

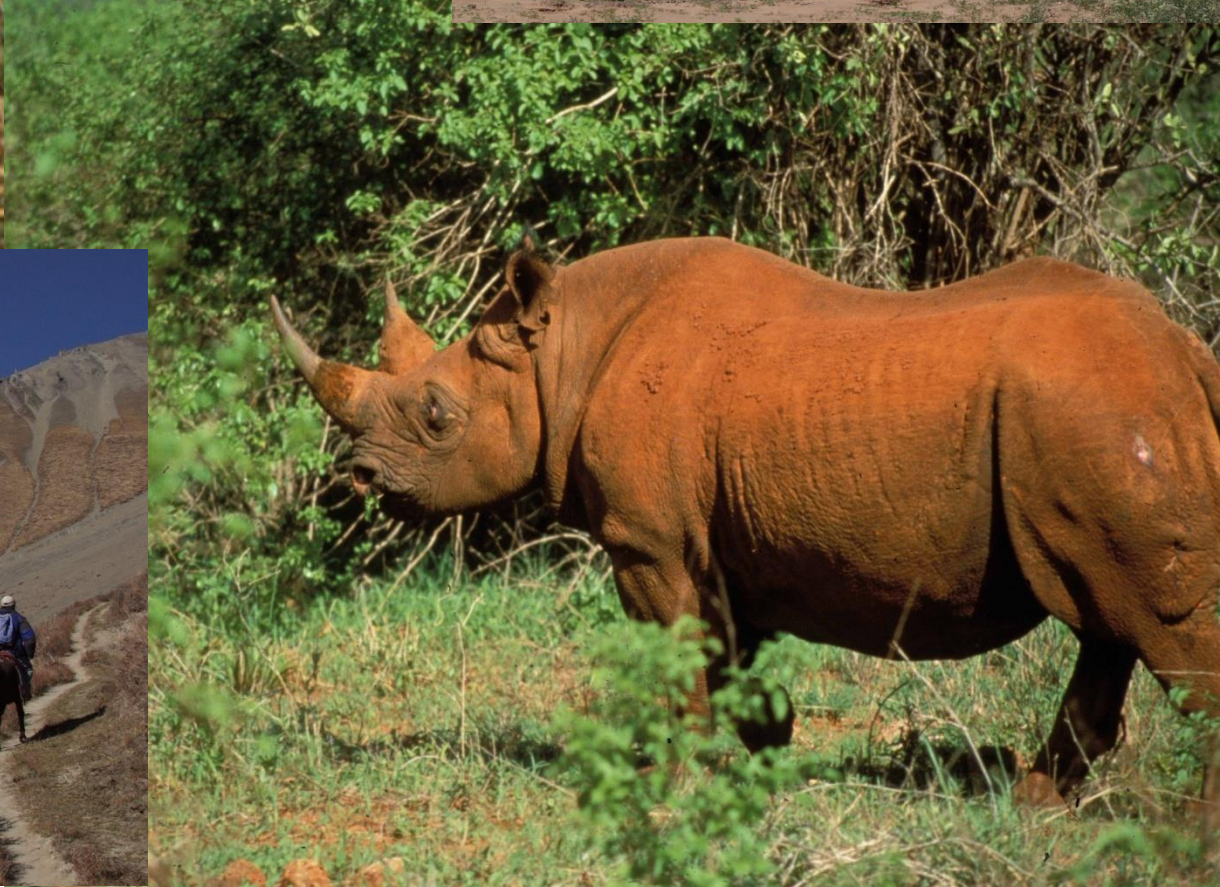
Why Evolutionary Game Theory is so Fantastic!

