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THE UNIVERSITY OF MELBOURNE

Sensitivity to uncertainty in Bayes nets

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What are they good for?

- A visual representation of cause and effect
- A platform for discussion and stakeholder input
- Analyses when data are scarce.
- Combining data, expert knowledge and experience.
- Understanding processes and testing ideas.
- Identifying important missing data
- Incorporating (some elements of) uncertainty.

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Red Imported Fire Ants

Advice to Ministerial Council with a sound technical basis for ensuring that

- the eradication program is on track (or otherwise) and
- that the field operations (surveillance and control) best suit the behaviour of the infestation.

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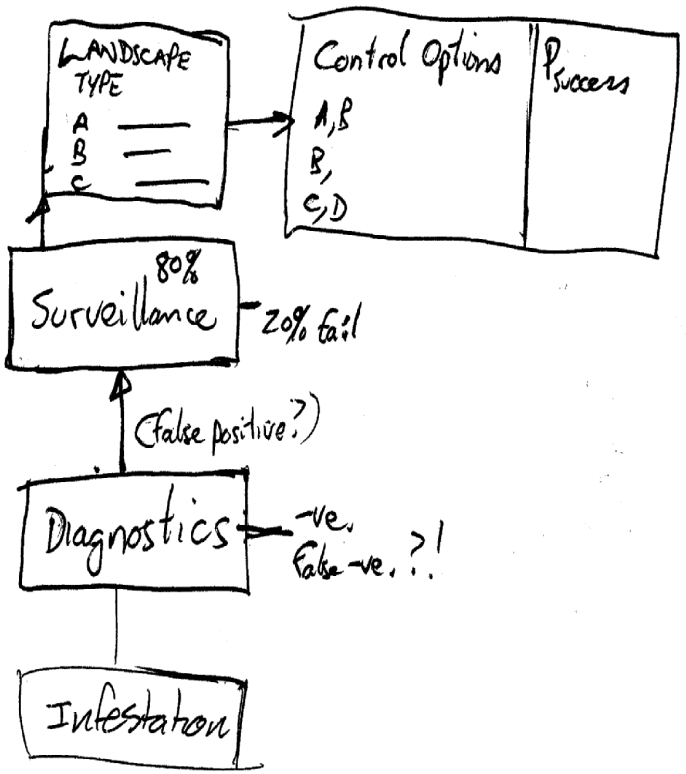
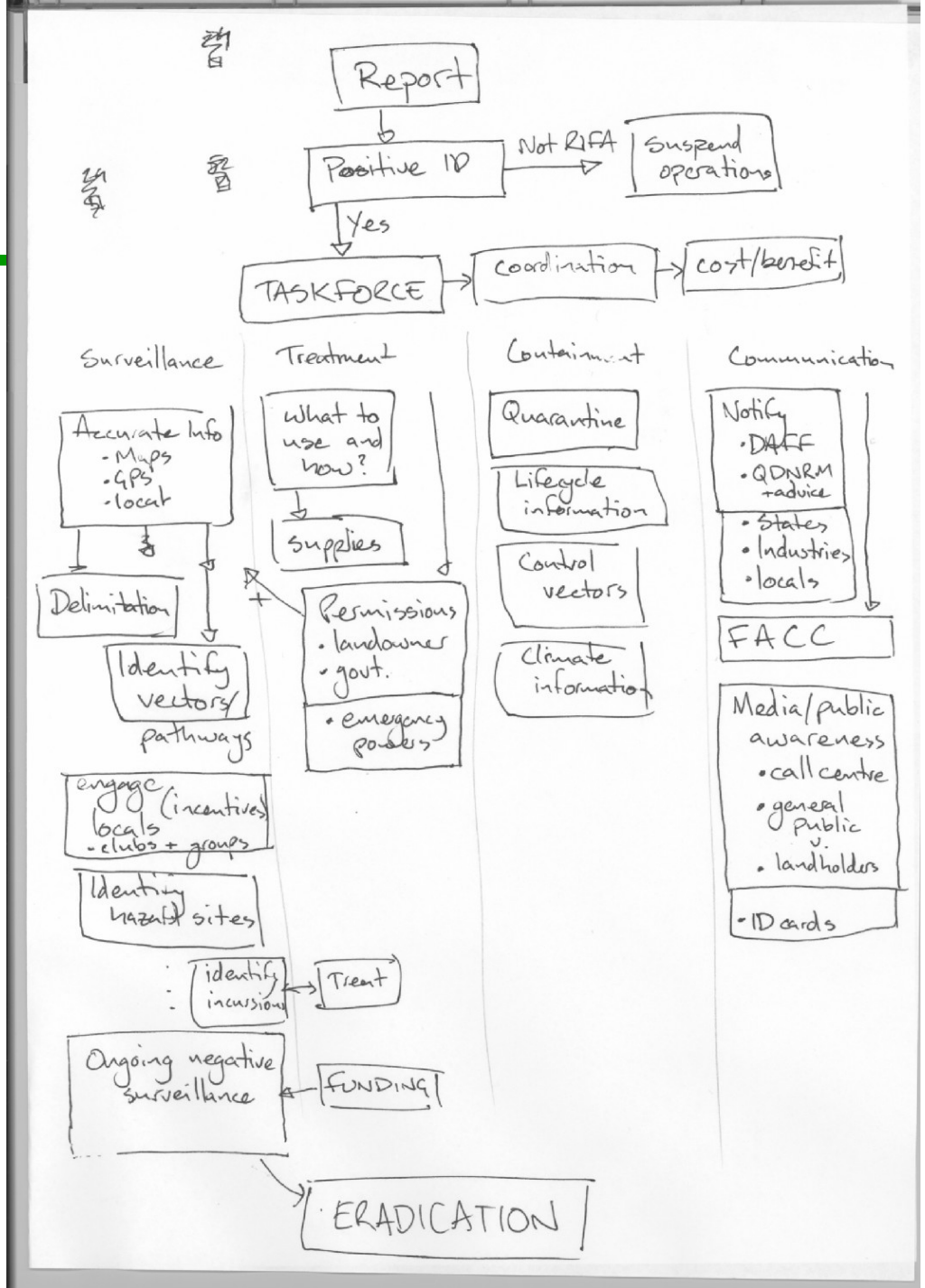
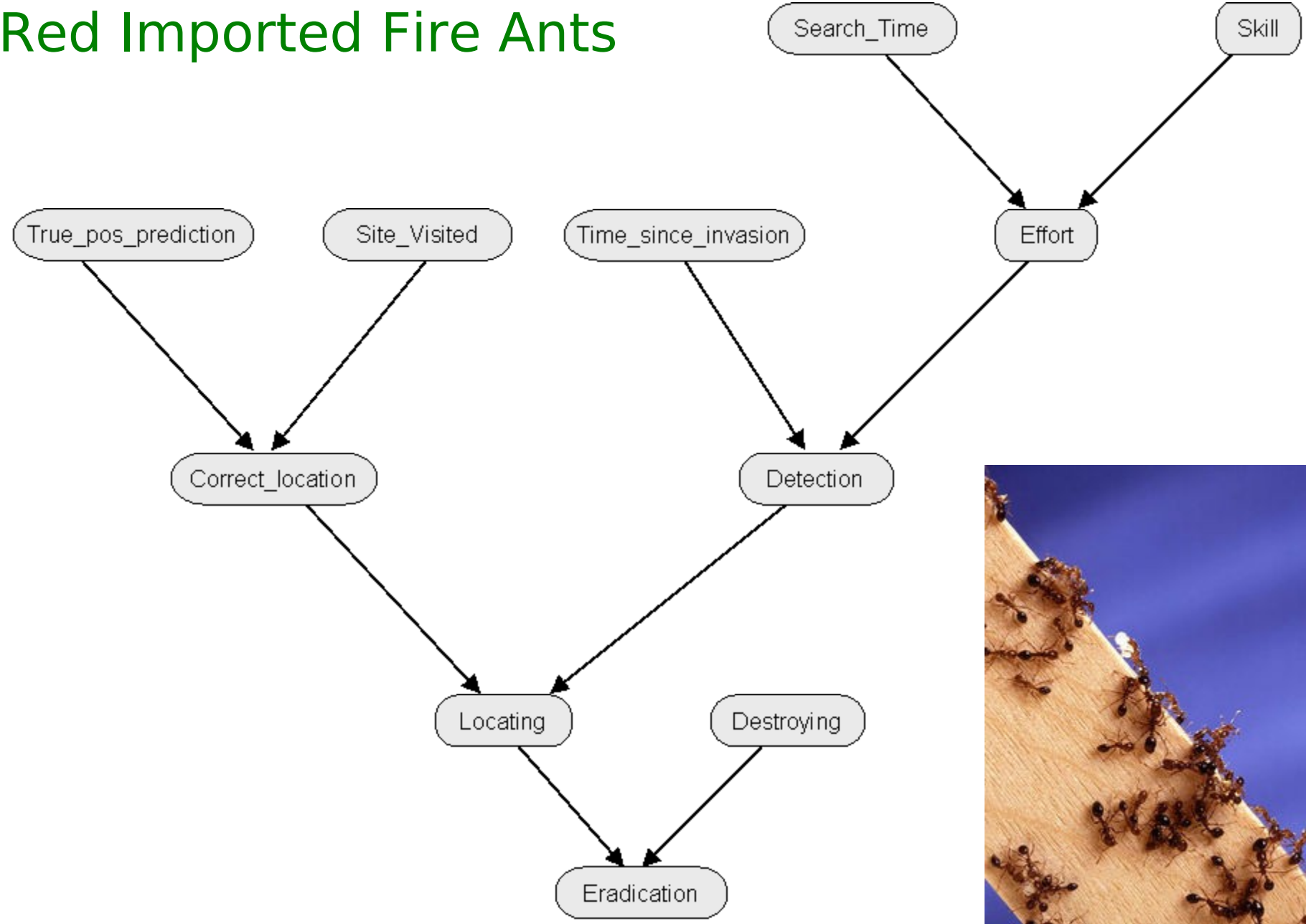
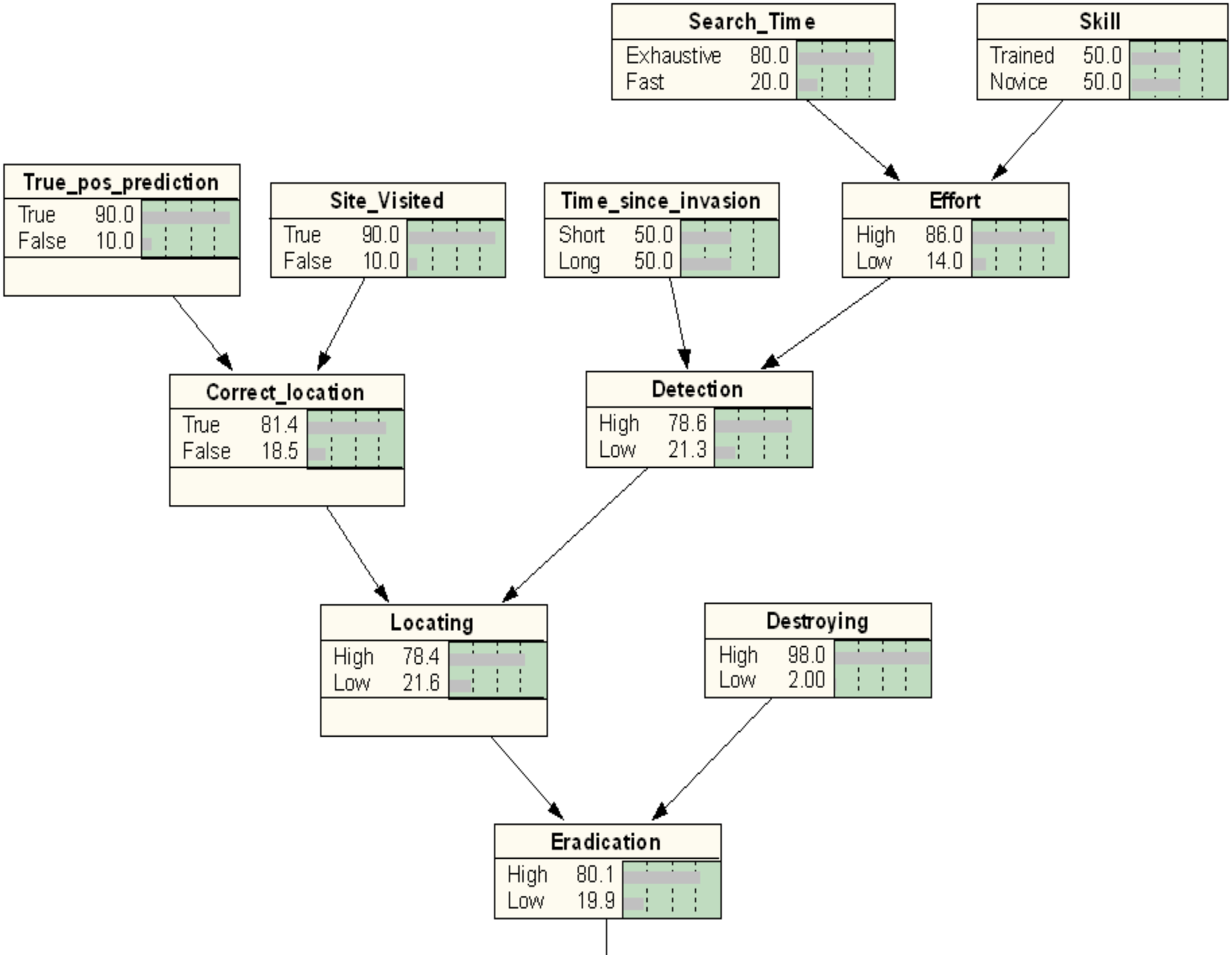
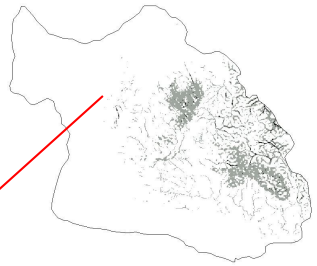




