Preparing for the Final
Nov 27, 11am, DBH 1300
90 minutes

Kalev Kask

ICS 271

Fall 2013

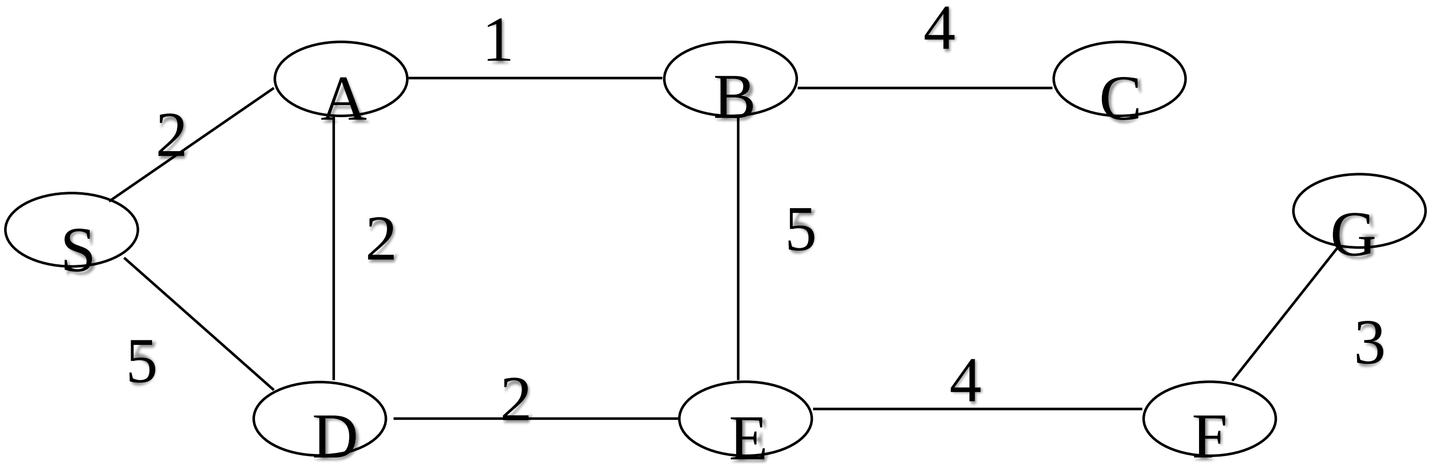
Material Covered

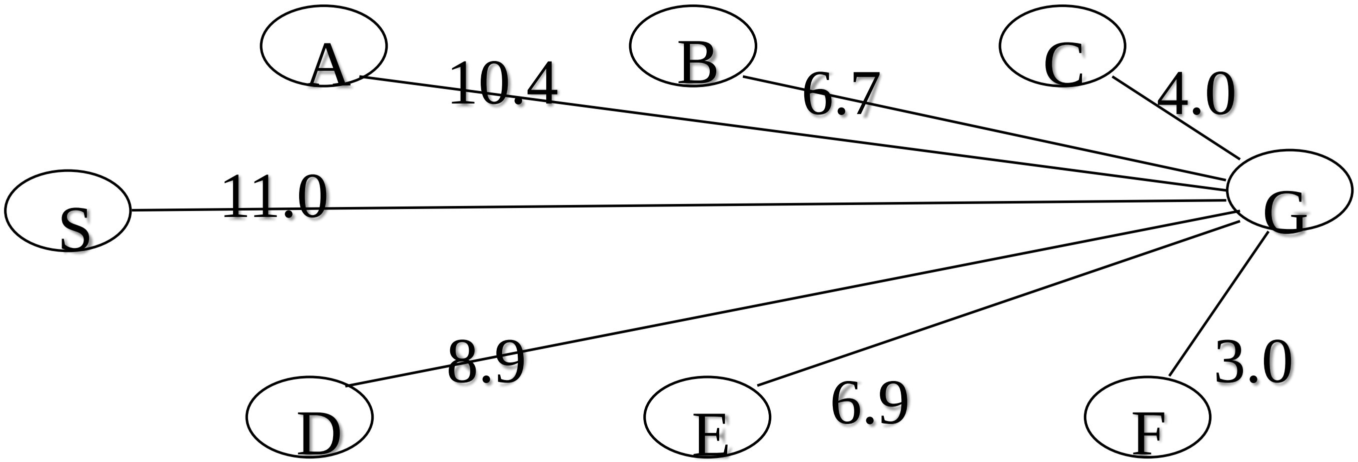
- Chapters 3-9
    - Search
    - Games
    - Constraint Satisfaction
    - Propositional Logic
    - First Order Logic

