

# Value of Information and Control

Computer Science cpsc322, Lecture 35

*(Textbook Chpt 9.4)*

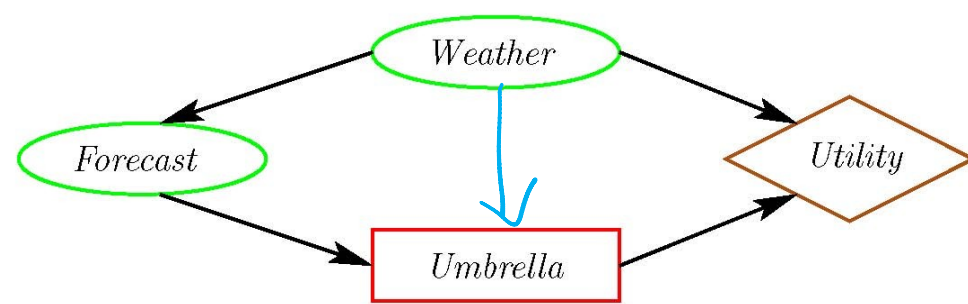
April, 14, 2010



# Lecture Overview

- Value of Information
- Value of Control
- Course Summary

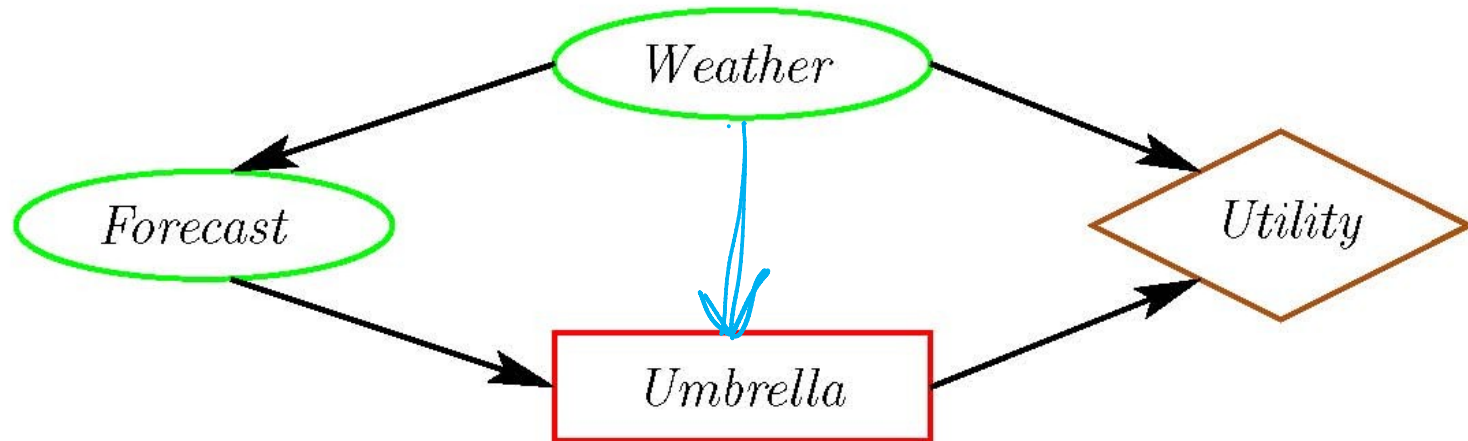
# Value of Information



- What would help the agent make a better *Umbrella* decision?
- The **value of information** of a random variable  $X$  for decision  $D$  is:  $EU(\text{Knowing } X) - EU(\neg \text{Knowing } X)$   
the utility of the network with an arc from  $X$  to  $D$  minus the utility of the network without the arc.
- Intuitively:
  - The value of information is always  $\geq 0$
  - It is positive only if the agent changes *the policy*

# Value of Information (cont.)

- The value of information provides a bound on how much you should be prepared to pay for a sensor. How much is a **perfect weather forecast** worth?

