Bayesian Networks
Decision analysis

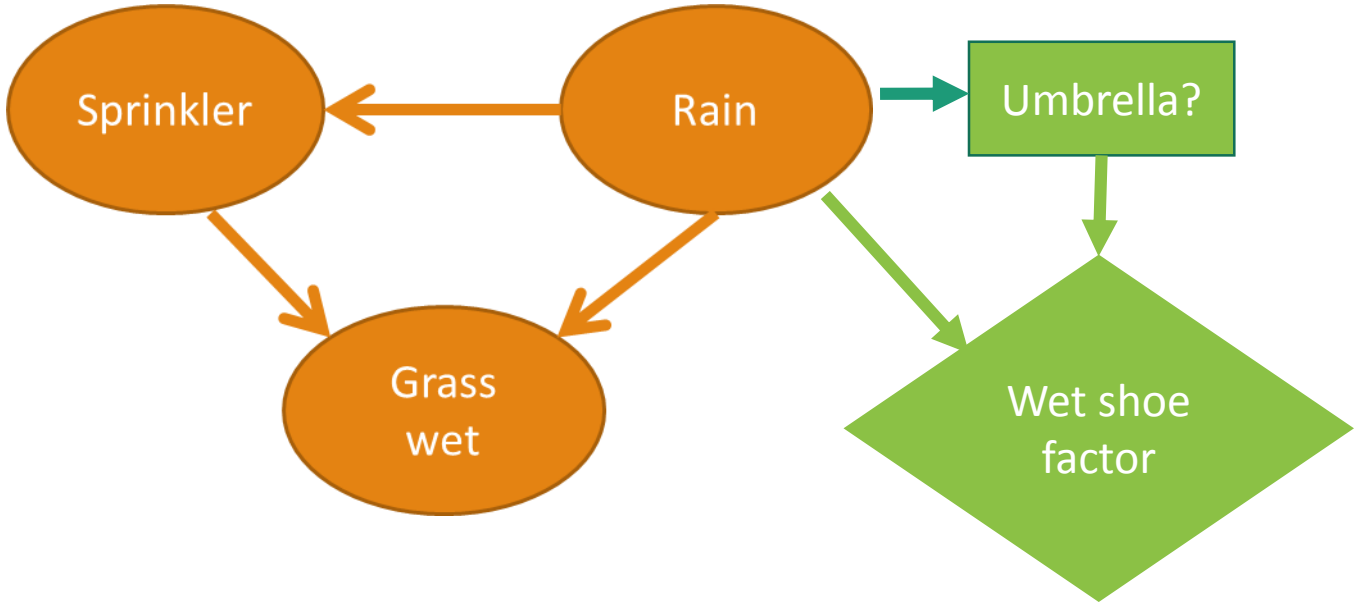
Ullrika Sahlin, Centre of Environmental and Climate Research
Lund University, Sweden
Ullrika.Sahlin@cec.lu.se
http://www.cec.lu.se/ullrika-sahlin

Recipe of a decision

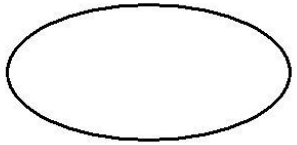
- Agents – decision makers
- Their values
- Decision alternatives
- An idea of what is a good decision
- Uncertainties in the outcomes of these alternatives

- BN -> Uncertainty quantified by beliefs conditional on available knowledge

Influence diagram



The decision.



