# Decisions in the Face of Risk

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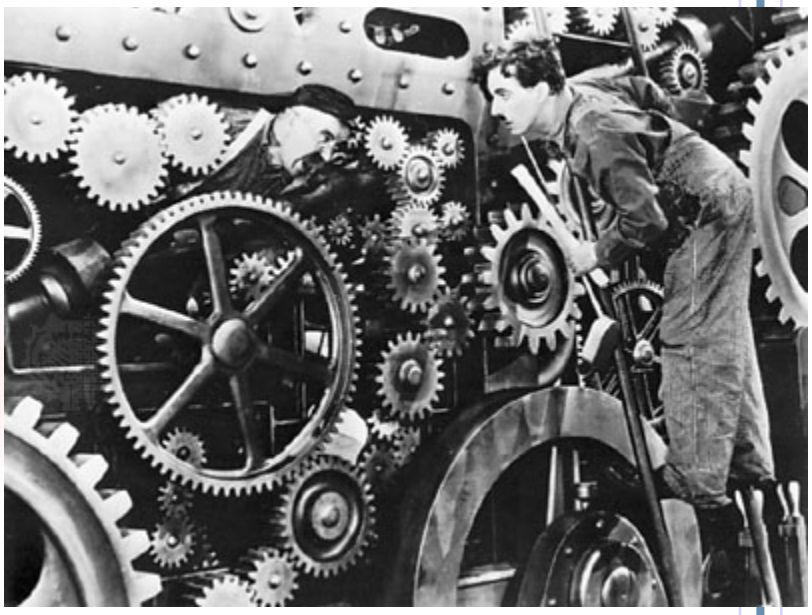
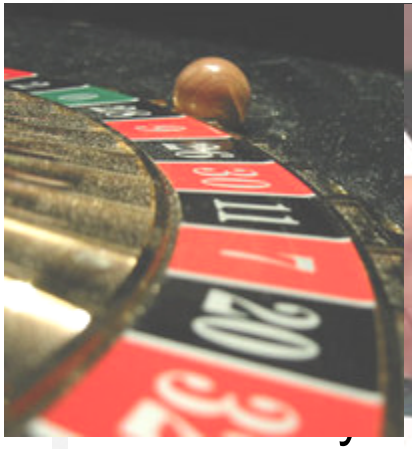
# Risk – a Modern Phenomena

- '…the boundary between modern times and the past is the mastery of risk…" *Against the Gods*, Bernstein



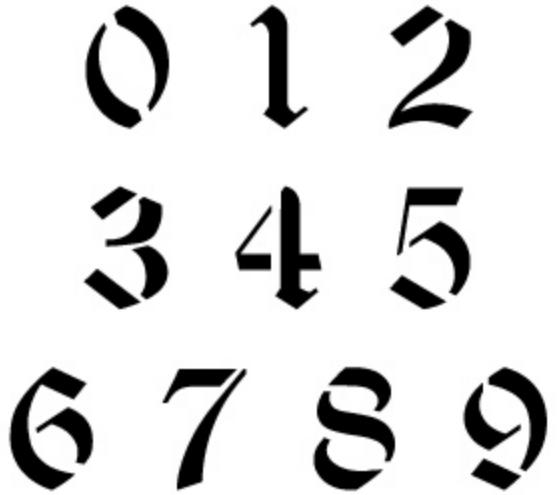
# Games of Chance and other Rational Decisions



- And th
- Ajax and Achilles playing dice o
- While t ays been games of chance, the desire utcome is a modern obsession.
  - the G nture into an exploration of probability
  - More of worldview than ability
    - F eating cycles of disarray seemed the norm
  - *Gam f God* (http://crapsdicecontrol.com/craps_disciples.htm )

# Of Chance Today and Tomorrow

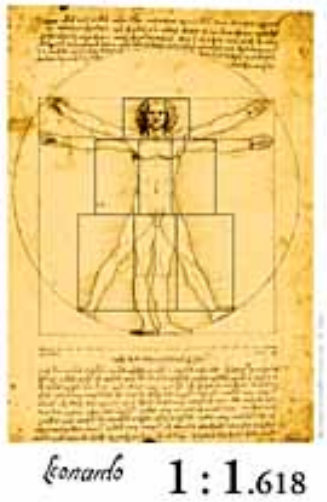
- There is ***one*** other seemingly insignificant, but essential ingredient regarding risk, probability and decision making that distinguishes our world from past cultures.
- Numbers…
  - We are a world immersed in numbers
  - Even tomorrow must have a number
    - Tomorrow is no longer a mystery
    - Just another turn of the clockwork

