09 / 26 / 08

Friday, September 26, 2008
9:59 AM

- Homework: read in the book pgs. 1-10 and do "You Try It" (to use Submit); Read 19-29 for lecture.
- C. Anthony Anderson (caanders@philosophy.ucsb.edu)

- **Logic:**
    - Won't turn into a robot
    - Just a way of helping you find out what is true
    - GOAL = truth (you have to accept that there are objective truths)
    - Goal of Logic is to preserve truth
    - "The Art of Thinking" or "The Science of correct inference or reasoning"
    - Methods/rules/techniques to get from true things to true things
    - Aristotle was the first to make a system with correct rules of thinking

Logic Important { Math, Science, Philosophy, Law, Life }

- **Field of Logic**
    - Two SubFields
        - **Inductive Logic**: accounts for most beliefs you have, reasoning concerned with probabilities (very feeble)
        - **Deductive Logic**: invented by Aristotle, surefire, no risk, can't fail reasoning, in very good shape, mathematics is based on this, foundational

- **Terms**
    - **Argument**: a collection of statements, (either true or false) one of which is designated as the conclusion, The rest are called premises of the argument.
    - **Premises**: information you use
    - **Conclusion**: what you infer from it
    - If premises logically show the conclusion, if the premises are true, the conclusion MUST be true, or is a **deductively valid argument**. (impossible to have true premises and a false conclusion)
        - Logic will only tell you about the relationship between the premises and conclusion, not the validity of the statements.
        - Alvin is an alligator
        - All alligators love to bay at the moon.
        - .:. Alvin loves to bay at the moon (can't be true since Alligators don't bay, but the argument is still deductively valid.
    - **Sound argument** = deductively valid and true premises (case above is valid, but not sound)

- **FOL First Order Logic**
    - Good for almost everything deductively reasoned
    -

09 / 29 / 08

Monday, September 29, 2008
10:05 AM

- **FOL = First Order Logic**
  - Collection of languages with a very simple structure/rules/grammar
  - Atomic Sentences: simplest kinds of sentences
  - The Analog of the name
    - Singular descriptive Terms like the "President of the United States in 2008", "George W. Bush"
    - Individual Constants - Block Language = "a, b.. If n, n2, n3…"
    - "george bush"
    - Individual Constants = any name.
    - **Same individual constant cannot represent two things**
    - **No imaginary things like Superman or Pegasus**
    - 1 Name for 1 Thing
    - **An object may have more than one name or no name at all**
  - Predicate Symbols:
    - Relation symbols. Used to say something about the name.
    - "George Bush loves Sarah Palin"
      - In English, George Bush is the subject, but in FOL, both GWB and SP are the subjects
      - Loves is a predicate symbol
      - This is a binary relationship because it is between two object
      - 3 = Tertiary Relationship
      - Rewritten as: Loves(george bush, sara palin) [atomic sentence] [arity 2]
      - President (george bush) [arity 1]
    - **Arity, or Degree** = tell me how many things the predicate directly applies to

- **Blocks Language**
  - Arity 1: Cube, Tet, Dodec, Small, Medium, Large
  - Arity 2: Smaller, Larger, LeftOf, RightOf, BackOf, FrontOf, SameSize, SameShape, SameRow, SameCol, Adjoins, =
  - Arity 3: Between
  - All the predicates express properties that are determinant/fixed (Tall is not a relative value)
  - = means IS (identity) not "a lot alike" or "similar" but defines an object

10 / 01 / 08

Wednesday, October 01, 2008
10:05 AM

- **<u>Logical Consequence</u>**
  - Logic aims to simplify this
  - **Argument**: a set of statements (declarative sentence that is either true or false), one of which is designated as the conclusion
    - By whom? Typically the person giving the argument
  - **Premises**: the rest of the statements in an argument that are not conclusions
  - **Conclusion**: something supported by the premises of the argument (hence, therefore, thus, ergo)
  - Syllogism: special type of argument with two premises

