INTRODUCTION & PROPOSITIONAL LOGIC

Dougherty, POLS 8000

Strategy in Politics

Professor:	Keith Dougherty
Home Page:	**spia.uga.edu/faculty_pages/dougherk/**
Office:	Baldwin 408, (706)542-2989
e-mail:	dougherk@uga.edu
Office Hours:	T&Th, 11:00am-12:00 p.m. and by appointment

Political Science

1. Is political science an oxymoron?
2. Perhaps science is a method, not a subject.

alchemy	chemistry
astrology	astronomy
social studies	political science

3. Science requires at least two elements:
   a. internally consistent theories
   b. tests of those theories
4. Internally consistent theories:
   a. avoid contradictions like "p" and "not p."
   b. make assumptions explicit, so they are not changed midstream.
   c. help assure that the conclusion follows from the premises (logically valid).
   d. allow researchers to handle complicated issues like strategic behavior.
   e. provide an explanation.

Strategy in Politics

Professor: Keith Dougherty
Home Page: **http://spia.uga.edu/faculty_pages/dougherk/**

Course Outline

I. Introduction to Logic
II. Social Choice Theory
III. Game Theory
    A. Sequential Games.
        1. Application: Marbury v Madison
    B. Simultaneous Games.
        1. Application: ratification of the Constitution.
    C. Incomplete Information.
        1. Application: the Cuban Missile Crisis
    D. Collective action theory and N-player games.
        1. Application: international alliances.
        2. Application: voter turnout and the political machines.

Strategy in Politics

Professor: Keith Dougherty
Home Page: **http://spia.uga.edu/faculty_pages/dougherk/**

Course Outline

IV. Single Dimensional Spatial Voting.

   A. Median Voter Theorem.

      1. Application: pivotal politics.

      2. Application: Downs' theory of mass elections.

V. Multidimensional Spatial Voting.

   A. McKelvey's Chaos Theorem

      1. Application: Government Formation in Parliaments.

      2. Application: pivotal voting at the Constitutional Convention.

      3. Application: the election of 1824.

Strategy in Politics

Professor: Keith Dougherty
Home Page: **http://spia.uga.edu/faculty_pages/dougherk/**

Grading

	Due Date	Percent of Grade
HOMEWORK 1 (social choice)	Jan 20	20%
HOMEWORK 2 (game theory)	Feb 3	20%
HOMEWORK 3 (n-player games)	Mar 3	20%
HOMEWORK 4 (spatial voting)	Mar 31	20%
RESEARCH PAPER	Apr 21	20%

Make-ups

1. Assignments will be lowered one letter grade for every **working** day they are late. Put late assignments under my office door (Baldwin 408).

Strategy in Politics

Professor: Keith Dougherty
Home Page: **http://spia.uga.edu/faculty_pages/dougherk/**

Other Business

1. All assignments are posted on my web page above (*not* e-commons).
2. Lectures will be updated by 11 pm Monday night -- at the latest.
3. Problem Solving
   a. The only way to learn math (and game theory) is through practice.
   b. I strongly recommend that you partner with at least one other student and pick one or two problems each week that you will solve. You can then compare answers to see if you are right.
4. Homeworks
   a. You must attempt to work through *as much of the homeworks as possible on your own, and then work with other students only when you are stuck or want to check your answers.*
   b. You need to write up your own answers, using your own words and explanations. If you turn in the exact same answer as another student, I will consider it academic dishonesty. Penalties apply.
   c. Every answer needs an explanation which includes how you derived the solution.
   d. Your answers should be neat. Hence, they will probably have to be re-written before they are turned in.

