


Testing Digital Systems I

Lecture 10: Boolean Testing Using Fault Models (FAN)

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FAN

- Internal and Input values assigned (FAN)
- New features
 - Stop Backtraces at Head Lines
 - Input Lines or Internal Lines that Cannot Cause Conflict
 - To reduce the number decisions
 - Immediate Implication
 - Both Forward and Backward
 - Unique Sensitization
 - Multiple rather than Single Backtrace
 - Multiple Objectives to reduce later conflicts

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Headlines

- Output signals of fanout-free cones
- Any value on headlines can always be justified by the PIs


We only need to backtrace to the headlines to reduce the number of decisions

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Fanout-Free Network

- Justify logic value 1 on f
 - Justify 1 on p and q
 - $a = b = c = d = 1$
- Justify logic value 0 on f
 - $a = 0$
- A fanout-free logic network with no redundancy
 - the logic value at the output of the logic network can always be justified without any backtracking


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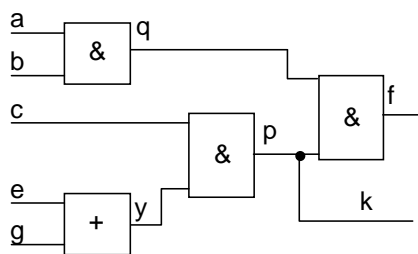
Head-Lines

- Bound Line
 - Any signal line which directly or indirectly fed by a fanout branch
- Free Line
 - Line that is Not Bound
- Head Line:
 - Free Line, and
 - Fanout Stem or Input of a Gate with Bound Output,

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Head-Lines



- f, f2 and k are the bound lines
- a, b, q, c, e, g, y and p are free lines
- p and q are head lines
 - p is a fanout stem and q is the only free signal line which is an input of a gate whose output is a bound line (f)

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How to mark?

- Start at the primary inputs of the logic network which are marked as free lines and move forward towards the output
- Whenever encounter a fanout
 - Mark each fanout branch as a bound line
- If the fanout stem is a free line
 - Mark it as a head line
- When encounter a logic gate,
 - The output of that gate is a bound line if and only if any of the inputs of that gate is a bound line;
 - Otherwise, the output of the logic gate is a free line
- If the logic gate output is a bound line
 - Any input of that gate which is a free line is marked as a head line