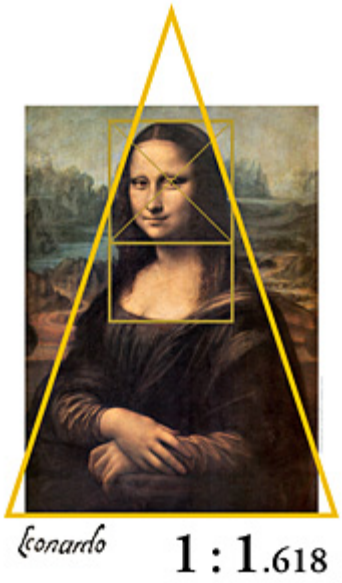



- Not possible prior to 500 A.D.
  - Hindus developed the modern numbering system
  - Before that, number systems were based on letters of alphabet
    - Calculations were essentially impossible (MV – X = ??)
    - No concept of “zero” – only useful in abstractions/calculations

# The Power of Counting (Middle Ages)

- In the west – 1202 - *Book of the Abacus* or *Liber Abaci* by Leonardo Pisano in Italy (known as Fibonacci)
  - the breeding of rabbits => Fibonacci series - "the golden mean"
  - THE FIBONACCI SERIES AND THE FINANCIAL MARKETS
    - http://www.luckymojo.com/fibonaccimkt.html



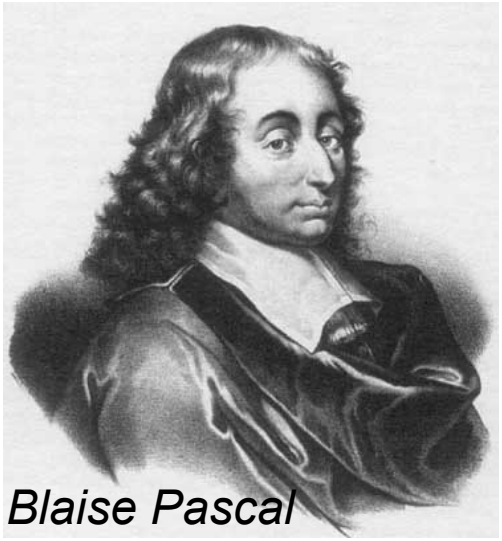




- In 1494 Luca Paccioli, a Franciscan monk, posed a puzzle:
  - "How to divide the stakes in *balla*, if game terminated early?"

# The rule of chance, law and decision (1600s)

- 1600s: Solving Paccioli's dilemma: Pascal and Fermat
  - What is *likely* to happen when more things *can* happen then *will*
  - Pascal's Wager regarding belief in God
    - Decision theory

| | Belief | Disbelief |
|---|---|---|
| God | + | - |
| No God | 0 | 0 |



*Blaise Pascal*

*Pierre de Fermat*

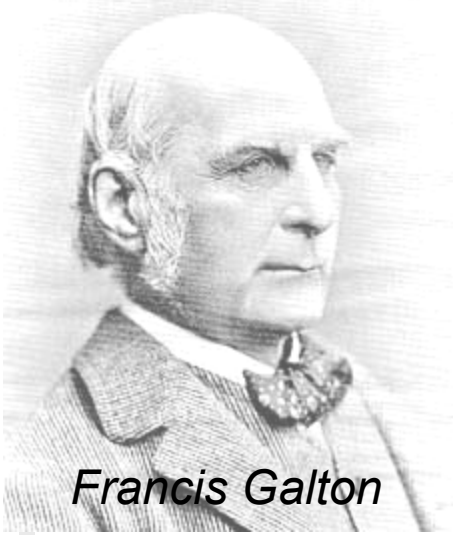
- The first application of "utility" in 1662:
  - Pascal's Port-Royal monastery: *Logic, or the Art of Thinking*
  - "Fear of harm ought to be proportional not only to the gravity of the harm, but also to the probability of the event."

