

Introduction to Game Theory:

A Brief History

Version 10/29/17





Development of Probability Theory



Pierre de Fermat (1607-1665)



Blaise Pascal (1623-1662)

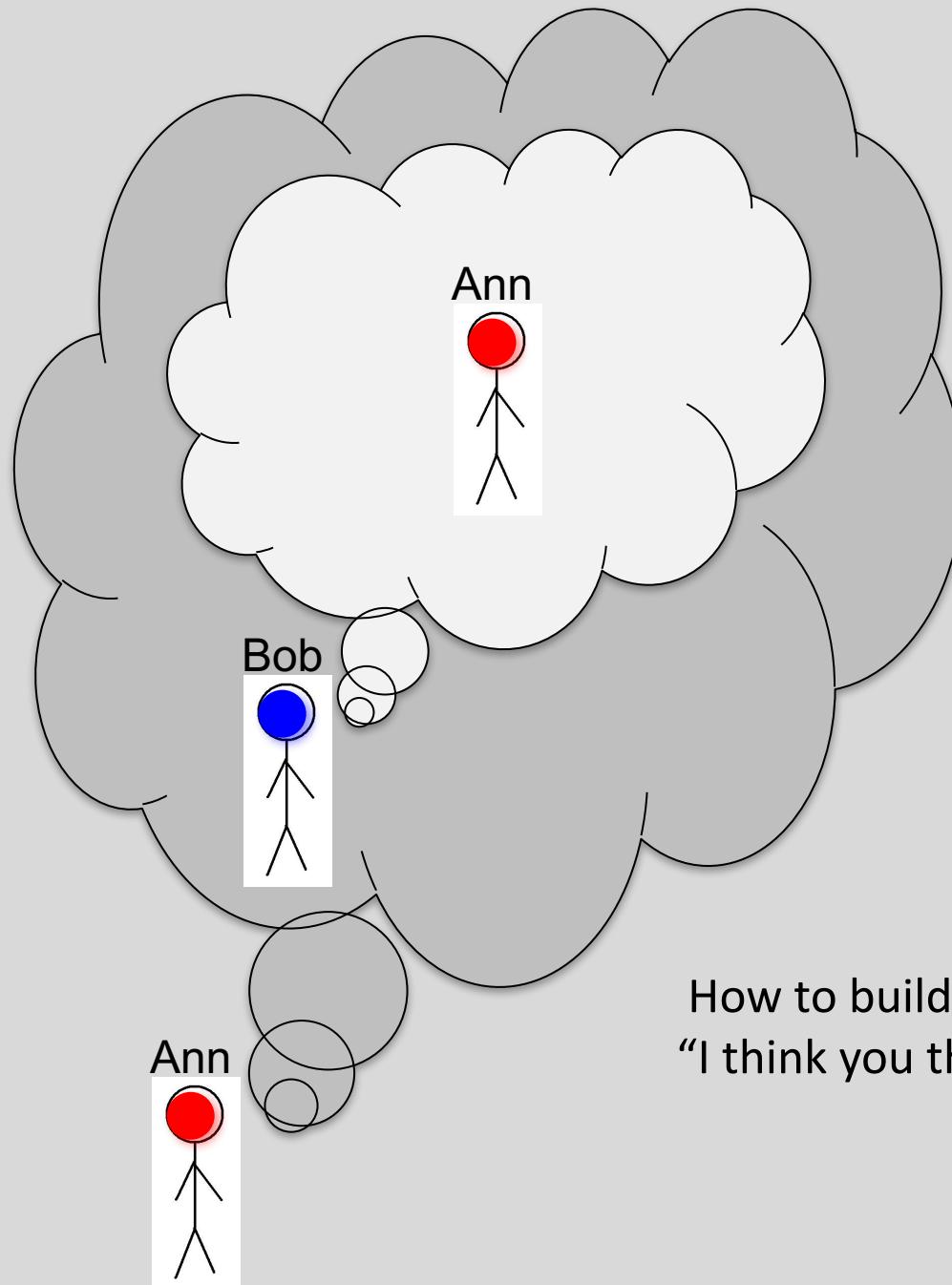
Games of Strategy vs. Games of Chance

In games of strategy, the uncertainty facing a player is not how Nature will act (tossing dice or coins) but about how other players will act