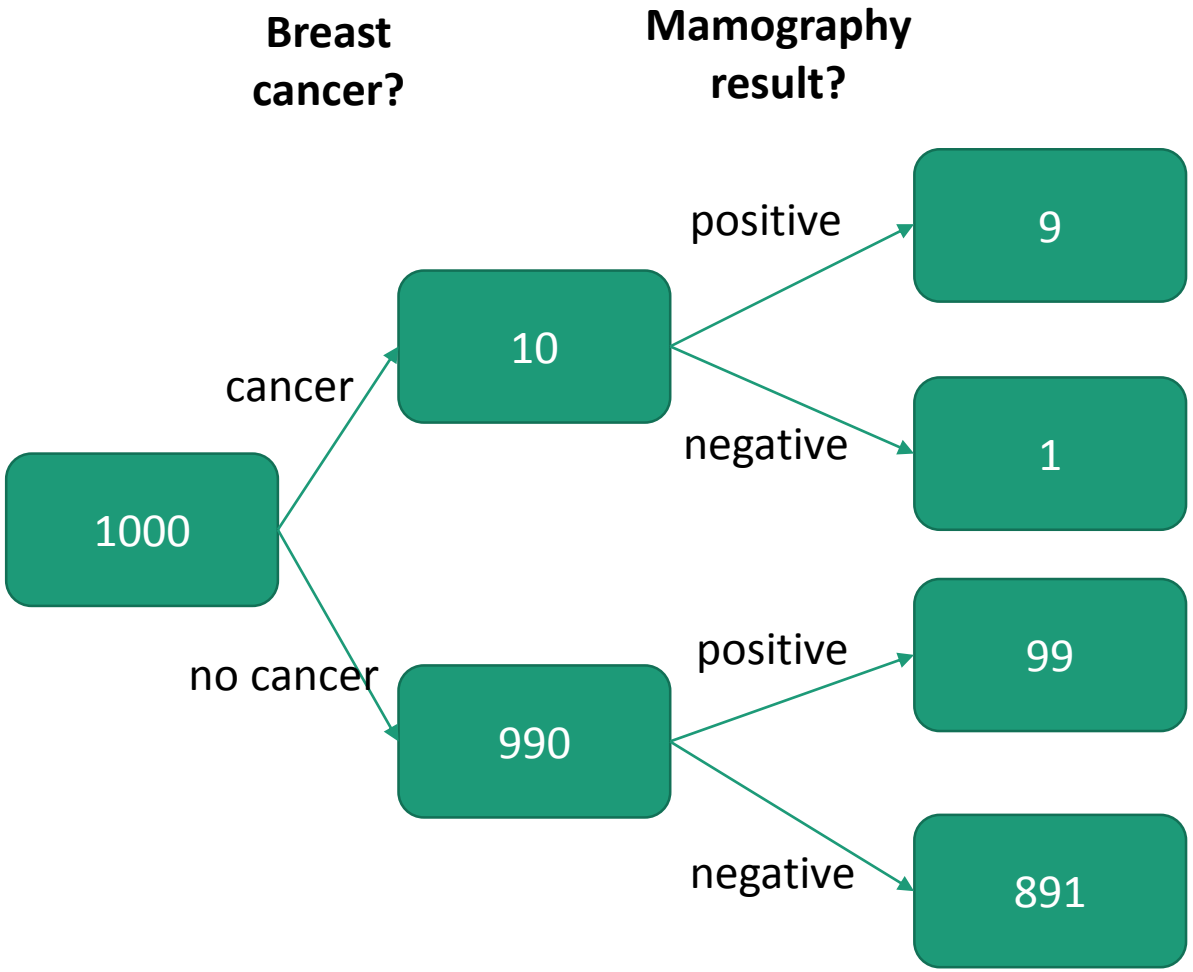
A chance variable that is out of the control of a decision maker.