# The past is the key to the future (1700s)

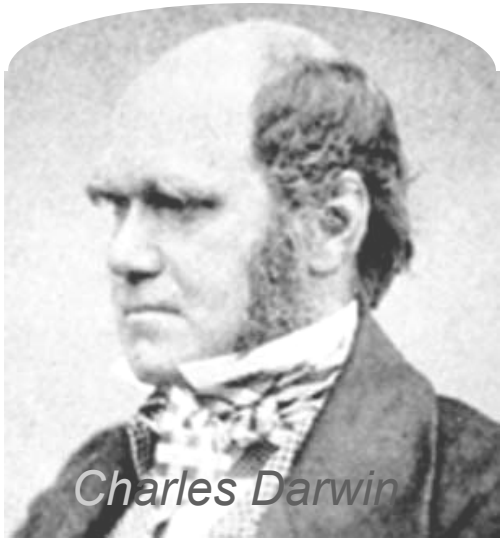
- Jacob Bernoulli, *The Art of Conjecture*, 1713
  - Law of Large Numbers (independent and random events)
- De Moivre: *independent* elements distribute about mean
- Daniel Bernoulli, 1738: the perception of utility
  - "… any small increase in wealth will be inversely proportionate to the quantity of goods previously possessed."
- Jacob: probabilities are not fixed for the events of life
  - risk cannot be managed completely *a priori* (prior to the event)
  - probabilities for life events can only be estimated *a posteriori*
- Thomas Bayes, 1764: first measurement of uncertainty
  - Uncertainty occurs when probabilities are *unknown*
  - Using new information to revise probabilities (reduce uncertainty)
- Laplace, 1809: "the central limit theorem"

# The Victorian Hope – the End of Risk (1800s)

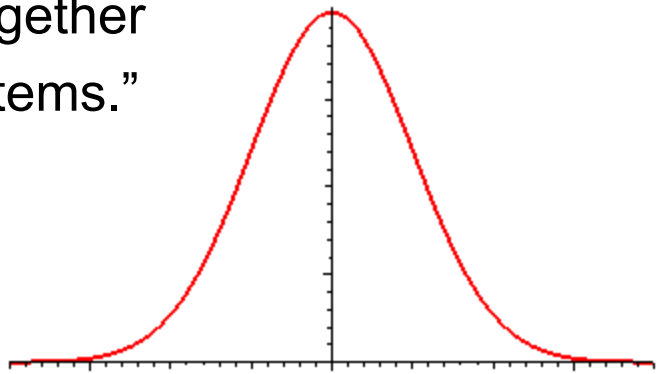
- Francis Galton: the message of the bell curve
  - Normal distribution => data belonged together
  - No normal distribution =>“dissimilar systems.”



*Francis Galton*



*Charles Darwin*



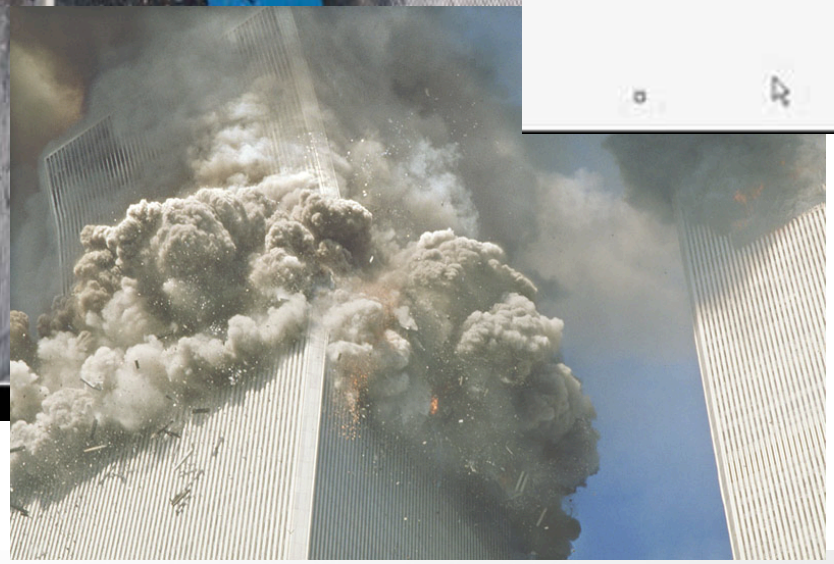
*The Bell Curve*

- Quetelet: analyzed 1829 census => “the average man”
- Galton: superiority of favored classes => social positivism
  - discovered that eminence does not last long
  - Paper, 1877, “regression to the means”