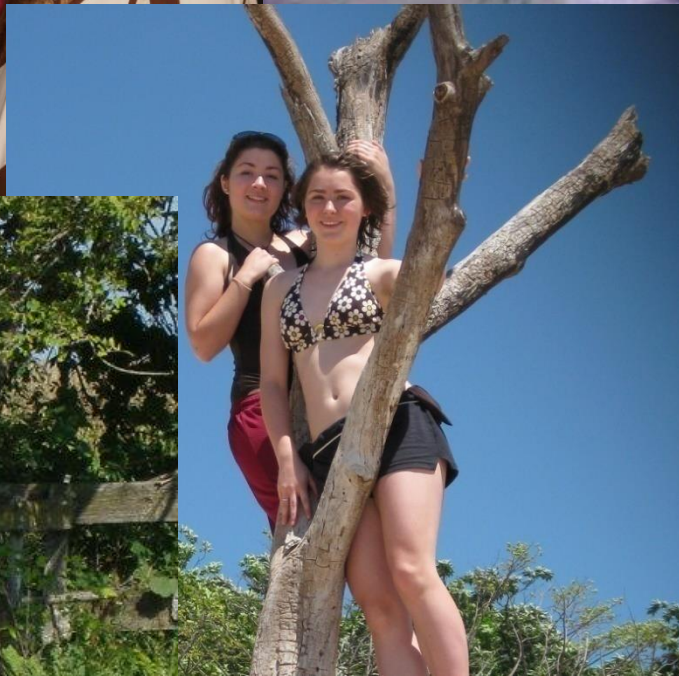
Joel S. Brown

University of Illinois at Chicago

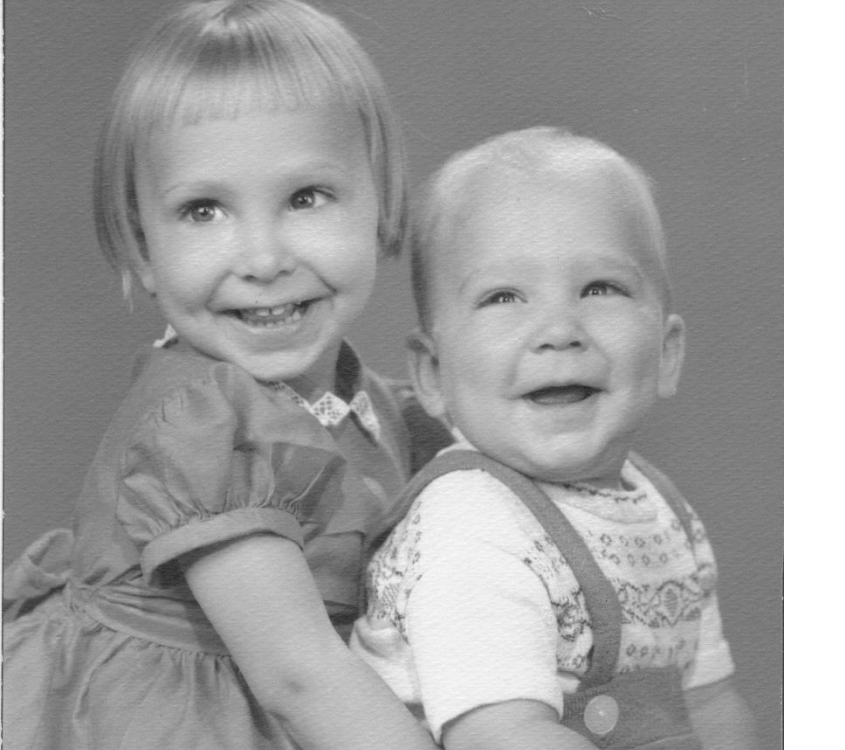


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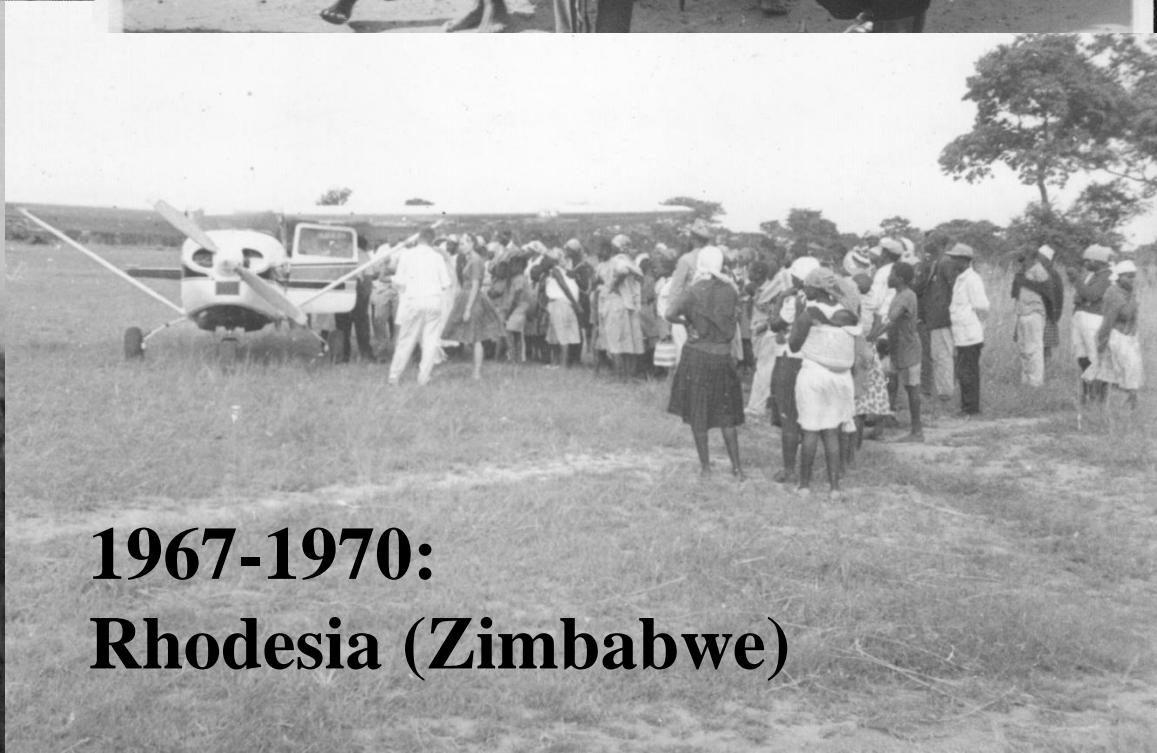