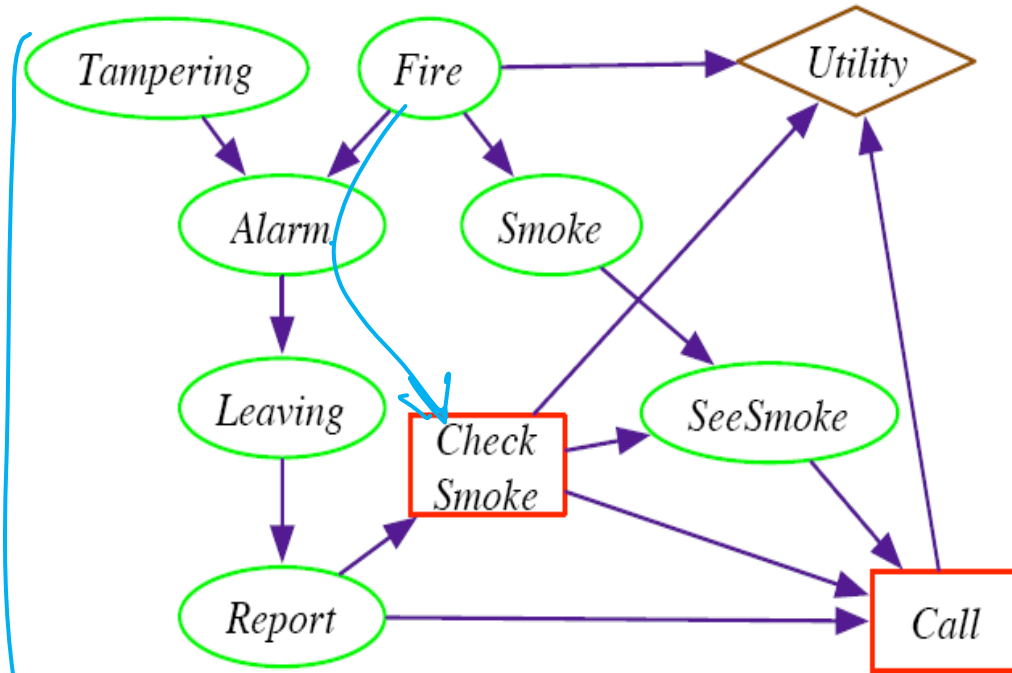


- Original maximum expected utility: 77
- Maximum expected utility when we know Weather: 91
- Better forecast is worth at most: 14




# Value of Information

- The value of information provides a bound on how much you should be prepared to pay for a sensor. How much is a **perfect** fire sensor worth?



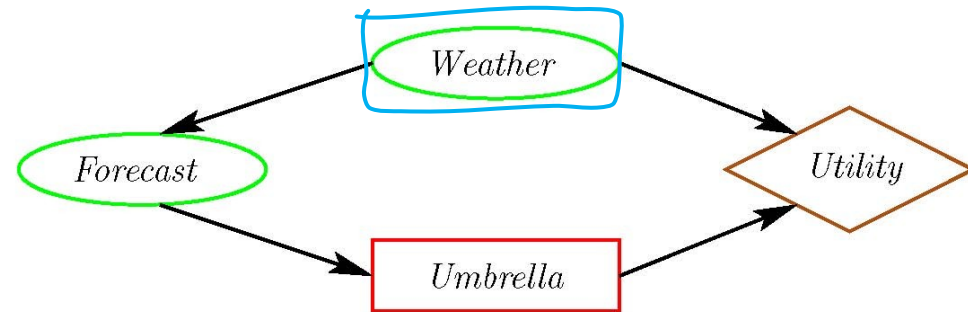
- Original maximum expected utility: -22.6
- Maximum expected utility when we know Fire:
- Perfect fire sensor is worth: 20.6

-2 - (-22.6) 

# Lecture Overview

- Sequential Decisions
  - Optimal Policy
  - Variable Elimination
- Value of Information
- **Value of Control**