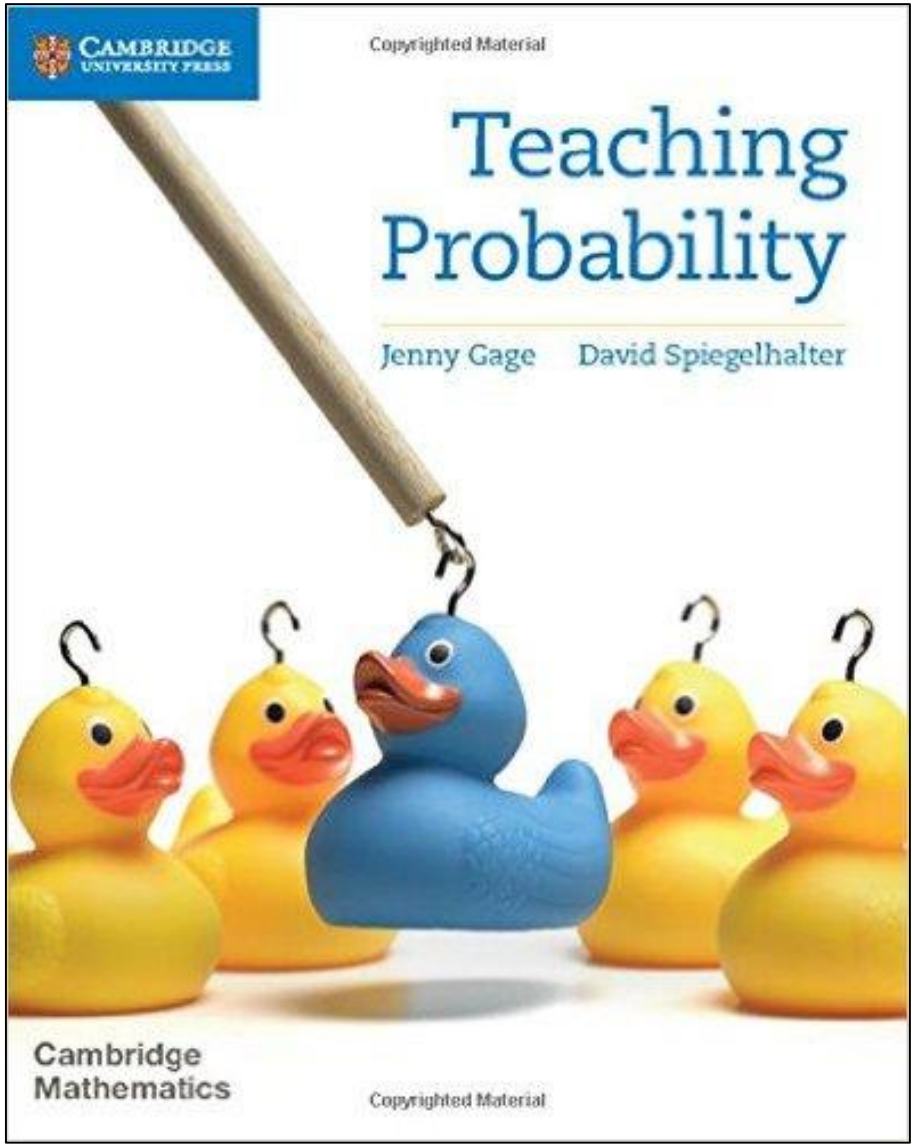
The objective of the decision. This is the variable the decision maker is attempting to maximize or minimize.

A deterministic function of the quantities that depend on it or an intermediate variable.