- **<u>Fitch Format</u>**
  - Standard Form of an argument)
  - An alleged conclusion is a logical consequence of premises if there is no possible situation in which the premises are true and the conclusion is false
    - Argument is then deductively valid
  - A deductively valid argument can have any combination of truth and falsities, except the one where the premises are true and the conclusion false
  - Truth-value = T or F
  - **Sound Argument**: logically valid and true premises (very reasonable)

- **<u>Methods of Proof</u>**
  - Possible is to be understood in the widest sense: means there is no contradiction hiding in the idea… it is thinkable without contradiction
  - Not an issue about physically possible (faster than light travel) is possible, even if not physically possible

10 / 03 / 08

Friday, October 03, 2008
10:06 AM

- Homework: Read introduction, chapters 1-3 do you try it pg. 8-10 and 24-25
- C. Anthony Anderson (caanders@philosophy.ucsb.edu)

- Talk to Professor about Textbook

- **Ideal Argument**
    - All the premises true
    - Conclusion is true
    - The conclusion follows from the premises (deductively valid)

- **Soundness:**
    - True premises
    - True premises guarantee a true conclusion (validity)
    - Conclusion is true

- Is
    - Is of predication (Frankie is happy)
    - Is of identity (Frankie is frank pike)
    - Is of Existence (Frankie is = Frankie exists)

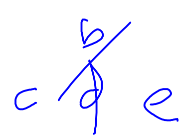
10 / 06 / 08

Monday, October 06, 2008
10:01 AM

- Homework:
  - Due Wednesday: Exercises 1.3, 1.4, 1.5, 1.9, 2.1, 2.2, 2.3 (Read Chapter 3)
  - Due Friday: Exercises 2.7 - 2.13 (THROUGH)

- Have to get the program
- **Identity**
  - Counted as part of logic
  - Completely general
  - Capgrase Syndrome: a delusion that some friend or family member has been replaced by an identical looking imposter
  - Rules of reasoning for identity
  - **Substitution**
    - (...a...) [statement about a]
    - a=b
    - .'. (...b...) [statement with a replaced with b]
      - If I say something about A, I can infer a statement with A replaced by B
      - *Elimination*
  - **Symmetric Identity**
    - Whenever it holds in one direction, it holds in the other
    - A = B
    - .'. B = A
  - **Reflexivity of Identity**
    - ...
    - .'. A = A
    - "is as smart as"
    - *Introduction*
  - **Euclid's Principle (Transitivity of Identity)**
    - A relationship is reflexive
    - A = B
    - B = C
    - .'. A = C
  - **Similarity is not transitive**
  - Analytic Consequences
    - Special logic depending on case
    - LeftOf (a, b)
    - .'. RightOf (b, a)
    - Doesn't always hold true, but given a set of circumstances, it can be consequential)

- Informal Proof
  - RightOf (b, c)
  - LeftOf (d, e) → left of (c, b)
  - b=d → left of (b,e)
  - .'. LeftOf (c, e)



- Formal Proof
  - 1 . a=b
  - ----------
  - 2 . a=a = Int [reflexivity of a]
  - 3 . b=a = Elim: 1,2 [elimination of a through 1 and 2]

10 / 08 / 08

Wednesday, October 08, 2008
10:03 AM

- **<u>Things to remember</u>**
  - n=n
    - Identity introduction (int.)
    - Not a result of any previous line
    - Rule of logic that doesn't require any premises
  - n=m, P(m), P(n)
    - Identity elimination (elim.)
    - References a past line and replaces one or more instances of m with n
  - P, P
    - Reiteration (reit.)
    - Already proved it, but it will simplify things later
    - Is still a logical consequence of itself (if p were true, it would have to be true)

Truth Tables

P	¬P
T	F
F	T

- **<u>Boolean Connections</u>**
  - Negation ¬ (∼, −)
    - Simplest possible logical concept
    - ¬ Home(mary) = Mary is not home
    - ¬ ¬ Home(mary) = double negative (Mary does not not have money)
    - Easier to read "is not the case that" or "not"
    - Truth functional (can be determined by its smaller parts)
  - Conjunction ∧ (&, ·)
    - ^
    - P^Q = P and Q
    - Truth is not independent of components… refer to table
  - Disjunction ∨
    - v, read as or
    - Or with a particular meaning. (not like in English where it is one or the other)
    - Inclusive disjunction, meaning both possibilities are included (faculty or staff only)
    - Also exclusive disjunction (may have stereo or TV) one or the other but not both