These players may themselves be thinking about how the first player will act

This creates a kind of **reflexivity** in a game of strategy

This notion has been at the heart of game theory from the early days on



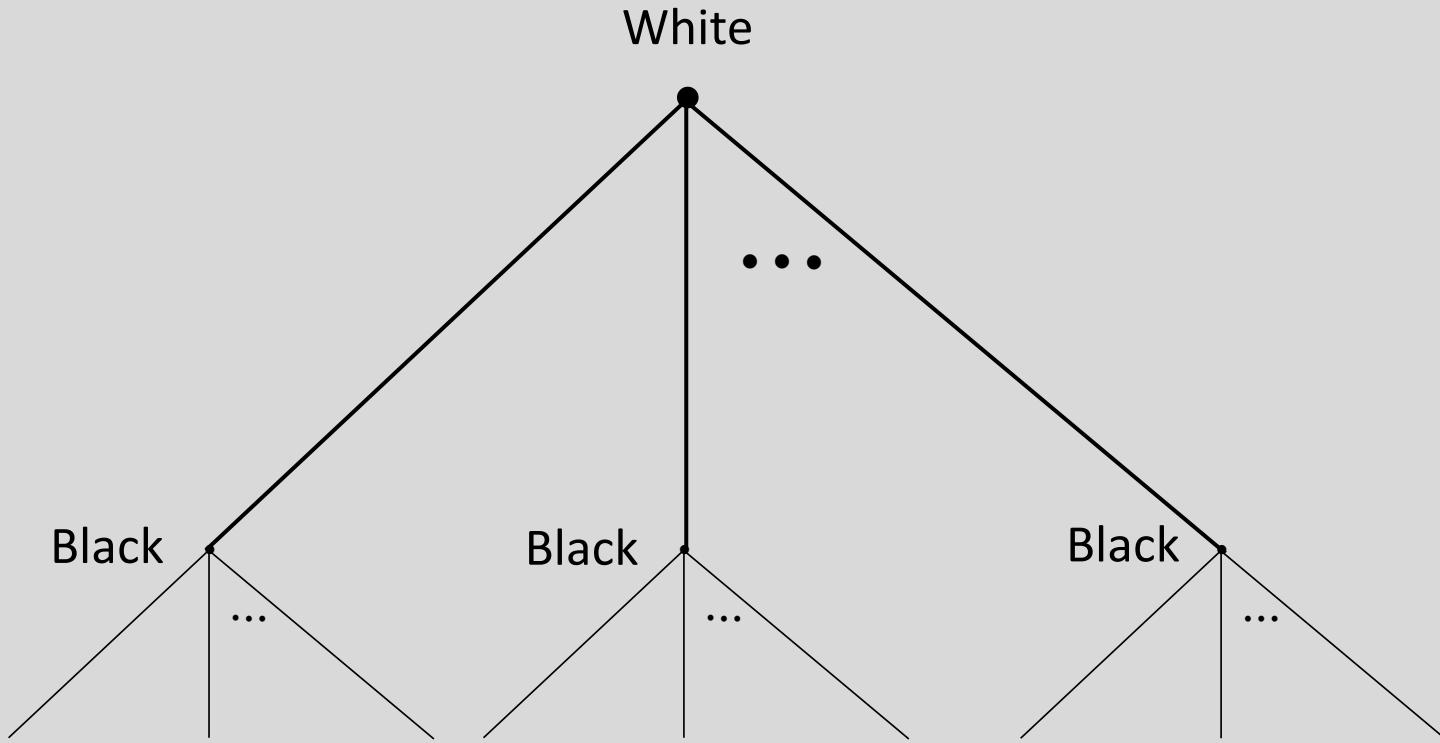
How to build a theory of
“I think you think I think ...”?

John von Neumann (1903-1957)

An enthusiastic polymath and urbane intellectual, he made major contributions to statistics, set theory, geometry, quantum mechanics, nuclear weapons design, fluid dynamics, game theory, and computer architecture.