Red Imported Fire Ants




Search_Time
Exhaustive 80.0
Fast 20.0
Skill
Trained 50.0
Novice 50.0
True_pos_prediction
True 90.0
False 10.0
Site_Visited
True 90.0
False 10.0
Time_since_invasion
Short 50.0
Long 50.0
Effort
High 86.0
Low 14.0
Correct_location
True 81.4
False 18.5
Detection
High 78.6
Low 21.3
Locating
High 78.4
Low 21.6
Destroying
High 98.0
Low 2.00
Eradication
High 80.1
Low 19.9



Search_Time

Exhaustive	80.0
Fast	20.0

Skill

Trained	50.0
Novice	50.0

True_pos_prediction

True	90.0
False	10.0

Site_Visited

True	90.0
False	10.0

Time_since_invasion

Short	50.0
Long	50.0

Effort

High	86.0
Low	14.0

Correct_location

True	81.4
False	18.5

Detection

High	78.6
Low	21.3

Locating

High	78.4
Low	21.6

Destroying

High	98.0
Low	2.00

Eradication

High	80.1
Low	19.9

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Decisions under risk

States		Acts a_1	a_2	...	a_m
s_1	p_1	v_{11}	v_{12}	...	v_{1m}
s_2	p_2	v_{21}	v_{22}	...	v_{2m}
⋮	⋮	⋮	⋮	⋱	⋮
s_n	p_n	v_{n1}	v_{n1}	...	v_{nm}