P	Q	P ∧ Q
T	T	T
T	F	F
F	T	F
F	F	F

P	Q	P ∨ Q
T	T	T
T	F	T
F	T	T
F	F	F

- Home(john) ^ (Home(mary) ^ Home(tom)
  - John or Mary or Tom is home

- Logical equivalents
  - ¬ P ^ ¬ Q   = ¬ (P v Q)
  - Tautology = comes out to be true no matter how you assign truth values to its constituents

- P v ¬ P (P and not P)
  - Always False
  - Simplest possible contradiction

10 / 10 / 08

Friday, October 10, 2008
10:07 AM

- Homework: Read chapter 4, do exercises 3.2, 3.3, 3.7, 3.10, 3.13 - 3.16, 3.18, 3.19, 3.20, 3.21

- Abbreviation
  - A ≠ B = ¬ (A = B)

- AND
  - Does not go between subjects
  - Goes between sentences
  - Bob and Tom went to the party
    - FOL: bob went to the party and tom went to the party

1) If P is a predicate of arity n, and a1, a2, … aN are individual constants, then P(a1,a2,…,aN) is an atomic sentence of first order logic)

2) If P is a sentence of first order logic, then ¬ P is a sentence of FOL

3) If P and Q are sentences of FOL, then so is (P^Q)

Truth Table for AND

P	Q	P^Q
t	t	t
t	f	f
f	t	f
f	f	f

Discussion Section

Lynn is not Jack's father or Jack's mother
¬ [Fatherof(lynn,jack) v Motherof(lynn,jack)]

Either Lynn is a man or Lynn is both a woman and not Jack's mother
Man(lynn) ^ [Woman(lynn) v ¬ Mother(lynn, jack)]

Lynn is a man or a woman and Lynn is not Jack's mother
(Man(lynn) v Woman(lynn))^ ¬ Mother(lynn,jack)

Jack is not a woman nor is he marries
¬ Woman(jack) ^ ¬ Married(jack)

Jill is not Jacks mother, however, Jill is related to Jack
¬ mother(jill, jack) ^ Related(jill, jack)

You can have tea or soda with your meal (as commonly understood)
[Withmeal(tea) v Withmeal(soda)] ^ ¬ (withmeal(tea) ^ withmeal(soda))
Why does it need those first parenthesis… can't read more into the rationale just because it is ambiguous.

<u>DeMorgan's Laws</u>

¬ (P v Q)	equivalent to	¬ P ^ ¬ Q
¬ (P ^ Q)	Equivalent to	¬ P v ¬ Q

Logical Consequence: apply across the board (generalities)

Analytical Consequence: talking about the logic within the meaning of the predicates (not general)

Counterexamples: a model that has all true premises and a false conclusion.

10 / 13 / 08

Monday, October 13, 2008
10:01 AM

- **Truth Tables**
    - First: list all the atomic sentences
    - N atomic sentences = 2^N Rows
    - Put half T's and half F's
    - Tautology = sentence where every row comes out true
        - A logically necessary truth (in virtue of the connectives)
    - a=a
        - Not a tautology because it cannot be shown in a truth table
        -

a=a	a=a
T	T
F	F

        - Doesn't prove anything, but is logically necessary
    - List all the atomic sentences that occur in either one
    - Construct a truth table

- Tautologically Equivalent
    - Say the same thing…
    - Tautologically valid: No row in the truth table where the premises all come out to be true, and the conclusion comes out to be false

10 / 15 / 08

Wednesday, October 15, 2008
10:04 AM

$A_1 A_2 A_3$	P	Q
T	T T	T
	T T	F

not taut

- Homework: Old Homework to Submit Amnesty until Monday
  - 4.22 - 4.24, 4.28 - 4.30 (make up 1.3, 1.5, and 2.1)

- Valid because of the meanings of the connectives?
- Logical Consequence. <-- (intuitive notion) Tautological Consequence