# Value of Control



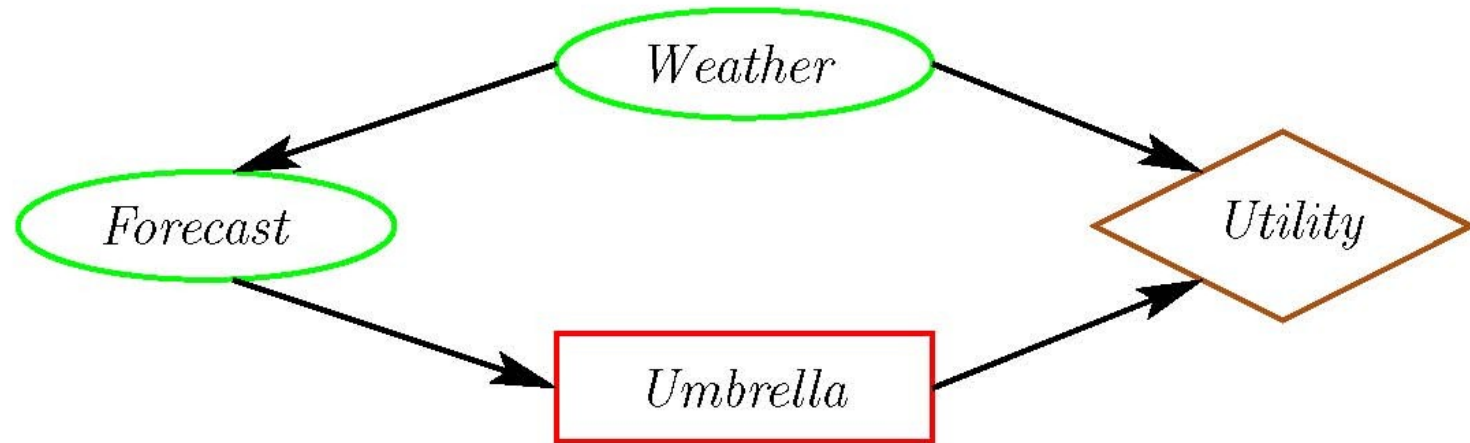
- What would help the agent to make an even better *Umbrella* decision? To maximize its utility.

| Weather | Umbrella | Value |
|---------|----------|-------|
| Rain    | true     | 70    |
| Rain    | false    | 0     |
| noRain  | true     | 20    |
| noRain  | false    | 100   |

- The **value of control** of a variable  $X$  is :  
the utility of the network when you make  $X$  a decision variable **minus** the utility of the network when  $X$  is a random variable.

# Value of Control

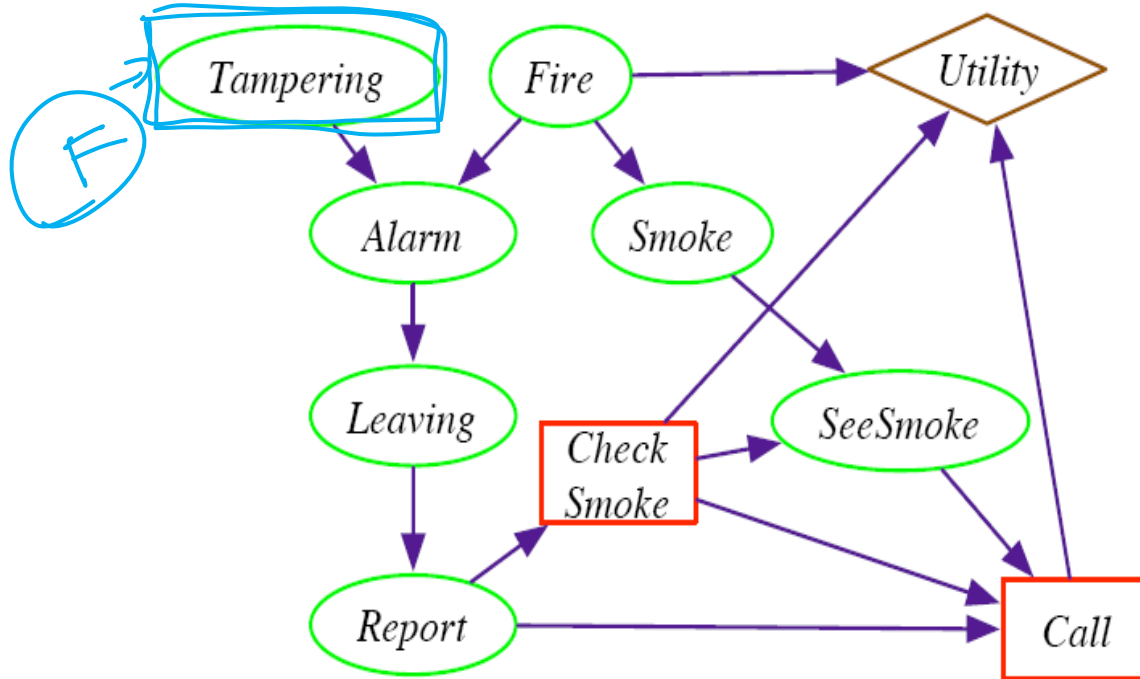
- What if we could control the weather?