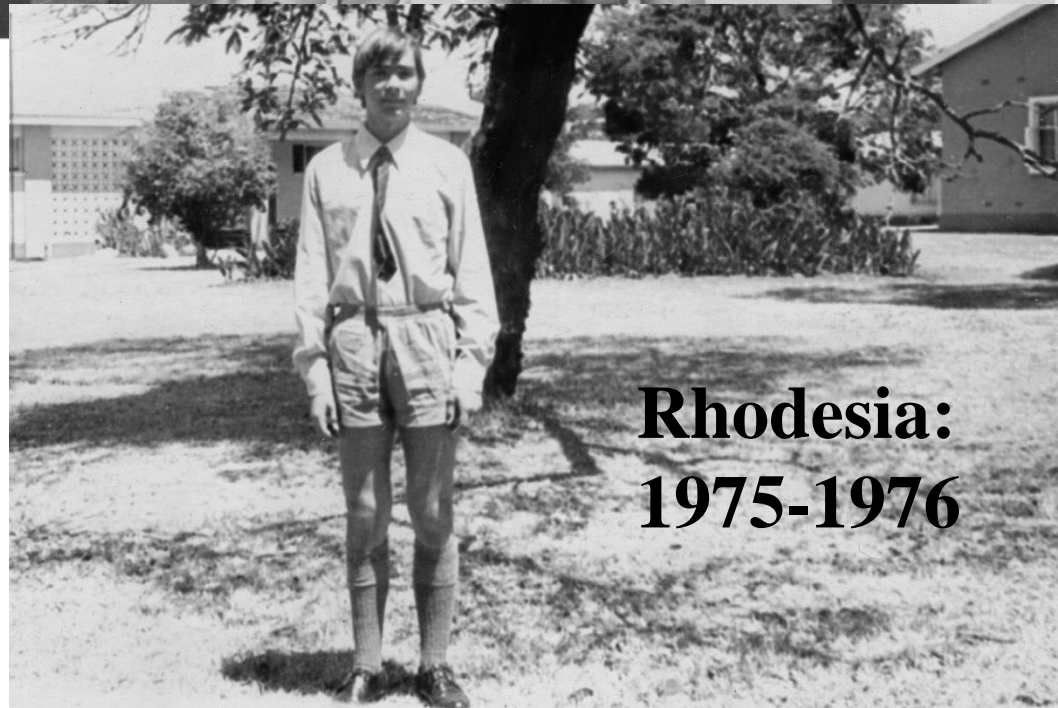