An Early Theorem of Game Theory --- about Chess



Theorem: For finite Chess, either: (i) there is a strategy that guarantees White a win; or (ii) there is a strategy that guarantees Black a win; or (iii) each player has a strategy that guarantees a draw

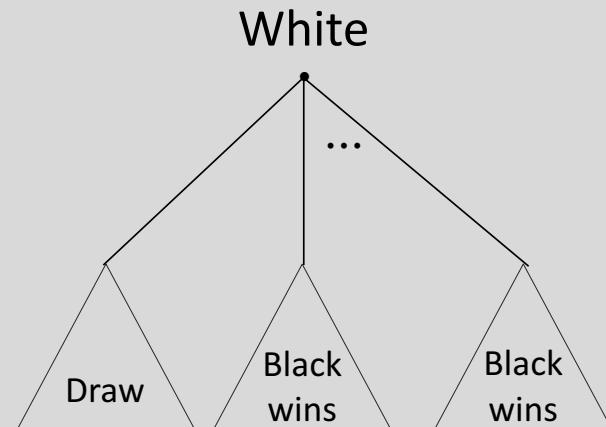
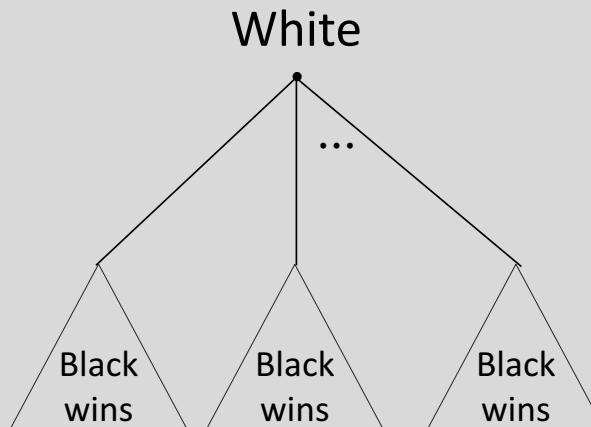
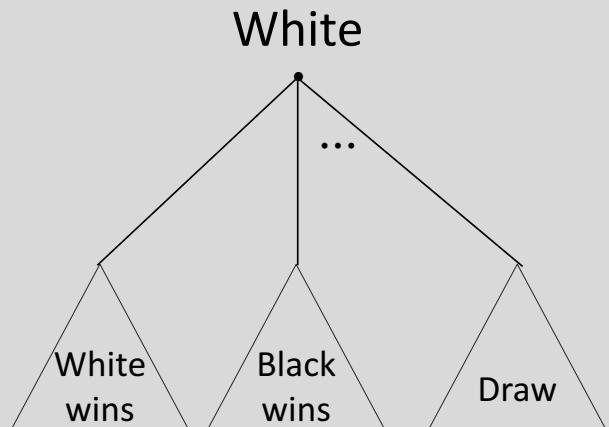
The Proof

We establish this result as a corollary to a more general theorem

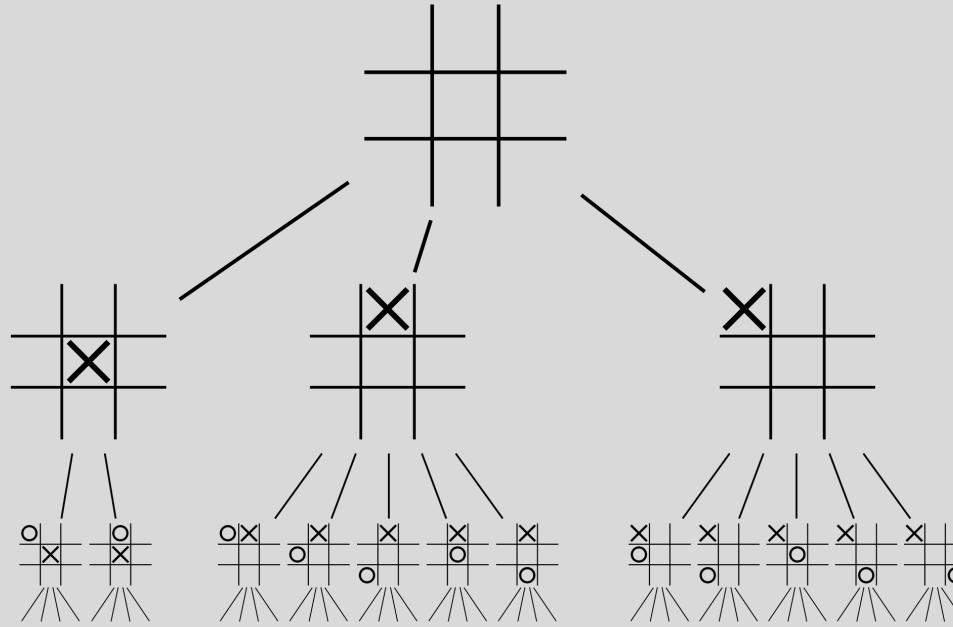
Theorem: Any two-player finite win-lose-draw game tree is “strictly determined” (in the above sense)