Chapters 3,4 (Search) Concepts

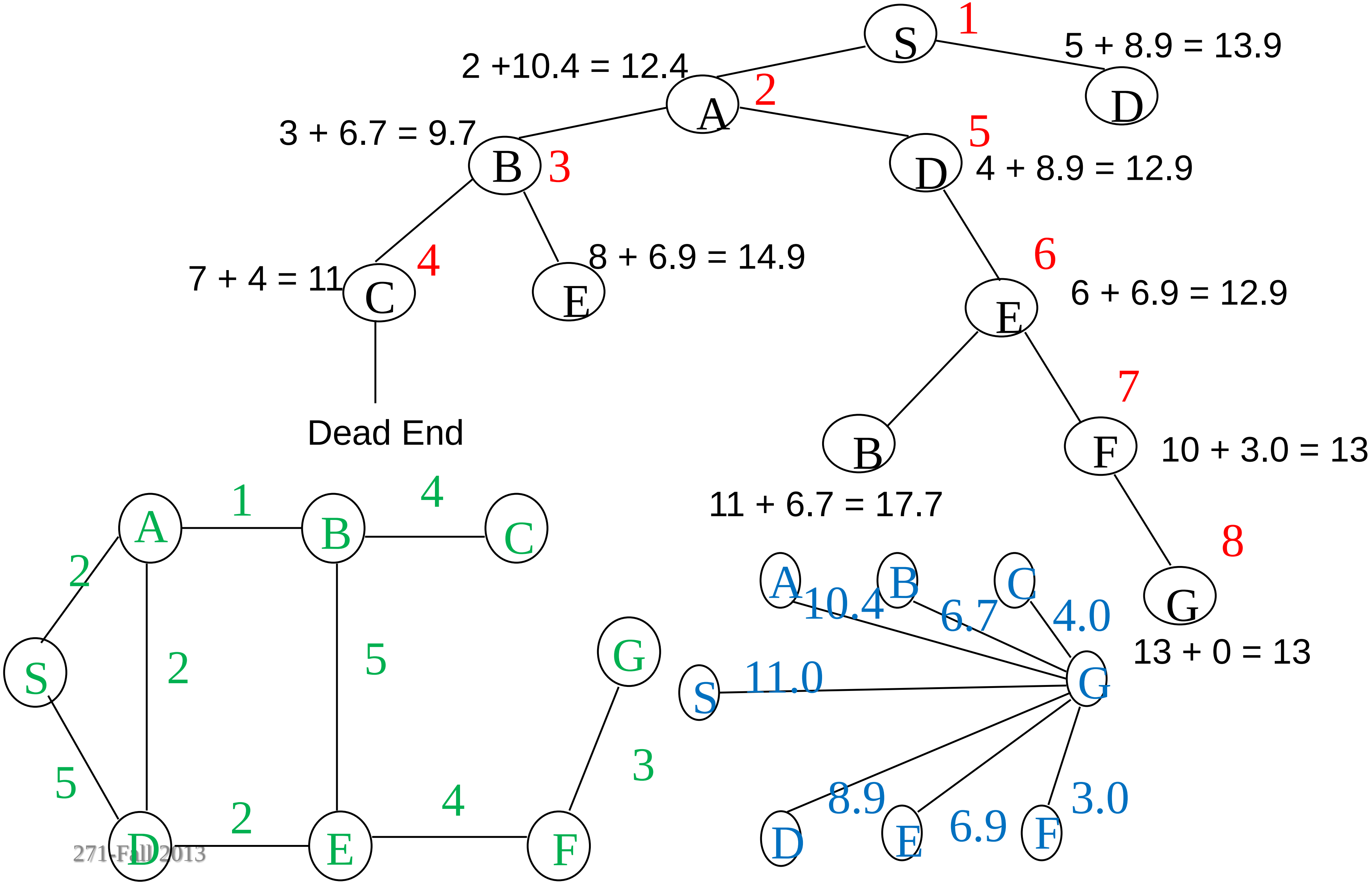
- Search space : states (initial, goal), actions
- Search tree/graph
- Breadth-first, depth-first, uniform-cost search
  - Expanding a node, open (frontier), closed (explored) lists
  - Optimality, complexity
  - Depth limited search, iterative deepening search
- Heuristic search
  - Heuristic fn, admissibility, consistency
  - f, h, g, h*, g*
  - Heuristic dominance
- Greedy search
- A*, IDA*
- Branch-and-Bound DFS
- Generating heuristics from relaxed problems, pattern databases
- Hill-climbing search, SLS, local vs. global maxima