- Definition: Q is a tautological consequence of P…Pn , if and only if in a joint truth table for P… Pn, and Q there is a row where all of P…Pn are T and Q is F

10 / 17 / 08

Friday, October 17, 2008
9:57 AM

- Homework: Amnesty Stuff, 5.15 - 5.18, 5.2, 5.8

- Tautological Valid: a tautological consequence of the premises

- **Shortcut Method (4.27)**
  - Cube(a) v Cube(b)
  - Dodec(c) v Dodec (d)
  - ~Cube (a) v ~Dodec(c)
  - .'. Cube(b) v Dodec(d)

  - Could make a truth table
  - Assume that it is not tautologically valid.
  - Would mean that some row in the truth table with all true premises and a False conclusion
  - Assign all truth values that are determined by that assumption, especially focusing on the conclusion
  - In the case above it is impossible, so it is tautologically valid.

- Shortcut Method (4.28)
  - Large(a) v Large(b)
  - Large(a) v Large(c)
  - .'. Large (a) ^ (Large(b) v Large(c))

  - A v B
  - A v C
  - A ^ (B v C)

  - Consider All Possibilities
  - If one of the possibilities works out, the argument is not tautologically valid

10 / 20 / 08

Monday, October 20, 2008
9:57 AM

- Homework: Chapter 6, exercise 6.1

- Abbott did it or Babbott did it or Cabbott did it

- Reductio ad absurdum
    - Proof by contradiction / Indirect Proof
    - Don't have to believe it, but assume P
    - Deduce some contradiction
    - Conclude not P

10 / 22 / 08

Wednesday, October 22, 2008
10:00 AM

- Homework: 6.2 - 6.6

- Conjunction Introduction
  - You can form the conjunction of any statements you already have.
  - Annotation: ^ Intro: 1,3
- Conjunction Elimination
  - You can break off a conjunct from any conjunction that you already have
  - Annotation: ^ Elim: 1
- Disjunction Introduction:
  - Add any number of disjuncts to a statement you already have
  - Annotation: v Intro: 1
- With Disjunction Elimination
  - Prove each of the disjunction components, and if they can each yield the same thing, you have your proof!
- Negation Elimination
  - Only works if the whole line is doubly negated (NOT COMPONENTS!!!)
  - Annotation: ~ Elim: 2
- Negation Introduction
  - Appeals to a subproof
  - If in a subproof, you are lead to a contradiction, you can assume the subproof's premise is false
  - Annotation: $\perp$ ("Falsum" The Standard Contradiction) goes after the contradiction
  - Annotation: ~ Intro: 1, 3-4 (cite initial line and subproof showing contradiction)
- Any statement is the logical consequence of a contradiction
- It is impossible for the premises to be true and the conclusion to be false in a valid argument

10 / 24 / 08

Friday, October 24, 2008
10:00 AM

- Midterm: Monday, Nov 3rd.
- Homework: Read Chapter 7 (Problems: Exercises 6.7 - 6.12)

$P \vee Q$

P

$\neg P$

P Reit

$\perp$ $\perp$ Intro

$\neg\neg P$ $\neg$ Intro

$Q \vee \neg\neg P$

10 / 24 / 08 - Discussion Section

Friday, October 24, 2008
1:00 PM

Proof 1

P ^ Q
~P

P ^ Elim 1
~ P Reit 2
_|_ Intro _|_
R

Proof 2

1 | P ∧ Q
2 | ¬P
---
3 | P ∧ Elim 1
4 | ⊥ ⊥ Intro 2,3
- - - - - - - - - - -
5 | R ⊥ Elim 4
- - - - - - OR - - - - - -
6 | | ¬R
7 | | ⊥ Reit 4
8 | ¬¬R ¬ Intro 5-6
9 | R ¬ Elim 17

1 | P ∨ (¬P ∧ Q)

P ∨ Q

2 | | ¬P ∧ Q
3 | | ¬P ∧ Elim 2
4 | | Q ∧ Elim 2
5 | | P ∨ Q ∨ Intro 4
6 | | P
7 | | P ∨ Q ∨ Intro 6
8 | P ∨ Q ∨ Elim 1, 2-5, 6-7