$$\max(E) = \max_{j=1,\ldots,m} \left\{ \sum_{i=1}^{n} p_i v_{ij} \right\}$$

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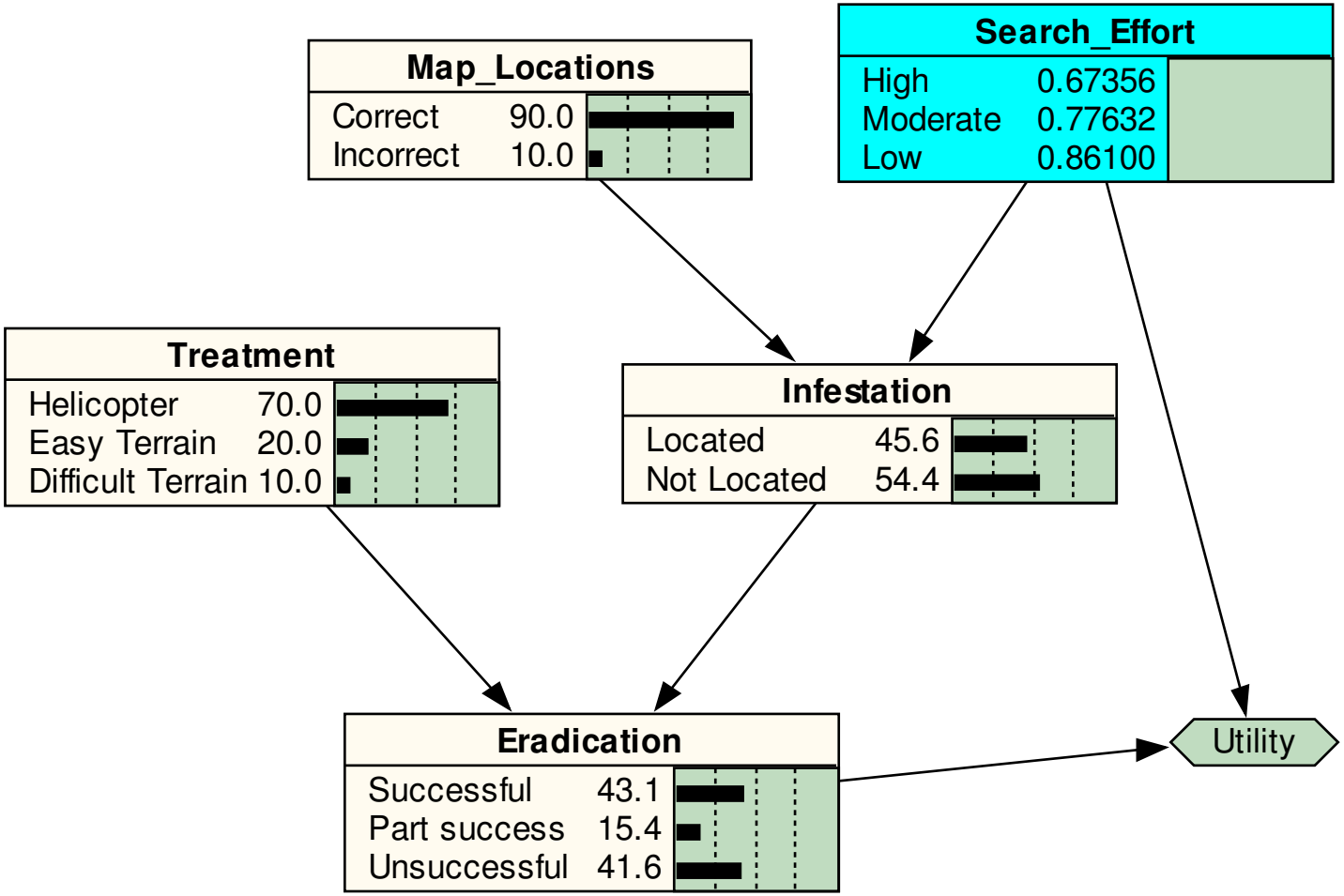
Decisions under risk