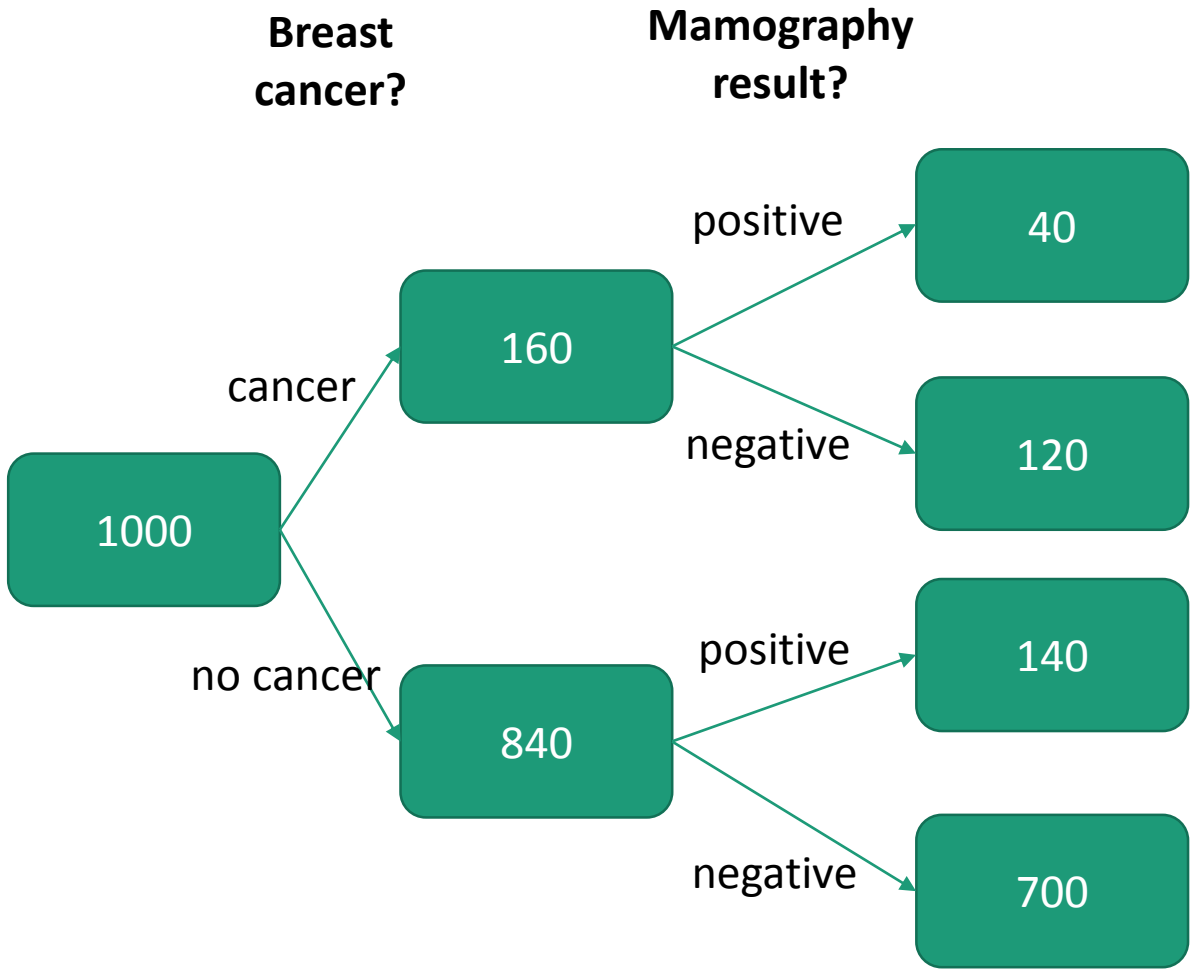
Influence.