Search Problem





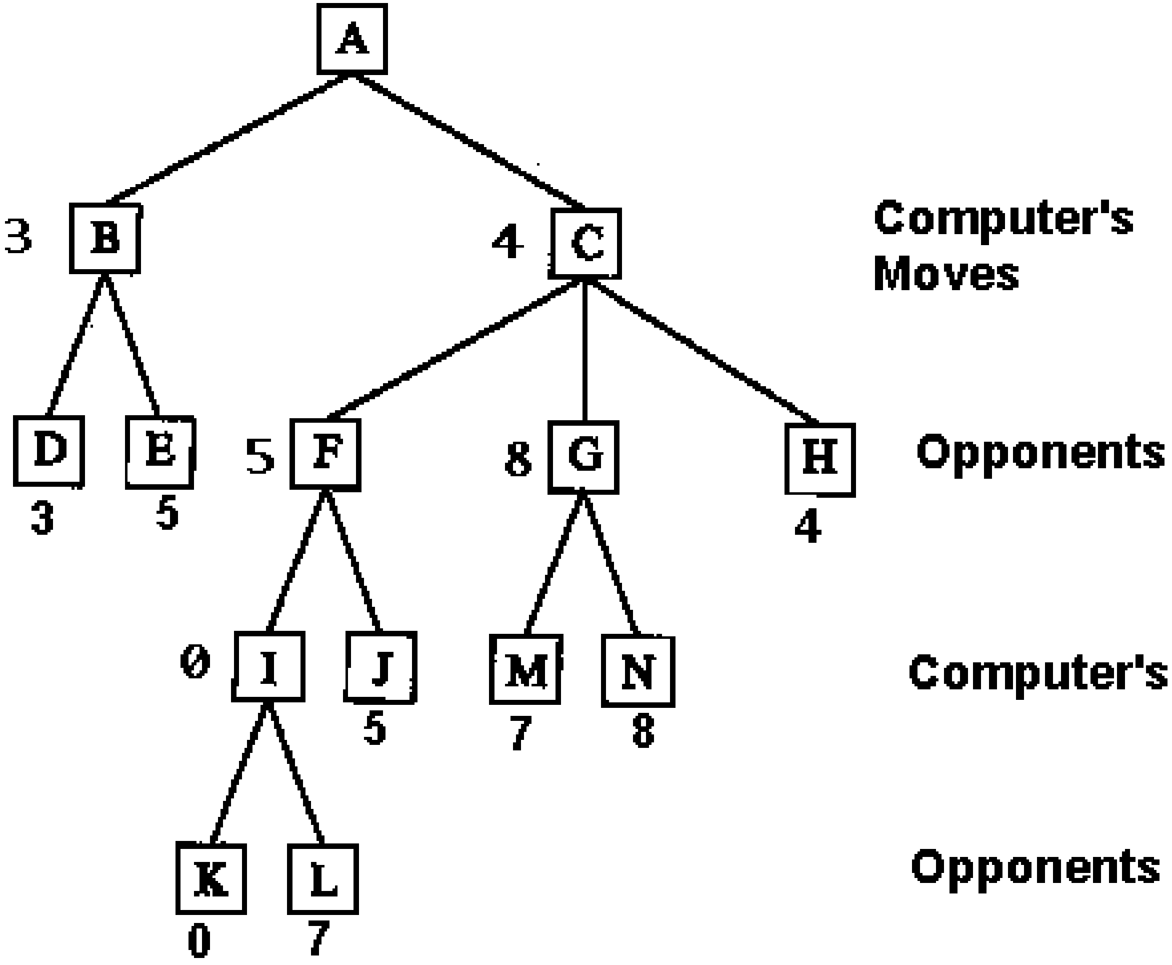
Example of A* Algorithm in Action



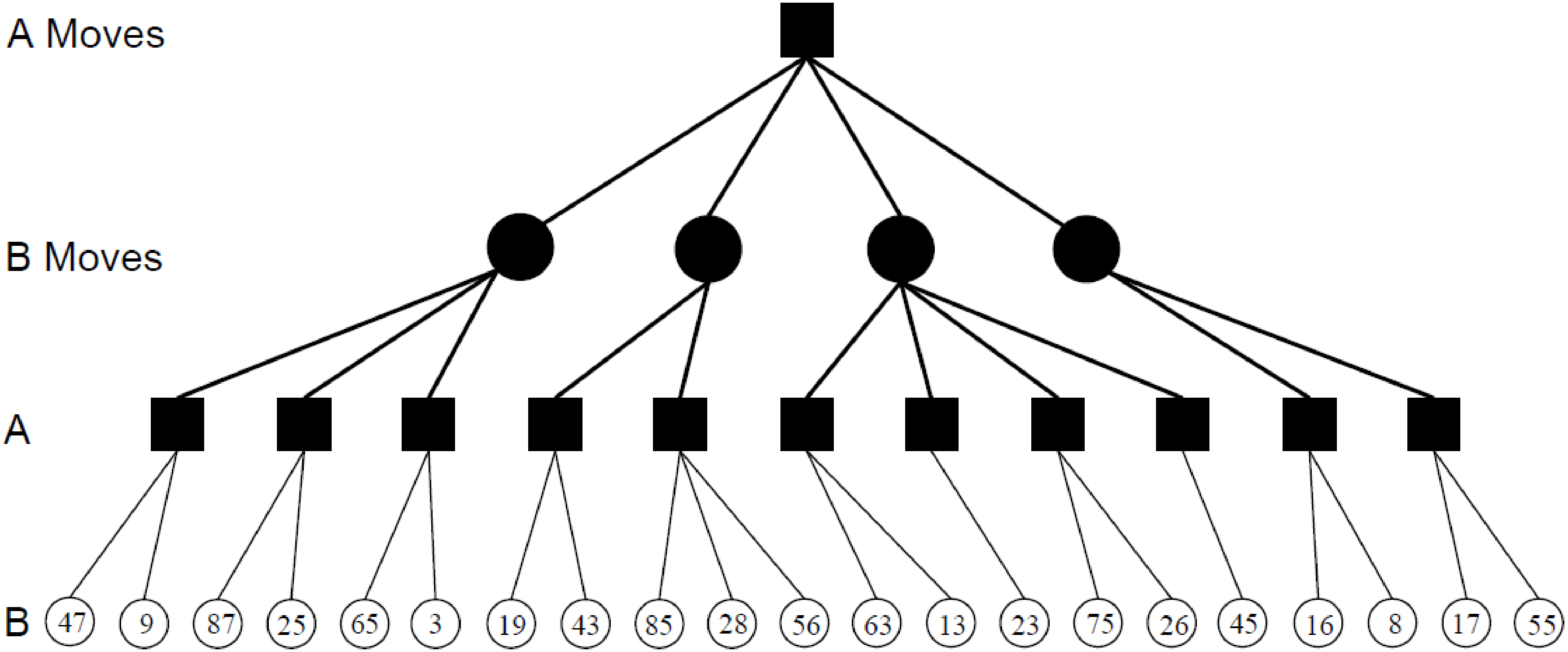
Chapter 5 (Games) Concepts

- Game tree
  - Players
  - Actions/moves
  - Terminal utility
  - MIN/MAX nodes
- MINIMAX algorithm
- Alpha/Beta pruning
  - Effect of node/move ordering on pruning
- Evaluation functions
  - Why do we need them?
- Stochastic games

