis appropriate to the source and nature of the data? (The analysis must be correctly performed and interpreted).
- Which conclusions are justifiable by the findings? Which are not?
- Are the conclusions relevant to the questions posed at the start of the study?

5. Presenting the Findings:

- The findings must be represented clearly, objectively, in sufficient but non-technical terms and detail to enable the decision-maker (e.g., a manager) to understand and judge them for himself. How do we do that?
- Are the findings internally consistent; i.e., do the numbers added up properly?
- Can the different results be reconciled?
- What is the significance of your findings?

6. Final (Summary) Presentation of Findings

- Who is the target audience now? General public? Manager at BA? Political decision-maker? Scientific colleagues?
- Format of presentations (more than one is possible): book? Article? PowerPoint presentation? Technical report? Publication ina scientific journal?
- Especially when addressing decision-makers, make sure that your findings and recommendation(s) are clearly put, Otherwise, you will have wasted the time, money, etc. for nothing.

Now each group shall prepare a study proposal and submit it in one week.

Envoi

Sound Development Policies Need Thoughtful Social Research Inputs

In a time of remarkable dynamic change, volatility and instability, some new tools may be needed

Natural and social scientists Of the developing world must master the quantitative techniques that have become essential parts of contemporary research…

YOU

Have to rise to the challenge!

Thus it is not just a matter of publishing learned papers or recognizing past individual achievements…

Thus it is not just a matter of publishing learned papers or recognizing past individual achievements…

it is very much a matter of incubating a revolution!

I know that this is very challenging

But I have confidence in you…

We may be small

Limited size, limited resources

The Competition

Large size, unlimited resources

But we will surprise the World!


Thank You

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