Strategy in Politics

Professor: Keith Dougherty
Home Page: **http://spia.uga.edu/faculty_pages/dougherk/**

Required Text

1. Dixit, Avinash, David H. Reiley, and Susan Skeath (1991) *Games of Strategy, 3nd ed. New York: W.W. Norton.*
2. Olson, Mancur (1971) *The Logic of Collective Action. New York: Harvard University Press.*
3. Hinich, Melvin and Michael Munger (1997) *Analytical Politics. New York: Cambridge University Press.*
4. Articles in the dropbox, anything marked with an **DP**. *Password: dougherty*

Preliminaries

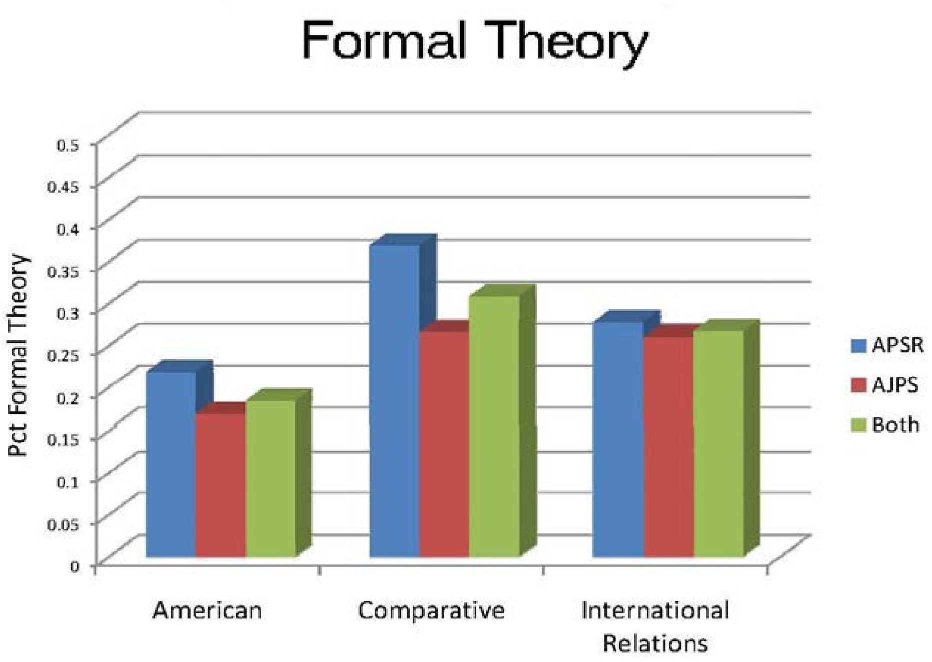
A. What is formal theory?

1. Construction and analysis of mathematical models.
2. Includes decision theory, social choice, game theory, spatial voting theory, behavioral game theory, and agent-based modeling (among others).
3. Rational choice theory is a particular type of formal theory.
   a. An actor is rational if he/she takes those actions that give him/her more preferred outcomes.
   b. Rational choice theory is a series of theories based on this premise.
4. Goal of formal theory: to explicitly deduce behavior that follows from a model's assumptions.

Preliminaries

B. Why learn formal theory?

1. To understand cutting edge research in your field.
2. To make sure your conclusions follow from your premises (i.e. to develop internally consistent theories of politics).
3. To derive empirical implications of formal models developed by others.



Introduction to Logic

A deductive argument is valid if the premises are related to the conclusion in such a way that the conclusion must be true if the premises are true.

Premises are the statements upon which an argument is based.

Valid Arguments

Example 1

It will either rain or snow tomorrow.

It’s too warm for snow.

Therefore, it will rain tomorrow.

Example 2

If today is Monday, then I have to teach today.

Today is Monday.

Therefore, I have to teach today.

Valid Arguments

<u>Valid Argument</u>

It will either rain or snow tomorrow.

It's too warm for snow.

Therefore, it will rain tomorrow.

<u>Valid, Formal Argument</u>

Let R = it will rain tomorrow.

S = it will snow tomorrow.

$[(R \vee S) \,\&\, {\sim}S] \rightarrow R$

Invalid Arguments

<u>Invalid Argument</u>

Bob is either liberal or conservative.

All liberals support Obama.

Bob supports Obama.

Therefore, Bob is a liberal.

Logical Operators

Operator	Symbol	Ordinary Language
Negation	~	not
Conjunction	&	and
Disjunction	V	or (either or both)
Conditional	→	if, then
Biconditional	↔	if and only if

Truth Table

P	Q	~P	P & Q	P V Q	P → Q	P ↔ Q
T	T					
T	F					
F	T					
F	F					

Statements: P, Q.

Ex: P – circuses are wonderful.