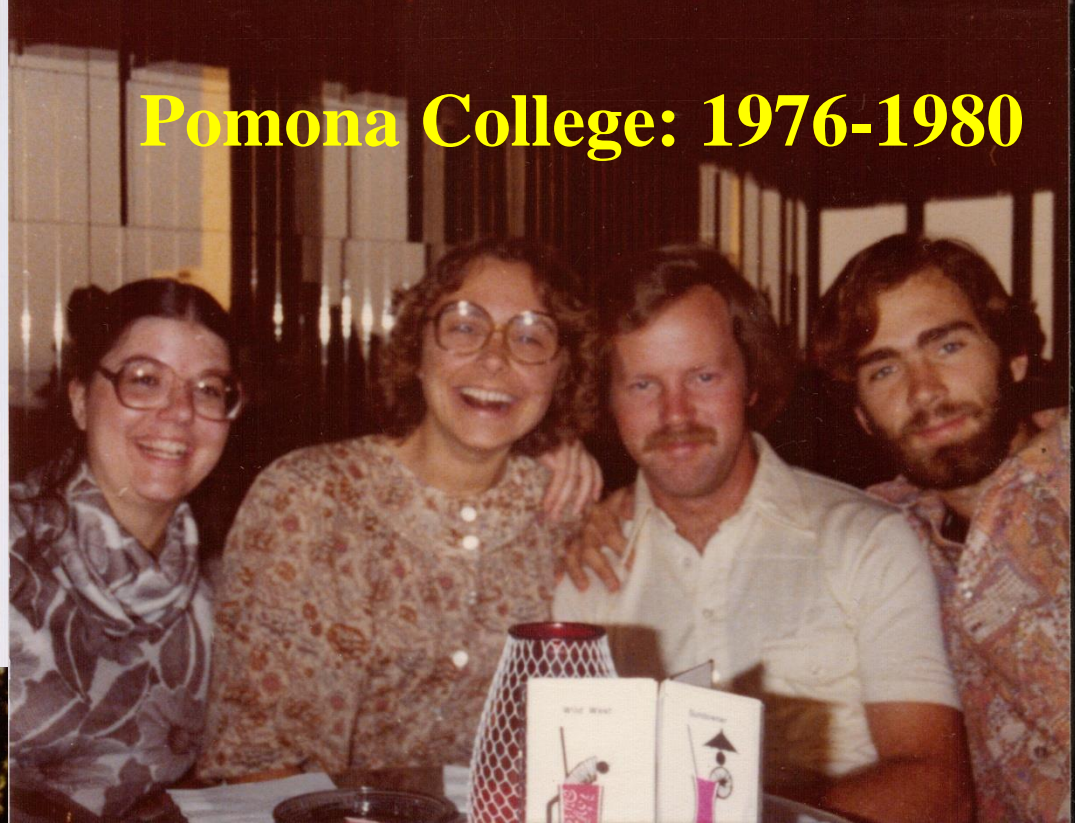
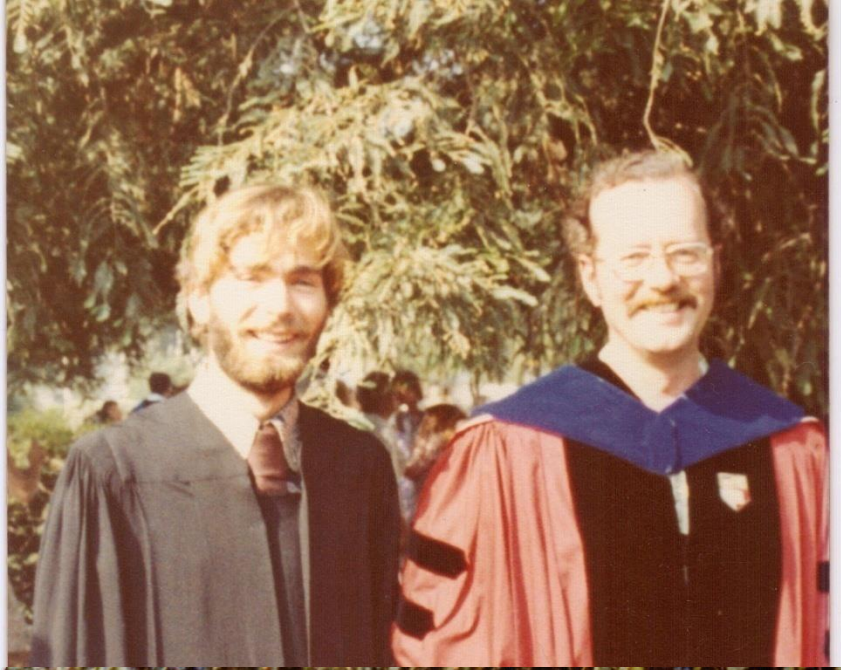