A Game tree


A
3 B
4 C
Computer's Moves
D 3
E 5
5 F
8 G
H 4
Opponents
0 I
J 5
M 7
N 8
Computer's
K 0
L 7
Opponents

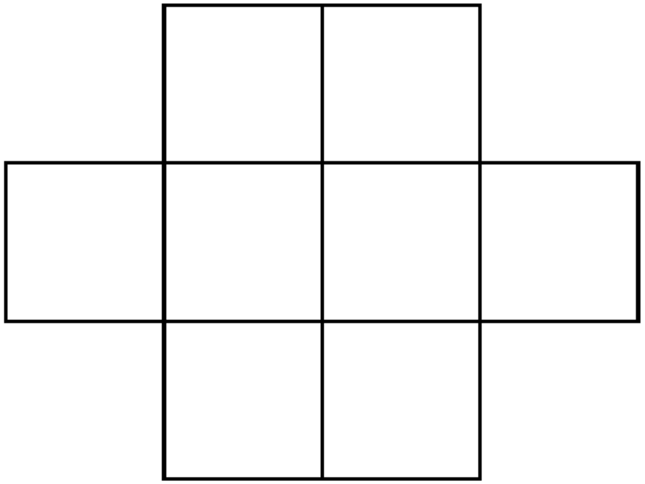
Another game tree



Chapter 6 (CS) Concepts

- Variables, domains, constraints
- A solution : assignment of values to variables so that all constraints are satisfied
- Constraint graph
- Local consistency
  - Arc-consistency, path-consistency, k-consistency
- Backtracking search
  - Variable, value ordering heuristics
- Interleaving search and inference
  - E.g. BT with arc-consistency
- Back-jumping, no-good learning
- Greedy local search
  - Min-conflicts
- Tree-structured CSPs
- Cut-set conditioning, tree-decomposition

A Constraint problem



The task is to label the boxes above with the numbers 1-8 such that the labels of any pair of adjacent squares (i.e. horizontal vertical or diagonal) differ by at least 2 (i.e. 2 or more).

(a) Write the constraints in a relational form and draw the constraint graph.

(b) Is the network arc-consistent ? if not, compute the arc-consistent network.

(c) Is the network consistent ? If yes, give a solution.

Chapter 7 (Prop Logic) Concepts

- Syntax
  - Propositional symbols
  - Logical connectives
- Semantics
  - Worlds, models
  - Entailment
  - Inference
- Model checking
- Modus Ponens
- CNF
- Horn clauses, Forward/Backward chaining
- Resolution
- DPLL backtracking search

