First-order Cogic

1. Motivation

PL (propositional logic) is thefficient at representing concepts.

e-g.(a) Descrising the fact that all the students in this class are CS majors

ne need atoms: Pi: Tim is a CS major

Pg: Sasha is a CS major

KB is: P, NP2NP3N-.. NPq

Easier is: You CSMajor (x)

(6) Describe "Someone in the class is an Astronomy minor"

we need atoms: Q: Tim is an Astronomy minor

Qq: Sasha is an Astronomy Minor

KB is Q, vQz v... vQq.

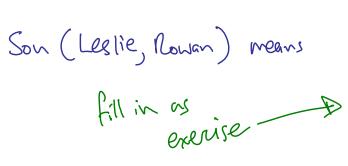
Easier is: A > AstronomyMinor (n)

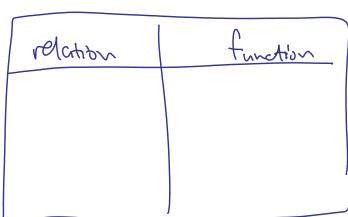
There exists

Thus, the basic idea behind <u>First-Order Logic</u> (FOL) is to add quantifiers (Y, Z) to propositional logic.
2. Details on first order logic
In more detail, Gol uses.
· objects - the elements in the domain of discourse (e.g. students in this class)
· relations - basic statements about the objects that Enote: The textsole can be true or false alls these predicates. e.g. CSMajor (Ashir) Helped (Joanna, Lam) Team (Tucker, Vy, Jon)
eg. Prog AsstPartner (Lam)
levalvates to Sasha

· quantifies - V, 3.

More details on relations:
-a unary relation is a property
e.g. Math Major (Tim) nears "Tim is a math major" Blue (Sky) nears "The Sky is blue
- binary relations follow an important ordering convention: $P(X,Y)$ often means "X is a P of Y"
e-g. Instructor (John, Sasha) wears "John is the instructor of Sasha Helped (Vy, Tucker) wears "Vy helped Tucker"
BIG WARNING: Functions and relations are completely different, but look the same.
Functions return objects Relations return true or false
Examples:
1. Father (John) maans:
fill in as





De Morgan's rules for quantifies

• $7 \forall x P(x) = \exists x 7 P(x)$

e-g. not all students in this class are CS majors

fill in as exercise

 $\neg \exists x P(x) = \forall x \neg P(x)$

e-g. no student in the class is an Astronomy Minor

= fill in as exercise

Note: follows easily from PL version of De Morgan, since Y is like a conjunction and I is like a disjunction.

Meaning of equals: The (=) sign means (the same object" e.g. Prog ArstPartrer (Sasha) = Lam

3. examples

Important examples from text book: 8.10, 8.11, 8.24

For interest only: see real-world applications of FOL on resources web page.