The proof of this theorem is by induction on the length of the tree

For the induction step, there are three mutually exclusive and collectively exhaustive cases to consider



Other Strictly Determined Games



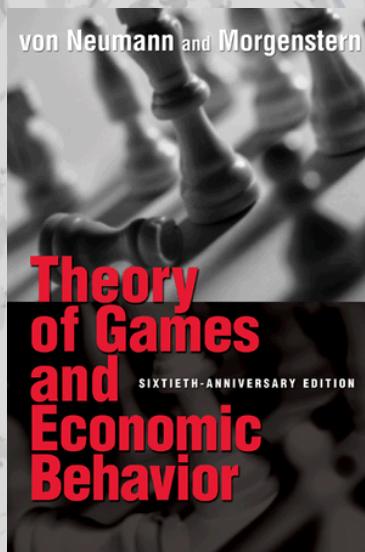
Tic-Tac-Toe (aka Noughts-and-Crosses) ... which case (i)-(iii) of the theorem applies?

Checkers (aka Draughts) ... which case (i)-(iii) of the theorem applies?

Chess ... ??

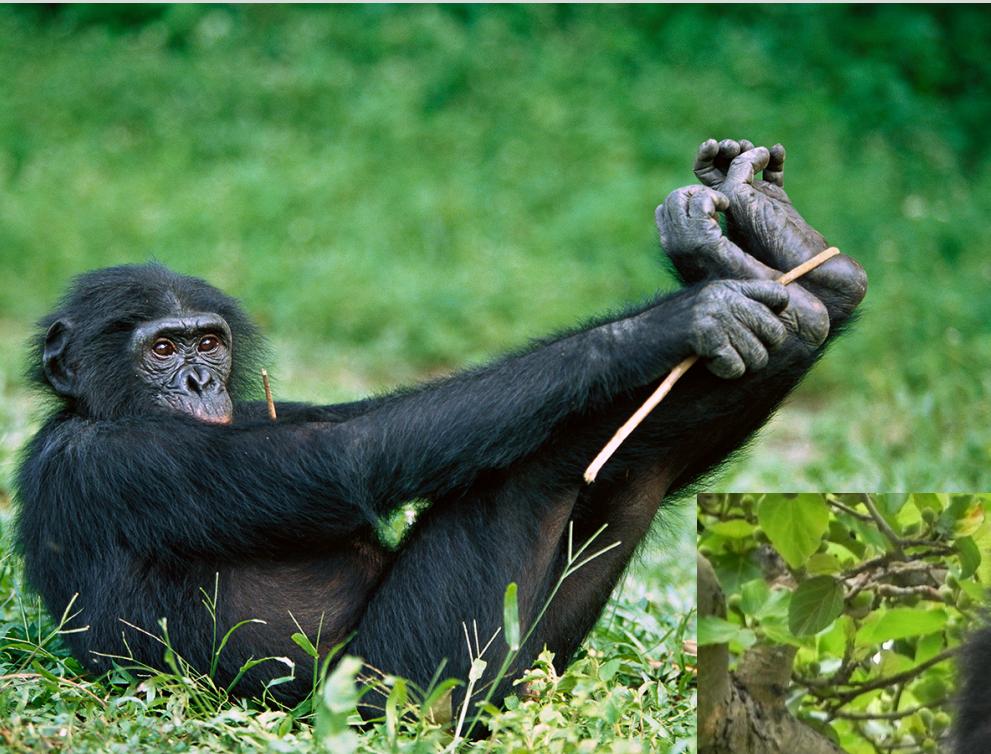
From Models of Parlor Games to Models of the World

In 1944, von Neumann teamed up with economist Oskar Morgenstern to write a book conceiving of the economy as a kind of (giant) game



Since then, game theory has been applied to animal behavior, biological cells, genes, ...