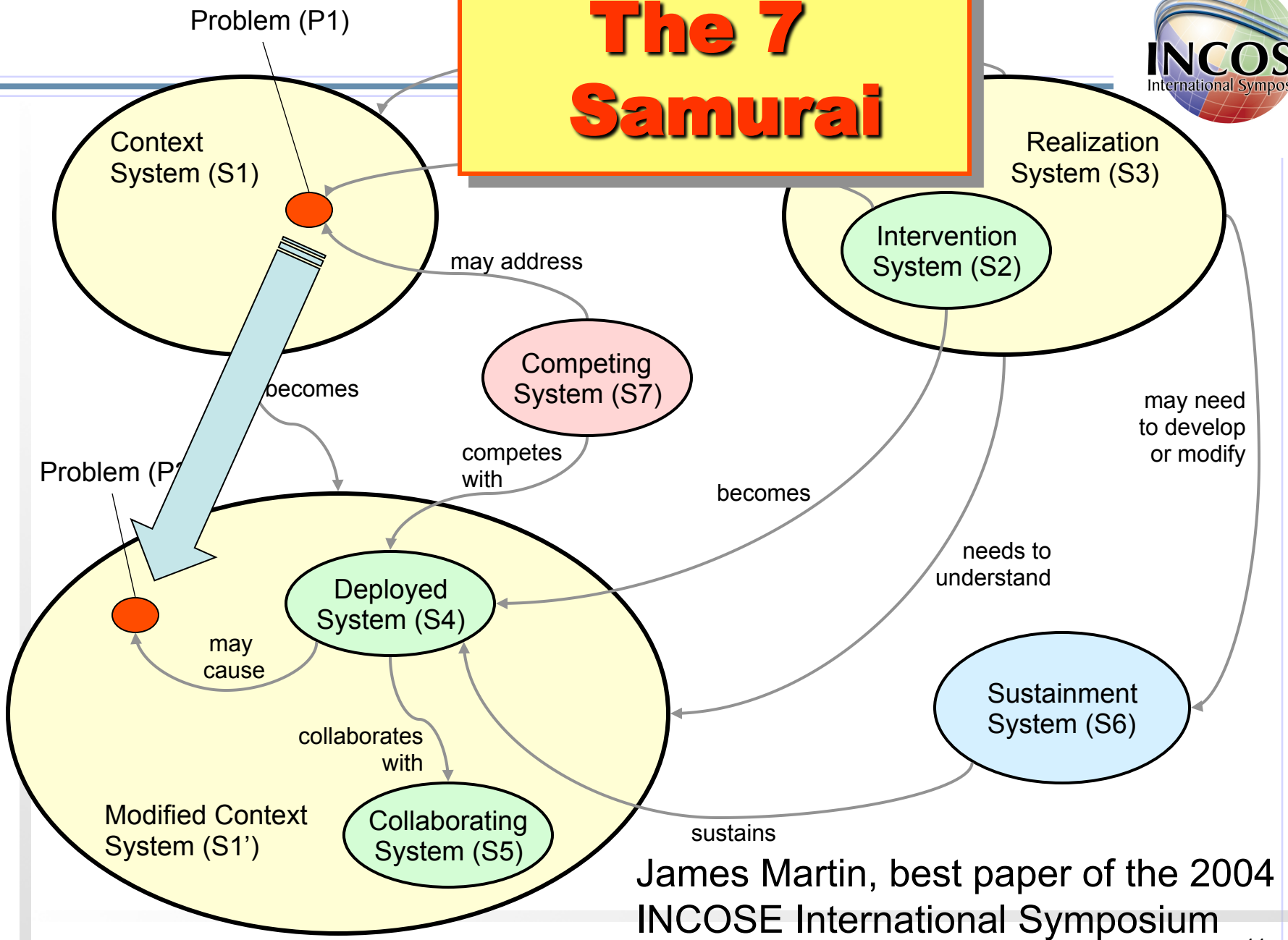
# Consistently Irrational (the modern era)

- The Victorians had a pervasive conviction of the underlying rationality of human decision making
- People do not consistently make decisions on the basis of what should rationally be in their own best interest
- Prospect Theory => most people are “loss averse”
  - Perverse tendency to cling to mistakes rather than move on
- People compartmentalize rather than view whole
  - Sub-optimize particular conditions or accept unnecessary losses
  - Unable to see how sub-scale level affects the overall situation
- Unaware that numerous biases influence decisions
  - Freshness of data, vividness of descriptions, multiple elements
- Aversion to uncertainty or ambiguity, except…
- Slavish adherence to the normal distribution is unwise

# the bottom



# The 7 Samurai




James Martin, best paper of the 2004 INCOSE International Symposium

# Managing Risk – the Never Ending Story

- Certainly, there will always be uncertainty and risk.
- If there is substantial risk, no single answer is sufficient.
- Probability based on data, OK when events independent
- Otherwise: mix of probability, Baysian analysis, bias analysis, other techniques (e.g. design resilient systems:)
  - identify the upset, adapt and make appropriate changes
  - isolate/neutralize offending input and any “infected” subsystem
  - operate at reduced efficiency until fix is implemented
  - if catastrophic failure undesired, perform controlled shut-down
- Risk management is ongoing process in development deployment, operations, upgrades & system replacement
- Pause during midst of a difficult project, think about risk, and consider that *you* may be a part of the problem.