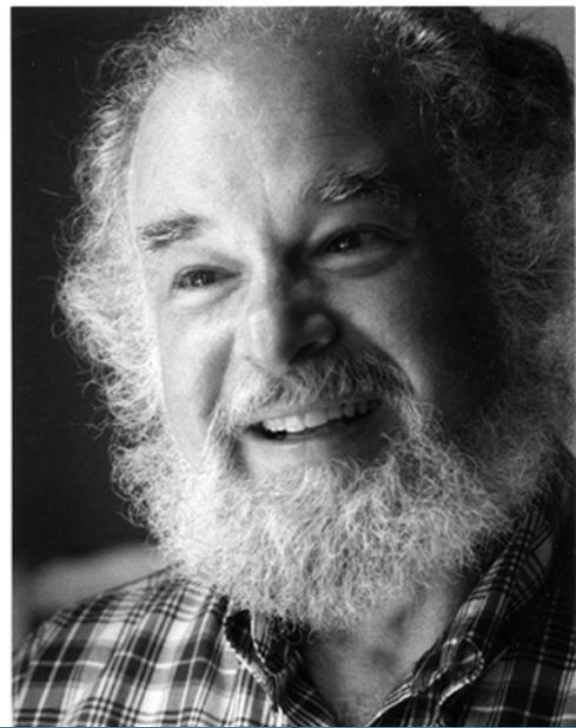
**1967-1970:
Rhodesia (Zimbabwe)**

Fullerton, CA: 1970-1975



**Rhodesia:
1975-1976**





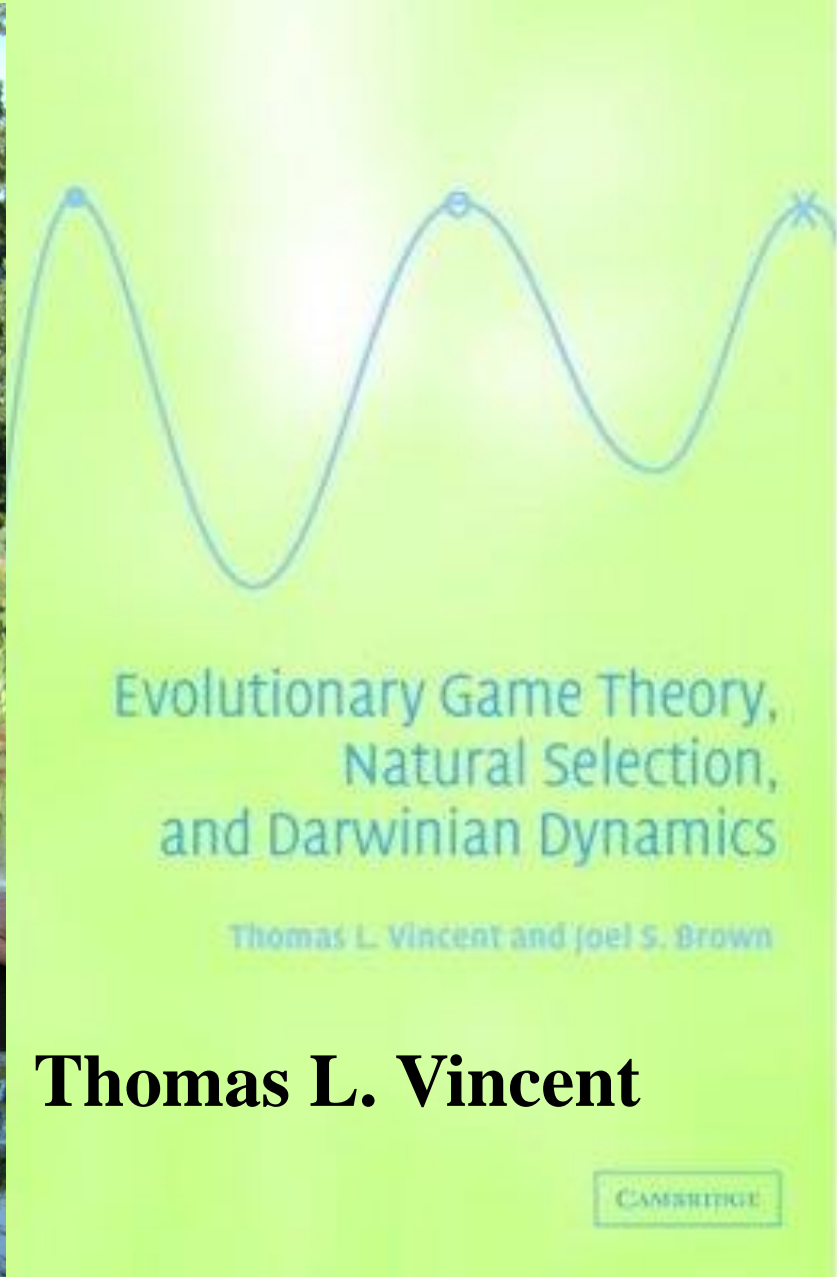
**Univ. Arizona:
1980-1986**





Israel: 1986-1987





Thomas L. Vincent

1935-2009



Game Theory



- The study of strategic decision making.
- The mathematics of solving conflicts of interests between rational decision makers.
- **Solving problems when your best strategy depends upon the strategies of others.**