∨ Elim

Proof by Cases

1 | P ∨ (P ∧ Q)
2 | | P
3 | | P Reit 2
4 | | P ∧ Q
5 | | P ∧ Elim 4
6 | P ∨ Elim 1, 2-3, 4-5

1. $(P \land \neg P) \lor Q$
2. Q
3. Q Reit 2
4. $P \land \neg P$
5. P $\land$ Elim 4
6. $\neg P$ $\land$ Elim 4
7. $\bot$ $\bot$ Int 5–6
8. Q $\bot$ Elim 17
9. Q $\lor$ Elim 1, 2–6, 4–8

γιαγια
παππους
θεια
θειος
μιτερα
πατερας
ξαδερφι/ος
αδερφι/ος
κορη
γιος
ανδρας
γυναικα
οικογενεια

1. $P \lor Q$
2. P
3. $P \lor (\neg P \land Q)$ $\lor$ Int 2
4. Q
5. $\neg(P \lor (\neg P \land Q))$
6. P
7. $P \lor (\neg P \land Q)$ $\lor$ I 6
8. $\bot$ $\bot$ I 5,7
9. $\neg P$ $\neg$ Int 6–8
10. $\neg P \land Q$ $\land$ Int 4,9
11. $P \lor (\neg P \land Q)$ $\lor$ Int
12. $\bot$ $\bot$ I 5,11
13. $\neg\neg(P \lor (\neg P \land Q))$ $\neg$ Int 5–12
14. $P \lor (\neg P \land Q)$ $\neg$ Elim 13
15. $P \lor (\neg P \land Q)$ $\lor$ Elim

10 / 27 / 08

Monday, October 27, 2008
10:00 AM

Exercises 6.24 - 6.27
Read 187-189, 198 - 207
Do all try it in Chapter 6

- If everything else try this:
    - Assume the negation and find a contradiction
    - Called Reductio ad Absurdum

    - Break up a conjunction, see what you can do
    - If you have to prove a conjunction,
        - prove the separate conjuncts
    - If you have to prove a disjunction:
        - Prove one of the disjuncts and then intro the disjunction
    - To eliminate a disjunct
        - Think about disjunction elimination (with all components)

- A New connective
    - If … Then…
    - Denoted As: … --> …
    - Conditional
    - If is called the antecedent
    - Then is called the consequent

    - P -> P is a tautology
    - Fallacy of Affirming the Consequent (P -> Q, Q, therefore P)

10 / 29 / 08

Wednesday, October 29, 2008
10:02 AM

- Midterm: Monday, November 3rd
    - Bring a bluebook
    - Covers all lectures, and chapters 1-7 (no new inference rules) except for optional sections
    - Finish reading chapter 7, work: 6.28 - 6.31

- "Literals" = atomic sentence or its negation

- The Material Conditional
    - Want:
        - truth-functional
        - Modus Ponens (if P then Q, P, therefore Q) to be (tautologically) valid
        - P -> P to be a tautology
        - Affirming the Consequent to not be (tautologically) valid

    - Subjunctive Conditionals (Counterfunctional Conditionals)
        - If so and so were the case, then...

    - Causal Conditions
        - If you continue to neglect that tooth, you will lose it…

    - Material BiConditional
        - P If and only if Q $\leftrightarrow$
        - Two way arrow

- If P, Q
- Q, if P
- Provided that P, Q
- Q, provided that P
- P only if (only in case of) there is a fire

10 / 31 / 08

Friday, October 31, 2008
9:59 AM

- Midterm: Monday November 3rd
  - Chapters 1-7, all lectures and anything introduced in you try it
  - Review Session: Sunday, this room, 3pm - 4pm
  - FALL BACK AN HOUR
  - Bring Brain

Today Is Monday → T
Tommorrow is Wed

- If A, Then B: A --> B
  - Just required that the red is not the case
  - If the antecedent is F, then the conditional is T
  - If the consequent is T, then the conditional is T
  - IF B IS OKAY, THE CONSEQUENT IS TRUE
  - Very weak conditional