Breast cancer screening



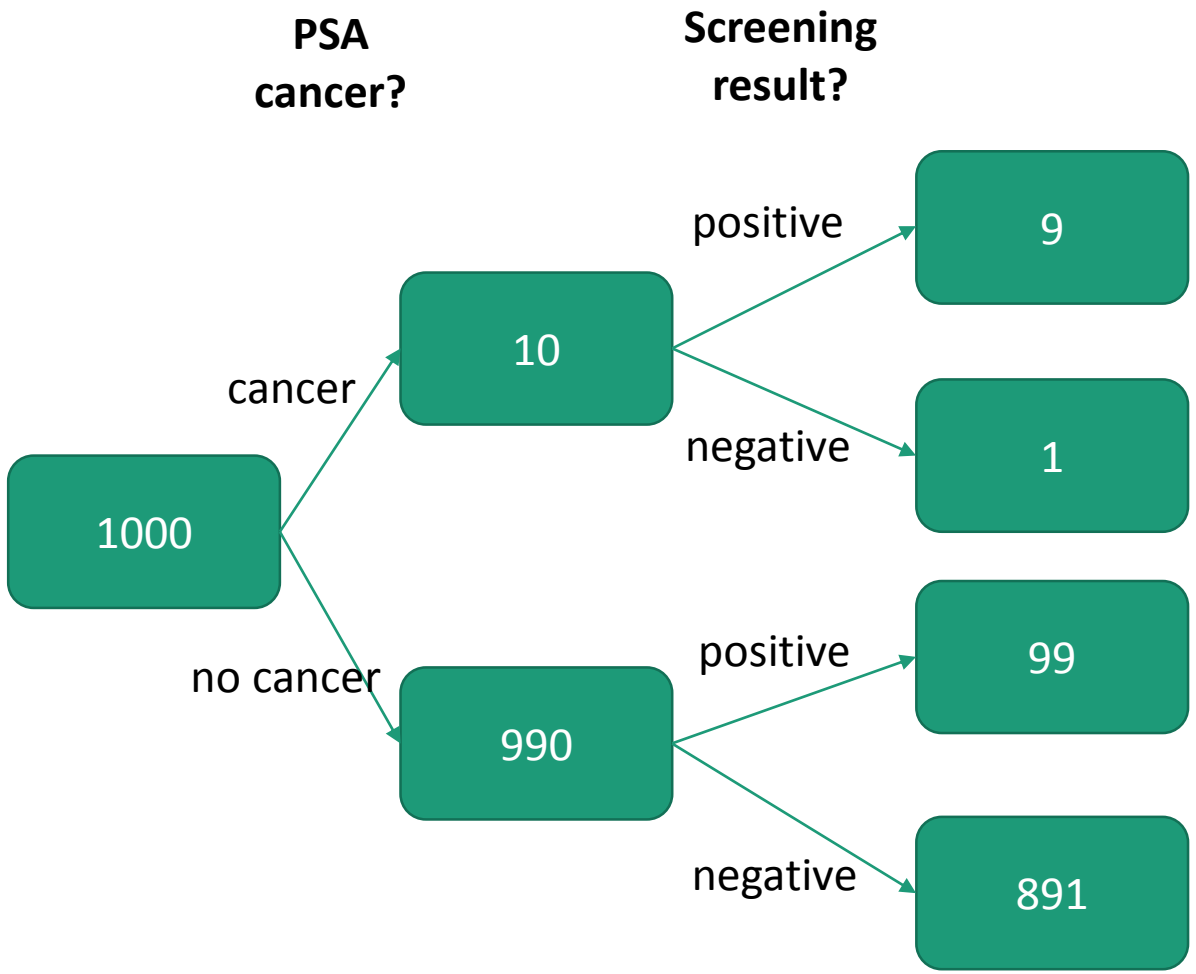


Breast cancer screening – setting impact on values



Advantage	Disadvantage
Death due to breast cancer avoided	Over-diagnoses (cancers detected and treated that would not have caused any harm if left alone)
	Cancer undetected
	False-positive diagnoses requiring further investigation + risk for problems with the biopsy

PSA cancer screening – setting impact on values

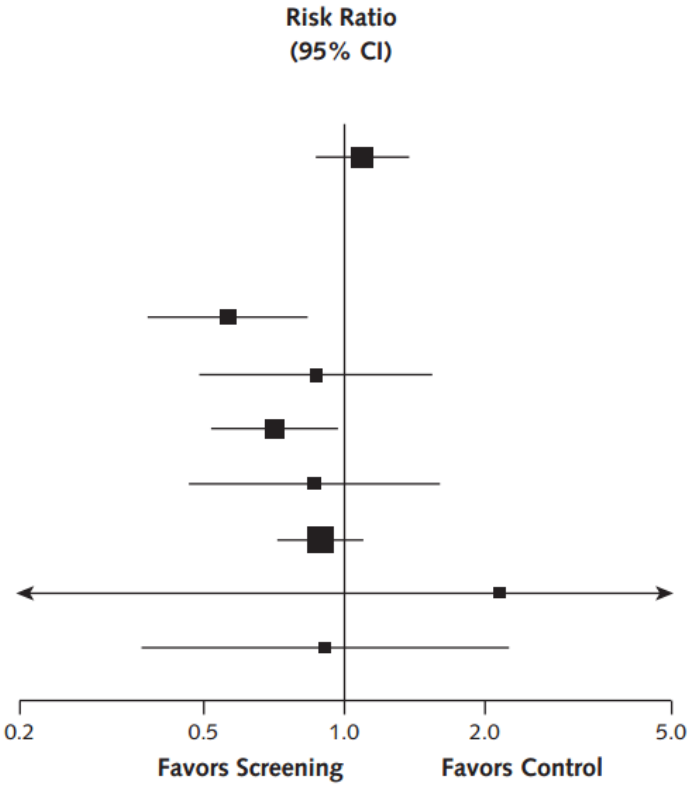


Advantage	Disadvantage
Death due to breast cancer avoided + risk for permanent damage	Over-diagnoses (cancers detected and treated that would not have caused any harm if left alone) + risk for permanent damage
	Cancer undetected
	False-positive diagnoses requiring further investigation

PSA cancer screening

Figure 2. **Relative risk of prostate cancer death for men screened with PSA versus control participants, by country.**