NOTE1

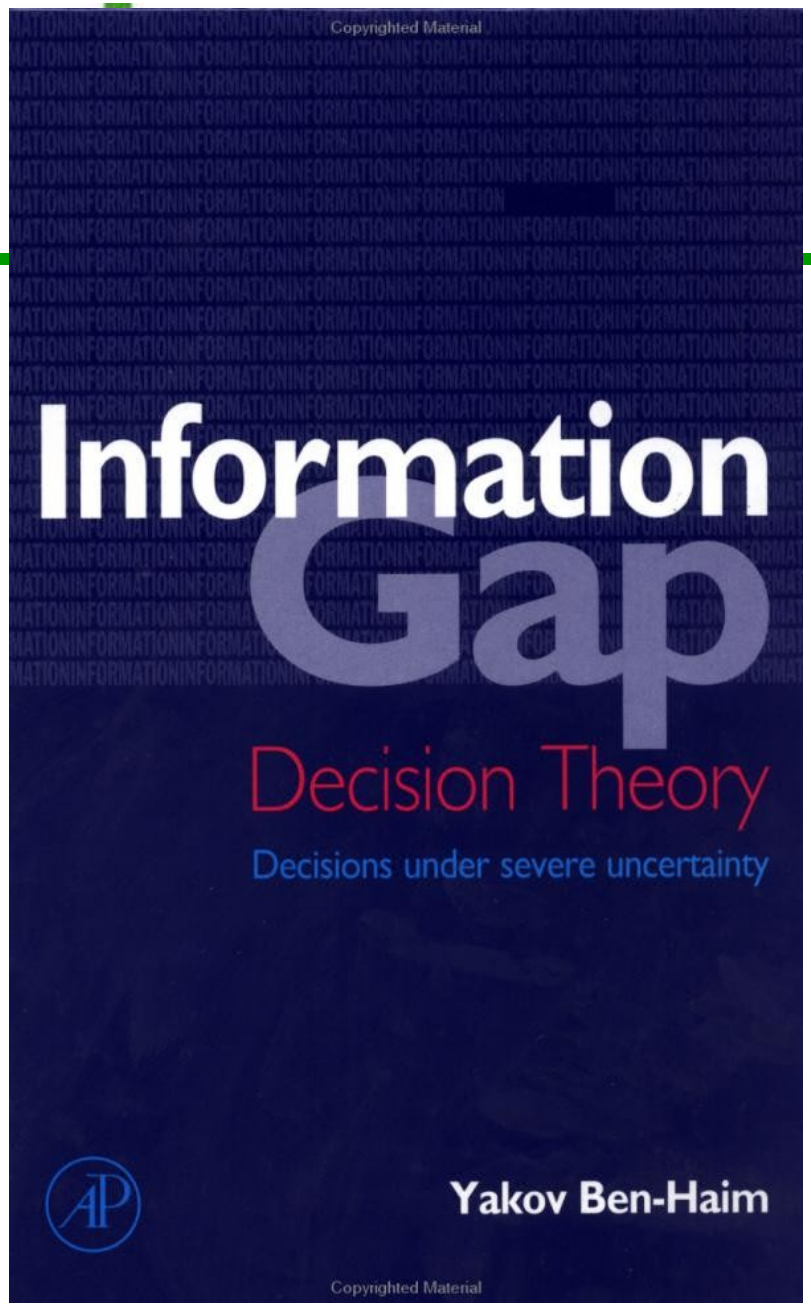
Decisions under uncertainty

Wald's maximin principle

$$v^* = \max_{x \in X} \min_{y \in Y} f(x, y)$$

But, since the affairs of men rests still incertain,
Let's reason with the worst that may befall.

William Shakespeare (1564-1616)
Julius Caesar, Act 5, Scene 1
with thanks to Moshe Sneidovitch



Sensitivity analysis requires three elements,

- a mathematical process model,
- a measure of performance, and
- a model for uncertainty.

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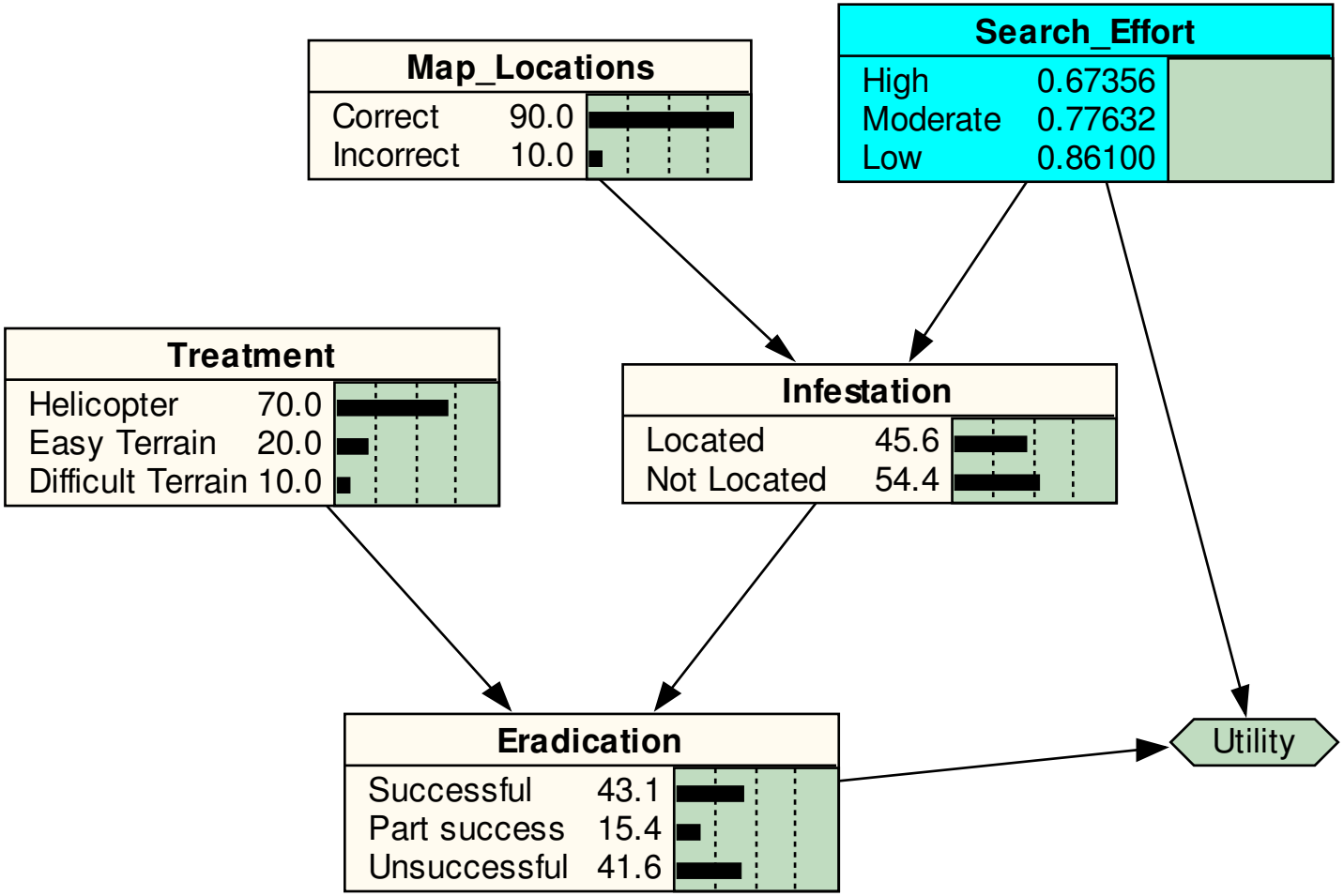
Process model and performance measure



