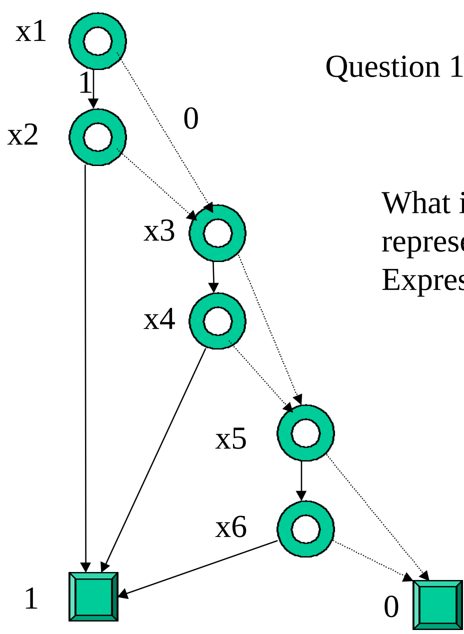
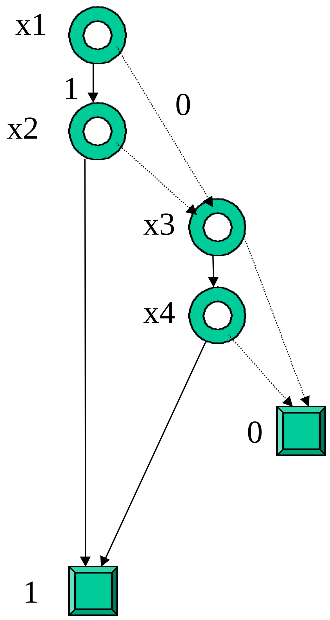
Midterm COM3220

- Open book/open notes
- Tuesday, April 28, 6pm - 7.30 pm



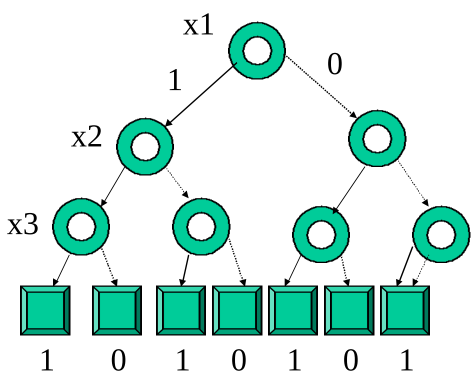
Question 1: 5 points

What is the Boolean function represented by this BDD?
Express it in terms of **and** and **or** only.



Question 2: 15 points

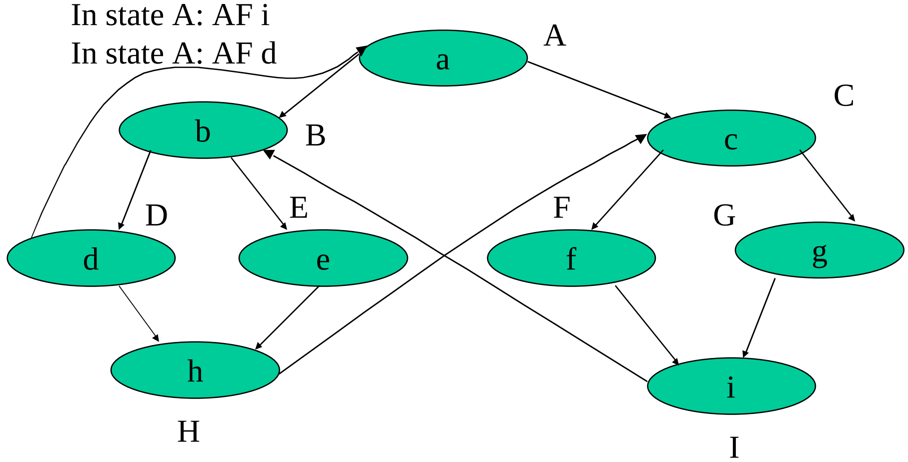
Consider the BDD on the left.
It uses the variable ordering
x1, x2, x3, x4.
Construct the BDD for the variable ordering x1, x3, x2, x4.