- Original maximum expected utility: 77
- Maximum expected utility when we control the weather: 100
- Value of control of the weather: 23

# Value of Control

- What if we control Tampering?



- Original maximum expected utility:  $-22.6$
- Maximum expected utility when we control the Tampering:  $-20.7$
- Value of control of Tampering:  $1.9$
- Useful to estimate how much it is worth to add.....

*security to assure that tampering is always = F*

# Learning Goals for today's (and Mon) classes

You can:

- Represent **sequential decision problems** as decision networks. And explain the **non forgetting property**
- Verify whether a **possible world satisfies a policy** and define the **expected value of a policy**
- Compute the number of policies for a decision problem
- **Compute the optimal policy** by Variable Elimination
- Compute value of **information and control** } ←

# Cpsc 322 Big Picture

## Environment

Deterministic

Stochastic

Problem

Static

Constraint Satisfaction

Query

|  |  |
|--|--|
| <p>Arc Consistency</p> <p><i>Vars + Constraints</i></p> <p>Search</p> <p>SLS</p> | <p>for CSP</p>   |
| <p>Logics</p> <p>Search</p>  | <p>Belief Nets</p> <p>Var. Elimination</p> <p>Markov Chains and HMMs</p> |
| <p>STRIPS</p> <p>Search</p> <p>CSP</p>   | <p>Decision Nets</p> <p>Var. Elimination</p>                             |

for complex planning

CSP for Inference

Sequential

Planning

Representation

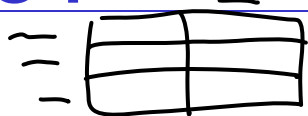
Reasoning Technique

# After 322 .....

349

## 322 big picture

Mostly  
in 422



Deterministic

Stochastic

- Machine Learning
- Knowledge Acquisition
- Preference Elicitation

CSPs

*Vars + Constraints*

Techniques to study  
SLS Performance

Query

**Logics**

- First Order Logics
- Temporal reasoning
- Description Logics

*Belief Nets*

More sophisticated  
reasoning

*Markov Chains and HMMs*

Where are the  
components of our  
representations  
coming from?

- The probabilities?
- The utilities?
- The logical formulas?

Planning

*Hierarchical Task  
Networks*

*Partial Order Planning*

*Markov Decision Processes  
and*

*Partially Observable MDP*

More sophisticated  
reasoning




From people and  
from data!

## Applications of AI

# TA Evaluation Forms

Please, evaluate only TAs you have interacted with for  
this course

## Teaching Assistants

- Hammad Ali      hammad@cs.ubc.ca       MSc
- Kenneth Alton      kalton@cs.ubc.ca      *(will be starting Jan 18)*       PhD
- Scott Helmer      shelmer@cs.ubc.ca       PhD
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# Announcements

- Fill out **Online Teaching Evaluations Survey**.
- It closes on Apr 17th

- **FINAL EXAM:** Mon Apr 19, 12:00-3:00 pm DMP 310 (NOT regular room)

Final will comprise: 10 -15 short questions + 3-4 problems

- Work on all practice exercises VISTA assessments
- While you revise the learning goals, work on review questions  
- I may even reuse some verbatim 😊
- Come to remaining Office hours! I am offering two hours on Fri (10-12)