A	B	$A \rightarrow B$
T	T	T
T	F	F
F	T	T
F	F	T

- Material Biconditional
  - Truth-Functional connective (only cares about t/f of the things it connects)
  - Conditional goes in both directions <-->
  - A if and only if B = A <--> B
    - If = A if B = B --> A
    - Only if = A only if B - A --> B
  - NEED TO BE ABLE TO CALCULATE THE TRUTH VALUE OF THESE STATEMENTS
    - (A <-> B) ^ (~C -> (D v E))

A	B	$A \leftrightarrow B$	$(A$	$\rightarrow$	$B)$	$\wedge$	$(B$	$\rightarrow$	$A)$
T	T	T	T	T	T	T	T	T	T
T	F	F	T	F	F	F	F	T	T
F	T	F	F	T	T	F	T	F	F
F	F	T	F	T	F	T	F	T	F

- Conversational Implications
  - Can you cancel the implication without contradiction? Then conversational .
    - Menu: you may have soup or salad. Can I have both, yes… only conversational then
  - No? Then actually implied
    - I know it -> I don't believe it… belief is part of knowledge
    - EXERCISE 6.30

Midterm Review

Sunday, November 02, 2008
3:01 PM

- Forget about 1.5 - 1.8
- 2.6
- 3.8
- 4.5
- 5.4

- FOL
  - First order logic
  - Only thing fixed in the language is the connectives and the order they are written
    - ^ v ~ ()
  - Arity = (degree) how many names you have to add after the predicate to get an atomic sentence
  - Arity 1 (only one name) Ex: Bald(Socrates)
  - Atomic sentences are the ones built up with a predicate with arity n and followed by n names
  - Add parenthesis if A v B v C... = (A v B) v C
  - <--> (if and only if / just in case) --> (if then, provided that, only if [isn't inverted]) HAVE TO KNOW THESE

- Methods of Proof
  - Truth tables
  - Explain what a tautology is
    - Formula that comes out true in every case, if you calculate its truth table and it always comes out true, it's a tautology
  - TT-Contradiction
    - Formula that comes out false in every case, if you calculate its truth table it will always come out false
  - Tautologically equivalent
    - If you construct the truth table for both sentences, and the final value comes out the same in every case, they are tautologically equivalent
  - Analytic Consequence
  - Tautological Consequence
  - Can't use AnaCon and TautCon
  - _|_ = Falsum same syntax as other atomic sentences
  - Intro, Elim, Reit,
  - = is a binary predicate, not a connective like v & ^

- Can show that an argument is not tautologically valid if you make a truth table, look for row with all true premises and false conclusion
- Valid argument does not need true premises

1 $\neg(A \vee B)$
2 A
3 $A \vee B$ $\vee$ Int 2
4 $\neg(A \vee B)$ Reit 1
5 $\perp$ $\perp$ Int 3, 4
6 $\neg A$ $\neg$ Int 2-5

- NEED TO KNOW DEFINITIONS
  - Memorize some key terms
  - Memorize truth tables for the connectives
  - Wants to know if you read the book
  - What's the arity of a predicate?
  - Truth values, atomic sentences,

- Rules of inference don't apply to parts of formulas

- What is a literal?
  - An atomic sentence or its negation

- Structure
  - Define tautology...
  - Proof (so difficult that no one can do it)
  - Compute truth tables for connectives (including the arrow)
  - ARROWS
  - Write sentences in first order logic (vice versa)
  - Is it a tautology?

- BRING SCRATCH PAPER
- No informal proofs

11 / 07 / 08

Friday, November 07, 2008
10:01 AM

- Homework: 7.14, 7.15, 7.16, 8.1, 8.2, 8.18-8.25

- Still have to do:
  - 8.2

- Show: If n is even, then n2 is even
  - Assume: n is even, i.e. n = 2k for some positive integer k
  - So n2 = nxn = 2k x 2k = 4k2 = 2(2k2)
  - .'. N2 is even

- |Even(n)
- |----------------
- |.'. Even(n2)
- Even(n) -> Even(n2)

11 / 10 / 08

Monday, November 10, 2008
10:02 AM

- Homework: 7.18, 7.19, 8.31-8.34

- Law of excluded Middle: P v ~P

- Soundness and Completeness

  $\vdash_T$
  - Soundness: valid and all true premises
    - There is a proof in Ft of the conclusion Q from the premises P1, P2, … Pn
  - Soundness theorem: if Q is not a tautological consequence of P1, P2, … Pn, then there is no proof of Q in FitchT from P1, P2, … Pn
  - Completeness Theorem
    - If Q is a tautological consequence of P1, P2… Pn then P1, P2, Pn Tt Q

- Quantifiers
  - The additional notions ALL, SOME, NONE, NO ONE, SOMEONE, etc.