Country	Screened		Control		Risk Ratio (95% CI)
	Deaths	Total	Deaths	Total	
PLCO trial					
United States	158	38 340	145	38 345	1.09 (0.87–1.36)
ERSPC trial					
Sweden	39	5901	70	5951	0.56 (0.38–0.83)
Belgium	22	4307	25	4255	0.86 (0.48–1.52)
Netherlands	69	17 443	97	17 390	0.71 (0.52–0.96)
Italy	19	7266	22	7251	0.86 (0.46–1.58)
Finland	139	31 970	237	48 409	0.89 (0.72–1.09)
Spain	2	1056	1	1141	2.15 (0.20–23.77)
Switzerland	9	4948	10	4955	0.89 (0.36–2.20)



ERSPC = European Randomized Study of Screening for Prostate Cancer; PLCO = Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial; PSA = prostate-specific antigen.

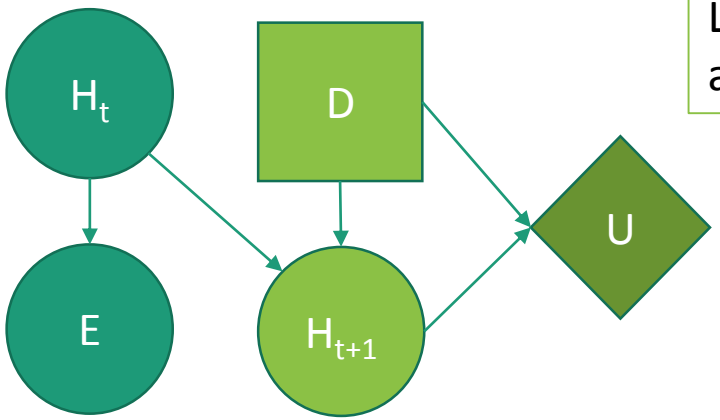
Multi Criteria Decision Analysis

1. Define problem & generate alternatives
2. Identify criteria to compare alternatives
3. Gather value judgments on relative importance of the criteria
4. Screen/eliminate clearly inferior alternatives
5. Determine performance of alternatives for criteria
6. Rand/Select final alternative(s)

Crayfish revisited – Multi Criteria Decision Analysis

attribute

Loss is 100 if crayfish still present after management and 0 otherwise



Management alternative	Cost	Neg Impact	Acceptance
Do nothing	0	0	0
Mechanical removal	10	2	10
Add poison	5	10	2