Question 3: 10 points

The BDD to the left is not reduced. Bring it to reduced form.

Question 4: 15 points
Which of the following formulas holds? Explain!
In state A: AF b
In state A: AF i
In state A: AF d



Some background

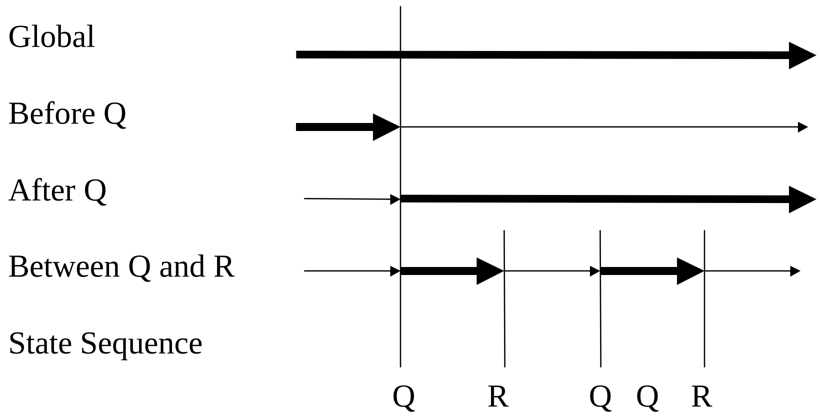
- The following questions involve a *scope* which is the extent of a programs execution over which a formula must hold. There are five basic kinds of scopes: global, before, after, between, after-until.

Some background

- *scope*
  - global (the entire program execution),
  - before (the execution up to a given state),
  - after (the execution after a given state)
  - between (any part of the execution from one given state to another given state)
  - after-until (like between even if the second state does not occur)

Some background

- A scope itself should be interpreted as optional; if the scope delimiters are not present in an execution then the specification will be true.



Four Formula Scopes

Question 5: Absence
2 points per unknown

- The purpose of the following CTL formulas is to describe a portion of a system's execution that is free of certain states.
- In the following you will have to find unknowns Y1, Y2, … Those unknowns you should replace by identifiers and/or symbols to make the formula correct. Example:
  Y1 + 3 = 8. Solution: Y1 = 5

CTL formulas for Absence

- P is false
  - Globally: Y1 Y2(!P)
  - Before R: A[!Y3 **U** (Y4 or AG(!R))]
  - After Q: Y5 G(Q Y6 AG(!P))
  - Between Q and R: Y7 G(Q=>A[!P **U** (Y8 or Y9 Y10 (!R))])
  - The next intentionally does not contain unknowns
  - After Q until R: AG(Q=>!E[!R **U** (P and !R)])

Question 6: Response 5 points per unknown

- The purpose of the following CTL formulas is to describe cause-effect relationships between a pair of states. An occurrence of the first, the cause, must be followed by an occurrence of the second, the effect, within a defined portion of a system’s execution.
- Find the three UNKNOWNs

CTL formulas for Response

- S responds to P: (P is the cause, S the effect)
  - UNKNOWN2 Q: AG(Q=>AG(P=>AF(S)))
  - UNKNOWN1: AG(P=>AF(S))
  - UNKNOWN3 R: A[(P=>A[!R **U** ((S and !R) or AG(!R))]) **U** (R or AG(!R))]
- Note: the three UNKNOWN are part of the explanation of the CTL formula. Each unknown is one word. Explain the formula for UNKNOWN3.

Question 7: Properties of assignment /10 points

- Assume that the property {q*y+x=a} holds before we execute the two assignment statements: x:=x-y; q:=q+1; Does the property still hold after execution of the two assignment statements? Explain your answer.

Question 8: Blackbox Testing: Topological Sorting

- Assume you have to test a program written for the following specification: Given a directed acyclic graph G=(V,E) with n vertices, label the vertices from 1 to n such that, if v is labeled k, then all vertices that can be reached from v by a directed path are labeled with labels >k.

What to do.

- Write test requirements and test specifications for this testing task. 30 points
- Outline an algorithm for implementing the specification. Any implications on your test requirements? 10 points