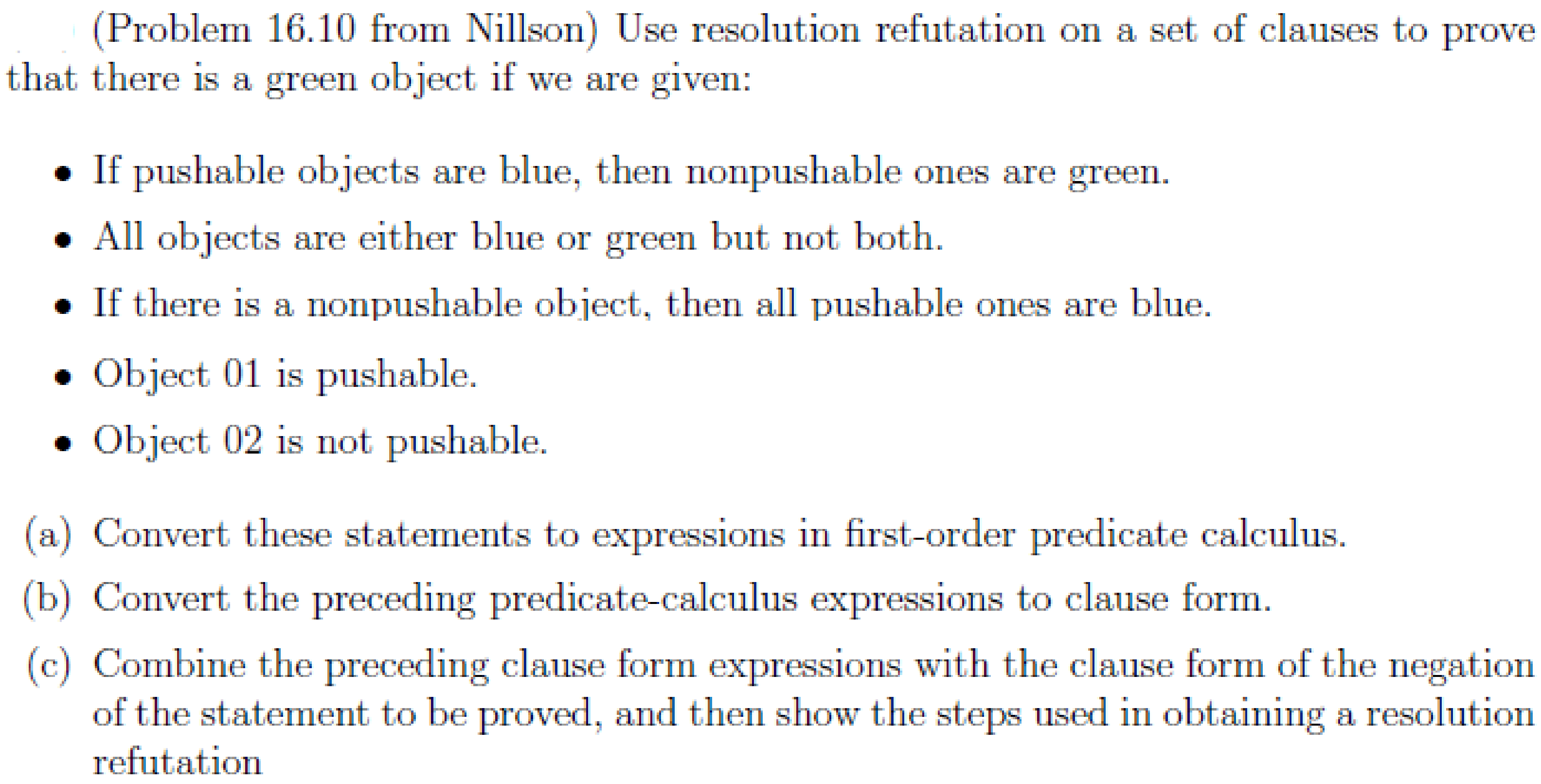
Chapters 8,9 (FOL) Concepts

- Syntax
  - Variables, const symbols, fn symbols, predicate symbols
  - Terms, atomic sentences
  - Quantifiers
- Semantics
  - Model, interpretation
  - Entailment
  - Inference

Chapters 8,9 (FOL) Concepts cont.

- Universal, existential instantiation
- Unification
- Generalized Modus Ponens
- Definite clauses, Forward/Backward chaining
- Converting a FOL sentence to CNF
- Resolution
  - Answer extraction

FOL Resolution Problem



(Problem 16.10 from Nillson) Use resolution refutation on a set of clauses to prove that there is a green object if we are given:

- If pushable objects are blue, then nonpushable ones are green.
- All objects are either blue or green but not both.
- If there is a nonpushable object, then all pushable ones are blue.
- Object 01 is pushable.
- Object 02 is not pushable.

(a) Convert these statements to expressions in first-order predicate calculus.

(b) Convert the preceding predicate-calculus expressions to clause form.

(c) Combine the preceding clause form expressions with the clause form of the negation of the statement to be proved, and then show the steps used in obtaining a resolution refutation

(d) Use resolution-answer-extraction to find a particular object that is green