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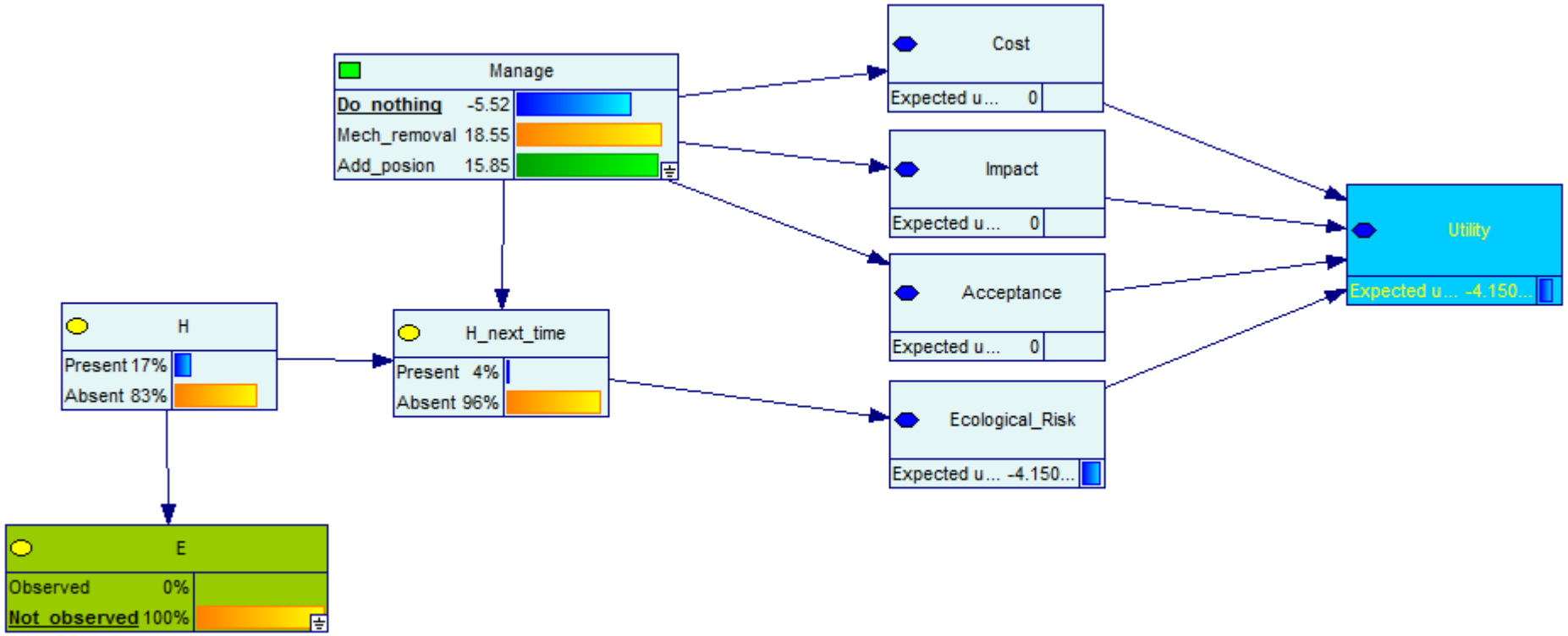
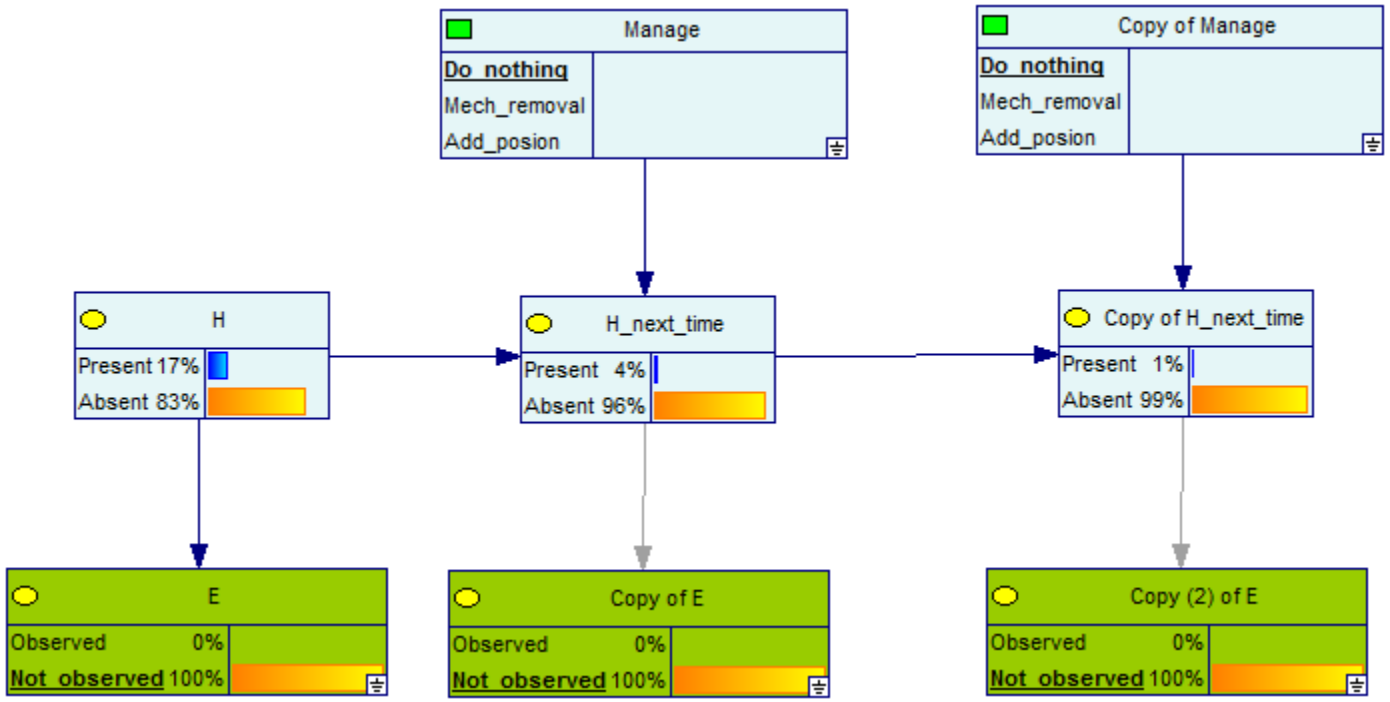
Crayfish revisited – MCDA