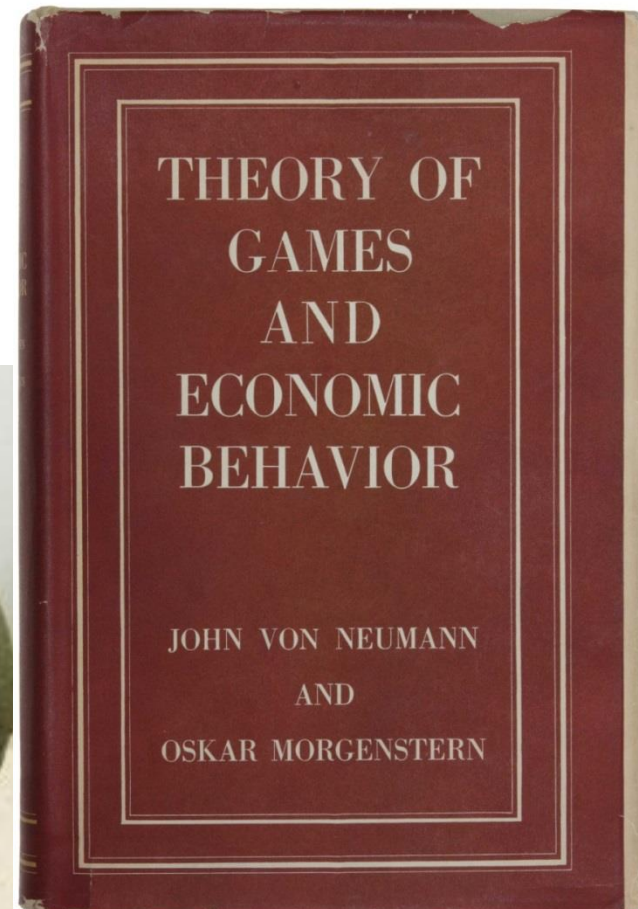


Game theory: Von Neumann and Morgenstern (1944)



“In mathematics you don’t understand things.
You just get used to them.”

John von Neumann (1903-1957)



No regret strategy: Nash (1951)

John Nash (born 1928)

“The Best for the Group
Comes when everyone
in the group does
what's best for himself
AND the group”



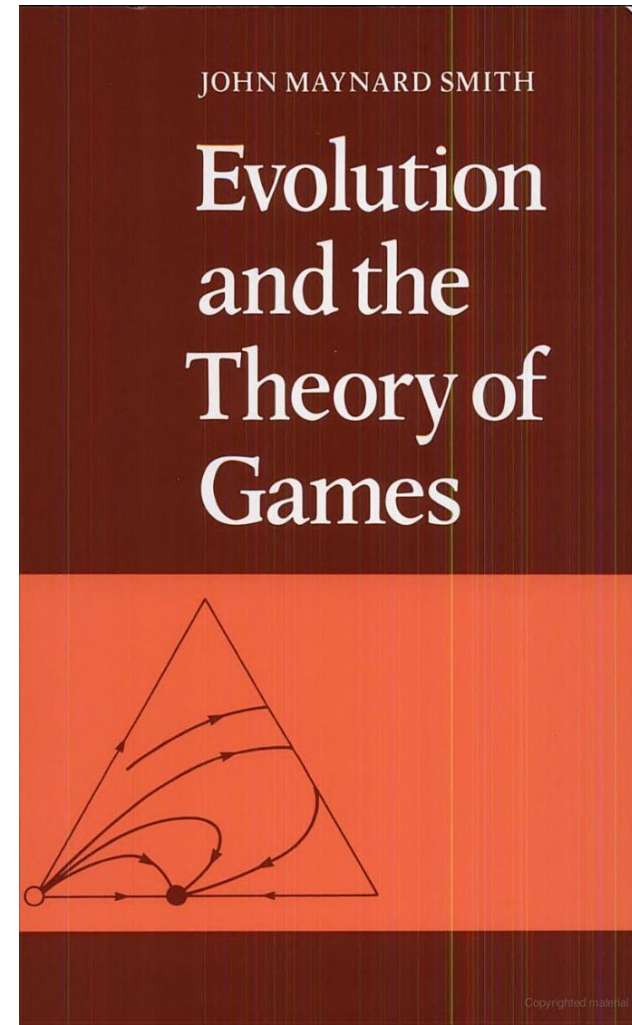
Evolutionary games: Maynard Smith and Price (1973)



John Maynard Smith
(1920-2004)



George Price
(1922-1975)



Games have:

Players
Rules
Strategies
Payoffs



*Success
with
Etiquette™*

Manners For Men



Unravel the mystique of etiquette and discover valuable techniques to sharpen your professionalism, corporate image, and business savvy to outshine the competition.

Administrative Support Associates

Prisoner's dilemma

Jesse's Actions

Confess

Don't confess

Frank's Actions

Confess

Both receive 5 years in jail

Jesse 10 years, Frank goes free

Don't confess

Frank 10 years, Jesse goes free

Both receive 2 years in jail.