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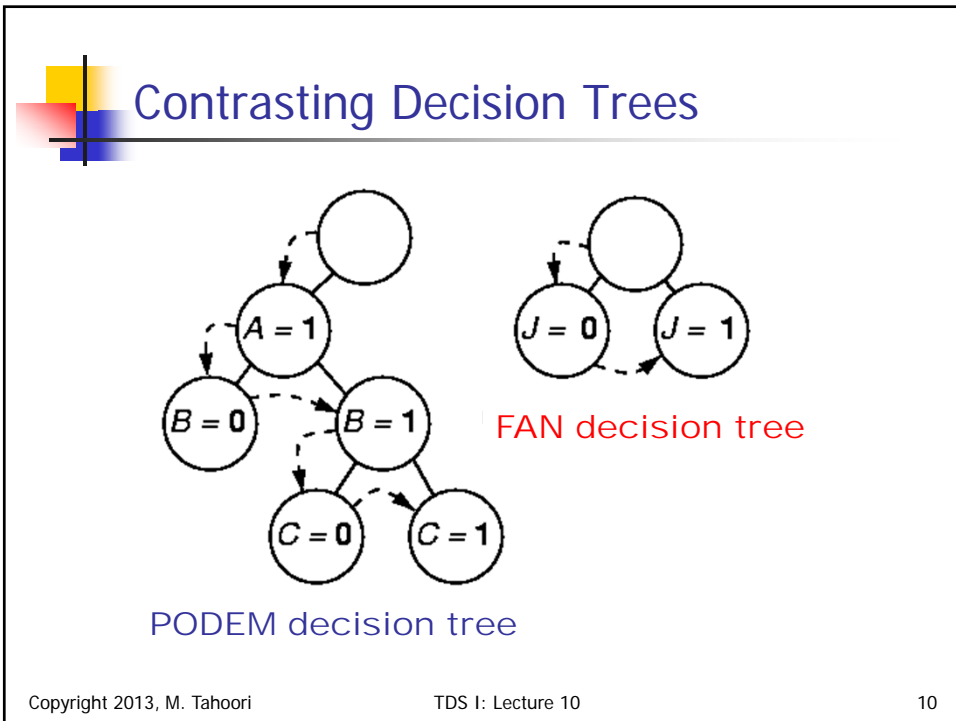
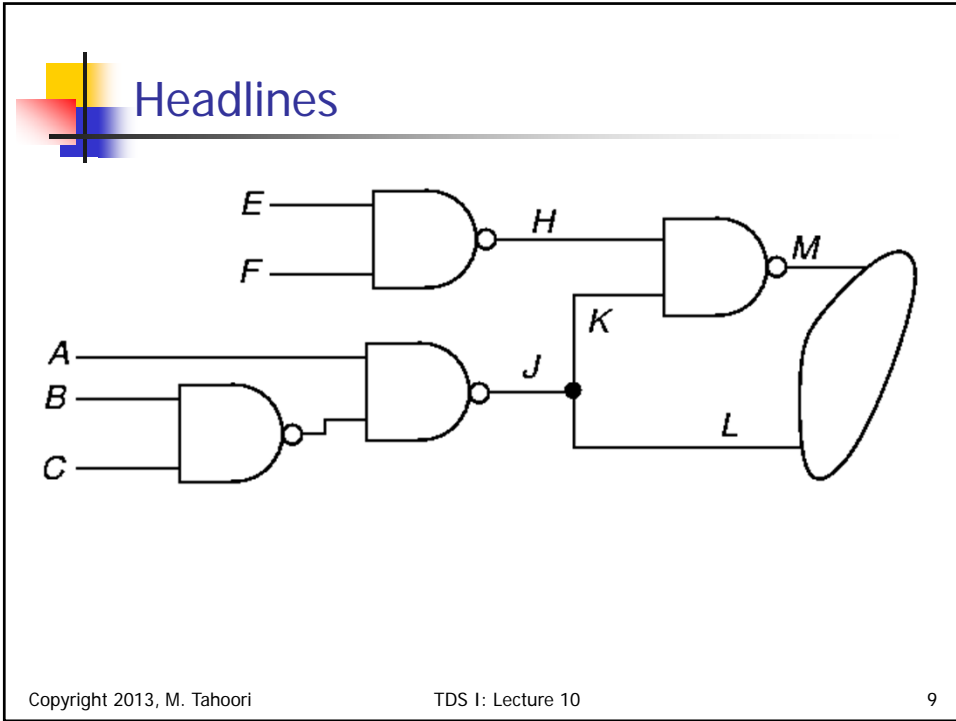
Head Lines

- PODEM
 - Objective: $j=1$, Set $d=1$
 - Objective: $j=1$, Set $c=1$
 - Imply — $j=1$, No Test Possible
 - Set $c=0$, Imply $j=0$

- FAN
 - Objective: $j=1$, Set $j=1$
 - Imply — $j=1$, No Test Possible
 - Set $j=0$

— Head line
— Bound line

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Immediate Implication

- PODEM Fails to Determine Unique Signals
- Backtracing operation
 - fails to set all 3 inputs of gate L to 1
 - Causes unnecessary search

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Immediate Implication

- FAN -- Early Determination of Unique Signals
- Determine all unique signals implied by current decisions immediately
 - Avoids unnecessary search

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Example Of Immediate Implication

- PODEM
 - Objective $r=0$,
 - Backtrace to b , Set $b=0$
 - Imply $p=1, r=1$
 - No Test Possible
 - Retry: Set $b=1$

- FAN
 - Objective, $r=\bar{D}$,
 - Assign $r=0$
 - Imply $e=q=p=0, a=b=1, c=0$

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Unique Sensitization

- PODEM Makes Unwise Signal Assignments
- Blocks fault propagation due to assignment $J = 0$

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Unique Sensitization

- Unique Sensitization of FAN with No Search
- FAN immediately sets necessary signals to propagate fault

————— Path over which fault is uniquely sensitized

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Multiple Objectives

- Objectives: $\{k=0, m=1\}$
- Backtrace from $k=0$ may favor $b=0$, but $\text{simulate}(b=0)$ would violate the second objective $m=1$!
- Makes backtrace more intelligent to avoid future conflicts

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