Crayfish again – Adaptive management



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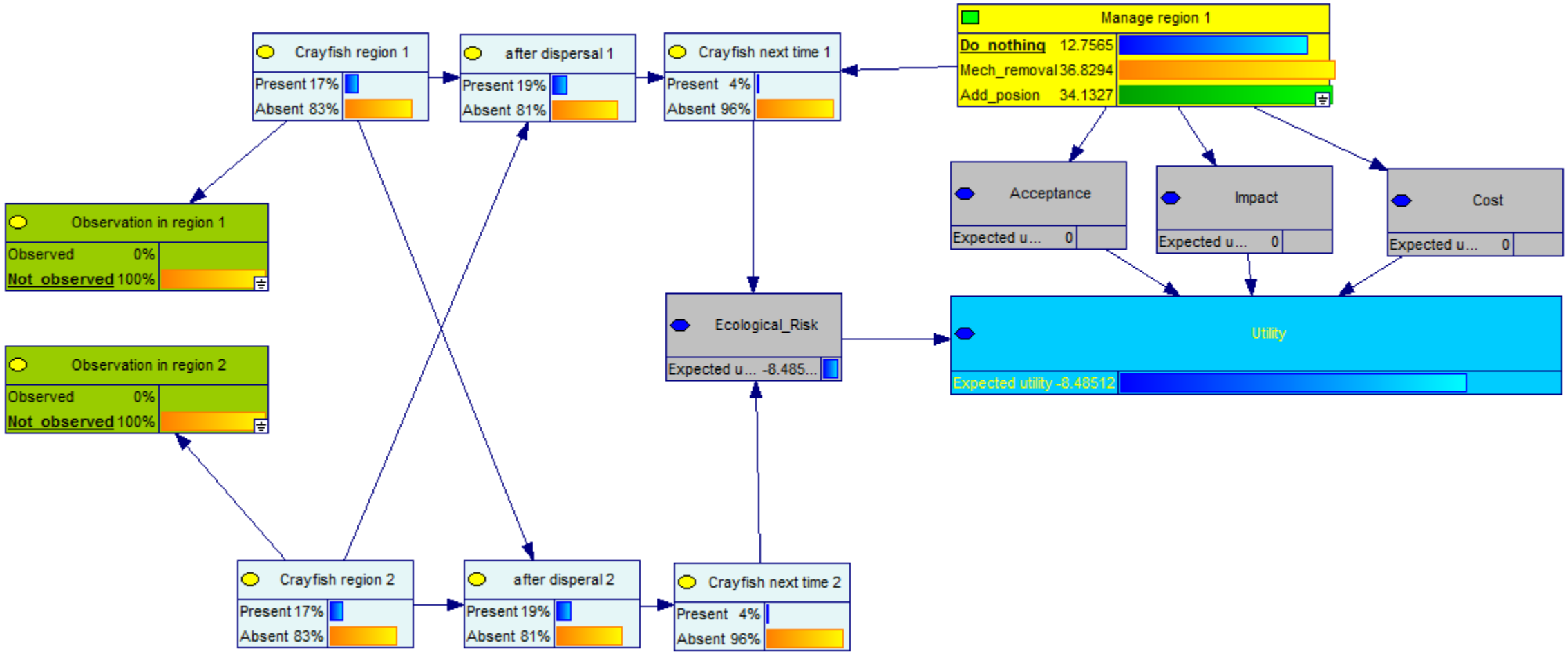
Crayfish (oh not again) – Spatial assessment



List

- Set target and derive states that increase the chances of reaching that target in the future
- Value of information analysis (requires utility nodes)
- Sensitivity analysis
- Scenario analysis

Confusion matrix

	Predicted condition	
True condition	Cancer	Not cancer
Cancer	TP	FN type II error
Not cancer	FP type I error	TN

Weighthing of criteria