Battle of the Sexes

		Joe	
		go to ball game	go to ballet
Sally	go to ball game	Joe is very happy; Sally is OK	Joe is unhappy; Sally is unhappy
	go to ballet	Joe is happy; Sally is happy	Joe is OK; Sally is very happy

Big-pig Little-pig Game

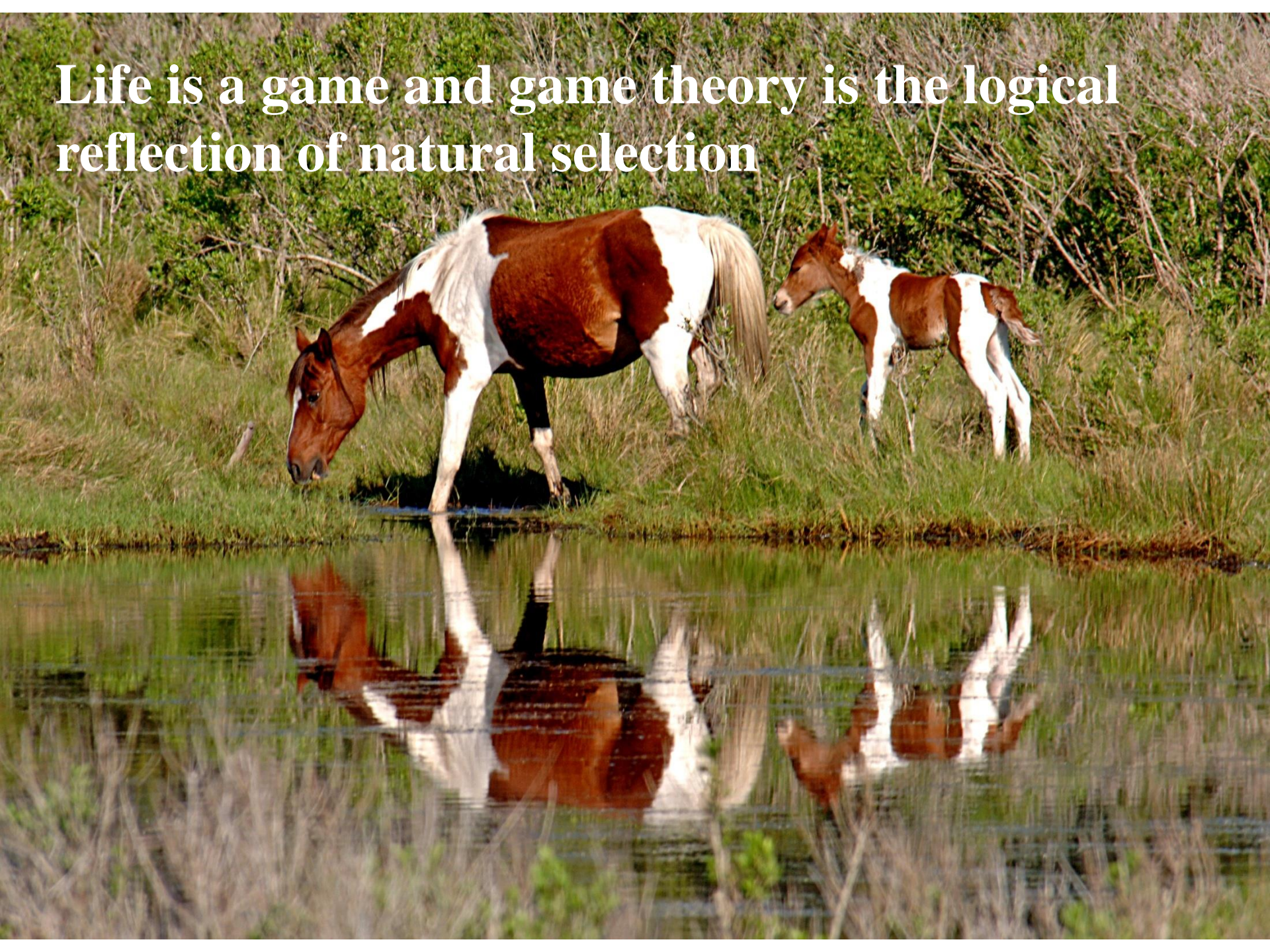
		Dominant Pig	
		Don't press lever	Press lever
Subordinate Pig	Don't press lever	Neither pig gets any food.	Subordinate pig eats most of the food before dominant pig pushes it away.
	Press lever	Dominant pig eats all of the food. Subordinate pig expends energy pushing the lever.	Subordinate pig can eat $1/3$ the food before dominant pig pushes it away.

Nature is.....