11 / 12 / 08

Wednesday, November 12, 2008
10:00 AM

- Homework: 9.1, 9.2, 9.3

- Exactly one, Exactly two… etc.
- At least two, at least three, … etc.
- Every
- No
- Some

Quantifiers: $\overset{\text{ALL}}{\forall}$ $\overset{\text{SOME}}{\exists}$

- Definitions of a WFF (Well Formed Formula) of FOL
  - A predicate of arity n, followed by n terms (in parenthesis with commas) is a well-formed formula (no atomic wff)
  - IF P and Q are wffs, then as are ~P(P^Q)
- Free or bound occurrences
  - A WFF has no free occurrences of variables

11 / 14 / 08

Friday, November 14, 2008
10:02 AM

- Exercises 9.5 - 9.7, 9.8 - 9.11, 9.15, 9.16
    - 9.11

$$\exists x \, (\mathrm{Cube}(x) \land \neg \mathrm{LeftOf}(b, x))$$

15

- Problems with

$$* \; \neg \exists x \, (\mathrm{Cube}(x) \land \mathrm{LeftOf}(b, x))$$

- Vacuously true: true because they are not present in the world (all f's are g's, but no f's in the world)
    - John has no children
    - "All John's Children are tall"... true... but so is "None of John's Children are tall"

11 / 17 / 08

Monday, November 17, 2008
10:00 AM

- Homework: 9.17, 9.18, 10.1, 10.2, 10.3, 10.4

- Have everything we really need for FOL at this point.

- Oddities
  - Ex Tet(a) is a well-formed formula
  - Ex Ax (Cube(x))

11 / 19 / 08

Wednesday, November 19, 2008
10:05 AM

- 10.10, 10.11, 10.12, 10.13

- Validity is based on the meanings of the connectives and the quantifiers, not based on the predicates.
  - Replace all atomic components by a single letter
  - If it is logically sound, then the argument is valid

11 / 21 / 08

Friday, November 21, 2008
10:00 AM

- Exercises: 10.20, 10.21, 10.22, 11.1, 11.2, 11.3, 11.4 (do all you try its)
  - 11.2
  - 11.3
  - 11.4

- ~(P v Q) = ~P ^ ~Q
- ~(P ^ Q) = (~P v ~Q)

- Tarski's-World Consequence = Additional TW Constraints
  - Analytical Consequence = Meaning of the Predicates
    - First Order Consequence = Ax, Ex, =
      - Taut Consequence = ^, v, ->, <->

- Every student studies some subject
  - Ax Ey (Student(x) -> (Subject(y) Studies(x, y,)))

- No Student Studies Every Subject
  - ~Ex (Student(x) ^ Ay(subject(y) -> Studies(x, y)))
  - Ax(Student(x) -> Ay (subject(y) -> Studies(x, y)))

- Only Students Study Every Subject
  - ~Ex Ay (Subject(y) -> (Studies(x, y) ^ ~Student(x)))
  - Ax (~Student(x) -> Ay (Subject(y) -> Studies(x, y))

- No subject is such that every student studies it
  - ~Ex(Subject(x) ^ Ay (Student(y) -> Studies(y, x)))

- Anyone who studies any subject is a student
  - Ax Ey ((Person(x) & Subject(y) ^ Studies (x, y)) -> Student(x))

11 / 24 / 08

Monday, November 24, 2008
10:08 AM

- Homework: 11.9 - 11.13
  - 11.11

- There are only two things
  - Ex Ey (x /= y ^ Az (z=x v z=y))