NOTE1

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Model for uncertainty

What is the greatest horizon of relative uncertainty within which all of the outcomes of a given action result in an adequate performance?

$$U_v(\alpha, \tilde{v}) = \left\{ v : \left| \frac{v_{ij} - \tilde{v}_{ij}}{\tilde{v}_{ij}} \right| \leq \alpha, i = 1,\ldots, I, j = 1,\ldots, J \right\}, \alpha \geq 0$$

$$\frac{\left| p_j - \tilde{p}_j \right|}{\tilde{p}_j} \leq \alpha$$

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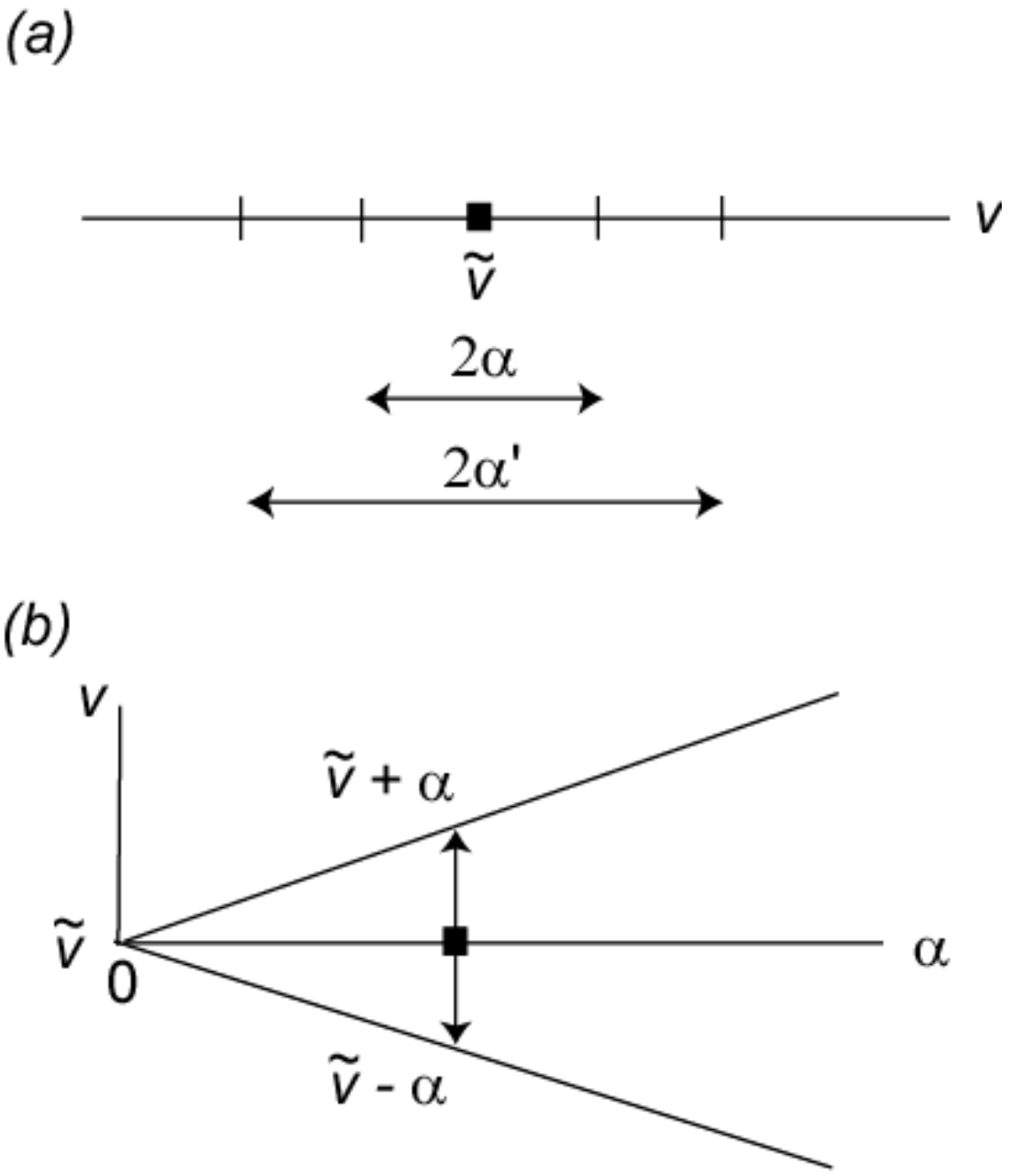