Ex: Q – joe likes circuses.

Truth Table

P	Q	~P	P & Q	P V Q	P → Q	P ↔ Q
T	T	F				
T	F	F				
F	T	T				
F	F	T				

Truth Table

P	**Q**	**~P**	**P & Q**	**P V Q**	**P → Q**	**P ↔ Q**
T	T	F	T			
T	F	F	F			
F	T	T	F			
F	F	T	F			

Truth Table

P	Q	~P	P & Q	P V Q	P → Q	P ↔ Q
T	T	F	T	T		
T	F	F	F	T		
F	T	T	F	T		
F	F	T	F	F		

Truth Table

P	**Q**	**~P**	**P & Q**	**P V Q**	**P → Q**	**P ↔ Q**
T	T	F	T	T	T	
T	F	F	F	T	F	
F	T	T	F	T	T	
F	F	T	F	F	T	

Note: if P is not true, then P is not related to Q and anything goes.

Truth Table

P	Q	~P	P & Q	P V Q	P → Q	P ↔ Q
T	T	F	T	T	T	T
T	F	F	F	T	F	F
F	T	T	F	T	T	F
F	F	T	F	F	T	T

Simple Proofs Using the Truth Table

Show ~ (A & B) → ~A v ~B

A	**B**	**~A**	**A & B**	**~B**	**~(A&B)**	**~A v ~B**	**~(A&B) → ~A v ~B**
T	T	F	T	F	F	F	T
T	F	F	F	T	T	T	T
F	T	T	F	F	T	T	T
F	F	T	F	T	T	T	T

Tautology: a statement that is always true regardless of the truth value of its premises.

- Ex: regardless of whether P or Q are true, it is always the case that ~ (A & B) → ~A v ~B.
- Theorems are conclusions that are deducible from premises.

Simple Proofs Using the Truth Table

Contradiction: a statement that is always false regardless of the truth value of its premises.

Ex: (A & ~A)

A	**B**	**~A**	**A & ~A**
T	T	F	F
T	F	F	F
F	T	T	F
F	F	T	F

Valid Arguments Using the Truth Table

$[(p \rightarrow q) \& (\sim q \rightarrow r) \& \sim r] \rightarrow \sim p$

p	q	r	p→q	~q→r	~r	~p	[(p →q)&(~q→r)&~r	[(p →q)&(~q→r)&~r] → ~p
T	T	T	T	T	F	F	F	T
T	T	F	T	T	T	F	T	F

Valid Arguments Using the Truth Table

$[(p \rightarrow q) \ \& \ (\sim q \rightarrow r) \ \& \ \sim r] \rightarrow \sim p$

p	q	r	p→q	~q→r	~r	~p	[(p →q)&(~q→r)&~r	[(p →q)&(~q→r)&~r] → ~p
T	T	T	T	T	F	F	F	T
T	T	F	T	T	T	F	T	F

Note: this statement is true if all of its premises are true, i.e. p, q, and r are true. Hence, it is valid.

Valid Arguments Using the Truth Table

$[(p \rightarrow q) \& (\sim q \rightarrow r) \& \sim r] \rightarrow \sim p$

p	q	r	p→q	~q→r	~r	~p	[(p →q)&(~q→r)&~r	[(p →q)&(~q→r)&~r] → ~p
T	T	T	T	T	F	F	F	T
T	T	F	T	T	T	F	T	F

However, the statement is *not* a tautology because it is false for at least one set of truth values – the green case above.

Conclusion

1. In general, formal theorists want to use valid arguments and tautologies to derive conclusions.
2. Formal theorists want to avoid contradictions.
3. They formalize political processes (i.e. put statements in mathematical form) because math and logic helps them assure that the conclusion follows from the premises.
4. Almost all theories are conditional: $A \rightarrow B$.
   a. What if the premises are false (i.e. ~ A)?
   b. Should we test formal theories?
   c. We cannot "test" whether a deduction follows using data. But we can test whether the assumptions are true or whether the theory as a whole applies to a topic of interest.
   d. Clarke, Kevin. A., & Primo, David M. (2012). *A model discipline: Political science and the logic of representations*. Oxford University Press.