- A complex dynamical system
- Hierarchical – from molecules to ecosystems
- **Product of natural selection**

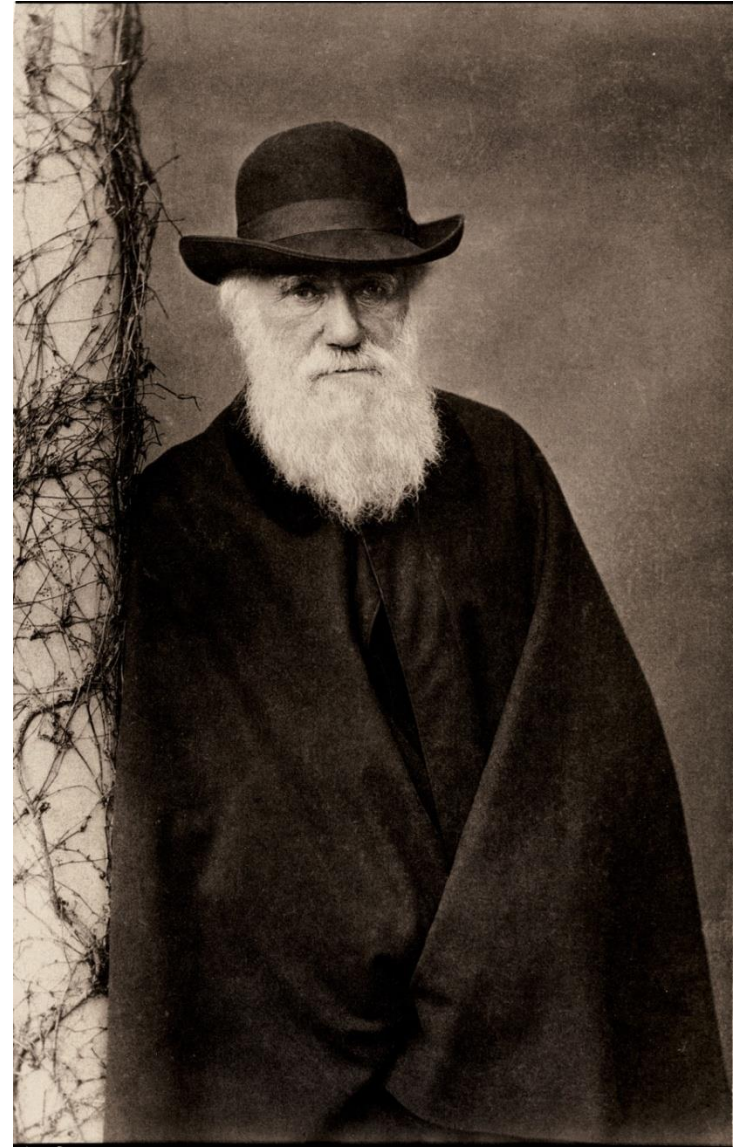


Life is a game and game theory is the logical reflection of natural selection



Goals

- Crash Course in Evolutionary Game Theory
- What do we mean by “Natural Selection”, “Adaptations”, and “Fitness”?
- Niches, Species, and Coevolution





Darwin's Postulates

- Heritable Variation
- Struggle for Existence
- Variation influences the Struggle

“In the survival of favoured individuals and races, during the constantly-recurring struggle for existence, we see a powerful and ever-acting form of selection”

Natural Selection can be studied

...

- Through the recipe of inheritance: genetics
- As a historical process: Phylogenetics
- Fit of Form and Function: Adaptations



Trends in the study of evolution

- Rediscovery of Mendel's Laws was a mixed blessing for understanding natural selection
- 1920's-1930's: Golden Age of Population Genetics: Fisher, Haldane, Wright and many others
- Led to Genetics Research Program: Genes became the lingua franca of natural selection
- 1950's and onwards: Quantitative Genetics

Contexts of Natural Selection

- Density Independent – selects for adaptations that maximize growth rates (speed)
- Density-dependent – selects for adaptations that maximize population size or resource use efficiency (efficiency)
- Frequency-dependent – an organisms fitness depends upon the frequency of other phenotypes in the population (????)

“Darwin would have loved game theory”

Douglas Kelt, Mendoza, Argentina, 2009

- Sexual Selection
- Sociobiology
- Predator-prey adaptations
- Habitat Selection

“I have tried lately to read Shakespeare, and found it so intolerably dull that it nauseated me.”



Life as a Game

- Organisms are the players
- Heritable traits are the strategies
- Organisms inherit rather than choose their strategies
- Per capita growth rates are the payoffs
- The environment sets the rules



Trends in Evolutionary Game theory

- Game theory: Von Neumann and Morgenstern (1944)
- No regret strategy: Nash (1951)
- Evolutionary games: Maynard Smith and Price (1973)
- Non-matrix: Continuous games: Auslander et al. (1978)

More trends in Evolutionary Game Theory

- G-function approach: Vincent and Brown (1984)
- Evolutionarily Stable Minimum: Abrams et al. (1993)
- Adaptive Dynamics: Metz et al. (1995)
- Three aspects of Evolutionary Stability: Geritz et al. (1998)
- Niche Coevolution: Ripa et al. (2009)