11 / 26 / 08

Wednesday, November 26, 2008
10:03 AM

- Homework: 11.16, 11.17, 12.16, 12.17, 12.18, 13.1

- Notes
  - S(c) = any constant
  - Universal quantifier Elmination
    - Want
      - Ax(P(x) -> Q(x))

new individual constant

$$
\begin{array}{l|l}
m & \quad \boxed{c}\ P(c) \\
 & \quad \vdots \\
n & \quad Q(c) \\
k & \forall x\ (P(x) \to Q(x)) \quad \forall\ \text{Intro } m\text{-}n
\end{array}
$$

12 / 03 / 08

Wednesday, December 03, 2008
10:01 AM

- Homework: 13.10 - 13.14

- Review Session; Saturday, December 6th, 1:00 - 2:00 pm
- Final Exam: Tuesday, December 9th, 8:00 - 11:00 am

- Need BlueBook for Final

No A is B

2 Translations

$\forall x\,(A(x) \to \neg B(x))$

$\neg \exists x\,(A(x) \land B(x))$

1	$\forall x\ Tet(x)$	
2	$Tet(a)$	$\forall$ Elim: 1
3	$\exists x\ Tet(x)$	$\exists$ Int: 2

1	$\forall x\ \neg Tet(x)$	
2	$\quad \exists x\ Tet(x)$	
3	$\quad\quad \boxed{a}\ Tet(a)$	
4	$\quad\quad \neg Tet(a)$	$\forall$ Elim: 1
5	$\quad\quad \perp$	$\perp$ Int: 3,4
6	$\quad \perp$	$\exists$ Elim 2, 3-5
7		

12 / 05 / 08

Friday, December 05, 2008
10:02 AM

- Final Exam: Tuesday, December 9th, 8:00 - 11:00 am (This room)
- Review Session: Saturday, December 5th, 1:00 - 2:00 pm (This room)

$\forall x \exists y R(x,y)$

can't get

1	$\exists y \forall x R(x,y)$	
2	$\boxed{a}$	
3	$\boxed{b}$ $\forall x R(x,y)$	
4	$R(x,y)$	$\forall$ Elim 3
5	$\exists y R(x,y)$	$\exists$ int 4
6	$\exists y R(x,y)$	$\exists$ Elim 1, 3-5
7	$\forall x \exists y R(x,y)$	$\forall$ int 2-6

13.23

1	$\forall y [Cube(y) \lor Dodec(y)]$	
2	$\forall x [Cube(x) \to Large(x)]$	
3	$\exists x \neg Large(x)$	
4	$\boxed{a}$ $\neg Large(a)$	
5	$Cube(a) \to Large(a)$	$\forall$ Elim : 2
6	$Cube(a) \lor Dodec(a)$	$\forall$ Elim : 1
7	$Dodec(a)$	Taut Con : 4,5,6
8	$\exists x\, Dodec(x)$	$\exists$ int : 7
9	$\exists x\, Dodec(x)$	$\exists$ elim 3,4-8

$\exists x\,(Cube(x) \wedge Small(x))$

$\exists x\, Cube(x) \wedge \exists x\, Small(x)$

Final Review

Saturday, December 06, 2008
1:00 PM

$\forall x\,(Tet(x) \lor \neg Tet(x))$

Tautology $\longrightarrow$ $\underbrace{\boxed{\forall x\, Tet(x)}}_{A} \lor \neg \underbrace{\boxed{\forall x\, Tet(x)}}_{A}$

- Something is a tautology if a formula representing its truth functional form is a tautology
- After TFF you can test to see if it is a tautology
- Something is a tautology if its TFF is a tautology
- CAN'T IGNORE THE CONNECTIVES/QUANTIFIERS

- If it is universally or existentially quantified it is NOT a tautology
- Brush up on truth-functional rules (TAUT CON)
- Tautology: "No matter what values you assign to the connectives or quantifiers, the thing comes out to be true"

Know This

13.5 346

P unless Q : $\neg Q \rightarrow P$

Page 187

P Only if Q

STUDY CIRCLES

$\forall\, \neg B(x)$
$\neg \exists\, B(x)$

Logically Equivalent

If Taut
FO Validity
Logically Valid

Don't spend too much time in past review...