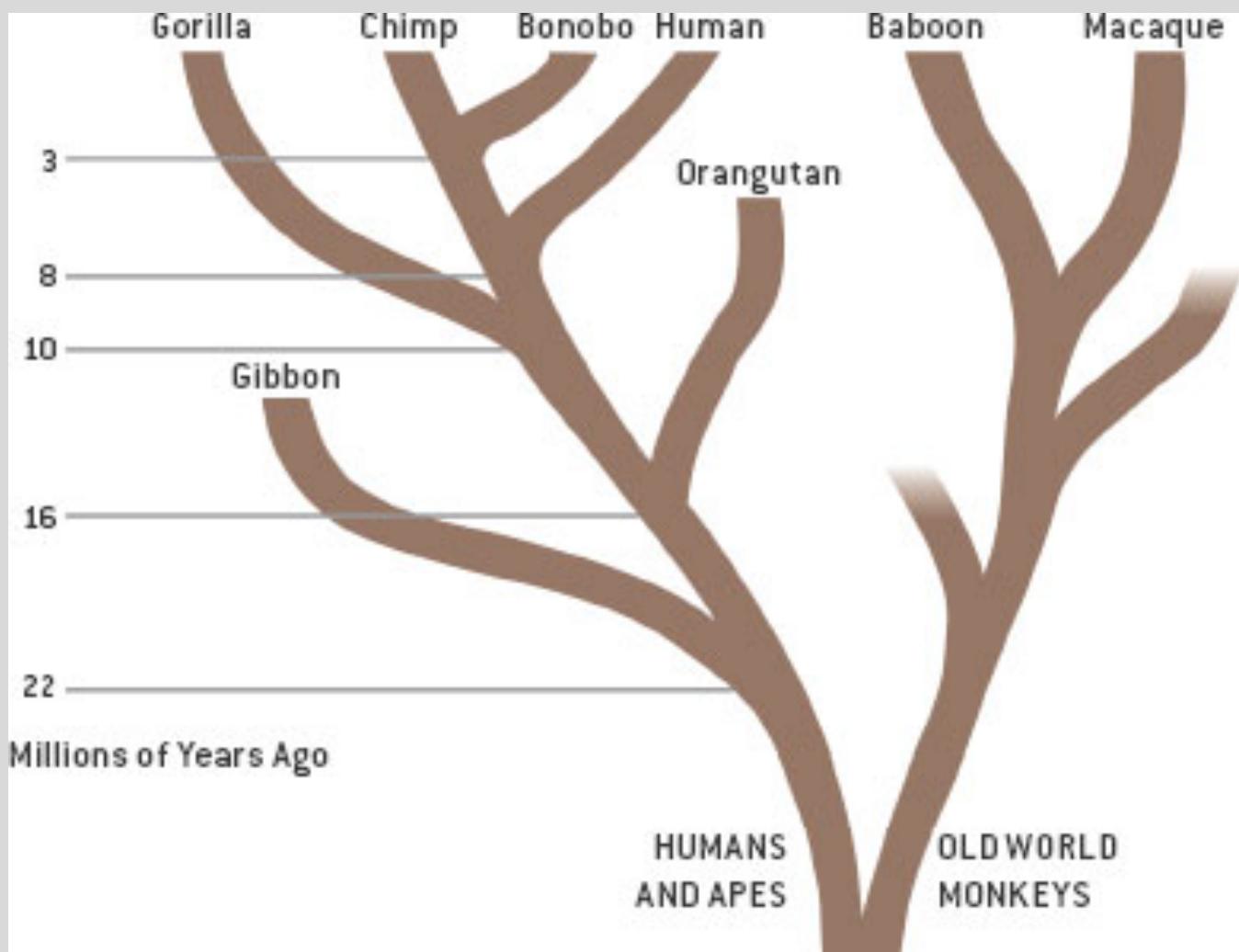
Dawkins, R., *The Selfish Gene*, Oxford University Press, 1976; Weibull, J., *Evolutionary Game Theory*, MIT Press, 1997; West, S., A. Griffin, A. Gardner, and S. Diggle, "Social Evolution Theory for Microorganisms," *Nature Reviews Microbiology*, 4, 2006, 597-607; image from <http://www.istockphoto.com/photo/crowd-of-people-above-gm171159648-19164839>



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The Expressive Power of Game Theory

To be a useful language for talking about human behavior, game theory needs to be able to describe both **competitive** and **cooperative** behavior

“Being both more systematically brutal than chimps and more empathic than bonobos, we are by far the most bipolar ape. Our societies are never completely peaceful, never completely competitive, never ruled by sheer selfishness, and never perfectly moral.”

-- Frans de Waal, *Our Inner Ape: A Leading Primatologist Explains Why We Are Who We Are*, Riverhead, 2006

“There can be no doubt that the tribe including many members who are always ready to give aid to each other, and to sacrifice themselves for the common good, would be victorious over other tribes. And this would be natural selection.”

-- Charles Darwin, *The Descent of Man, and Selection in Relation to Sex*, 1871, Ch.5