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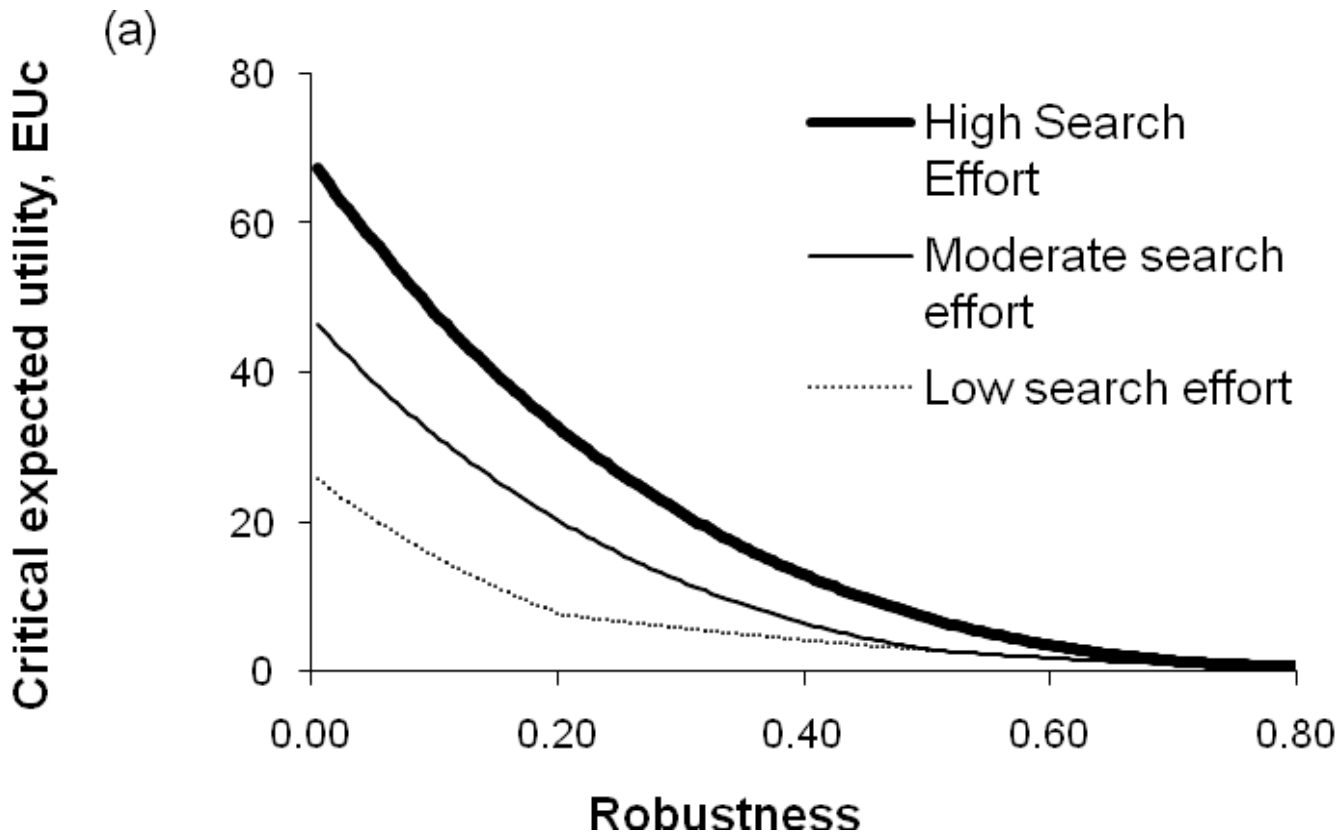

Ignoring search costs

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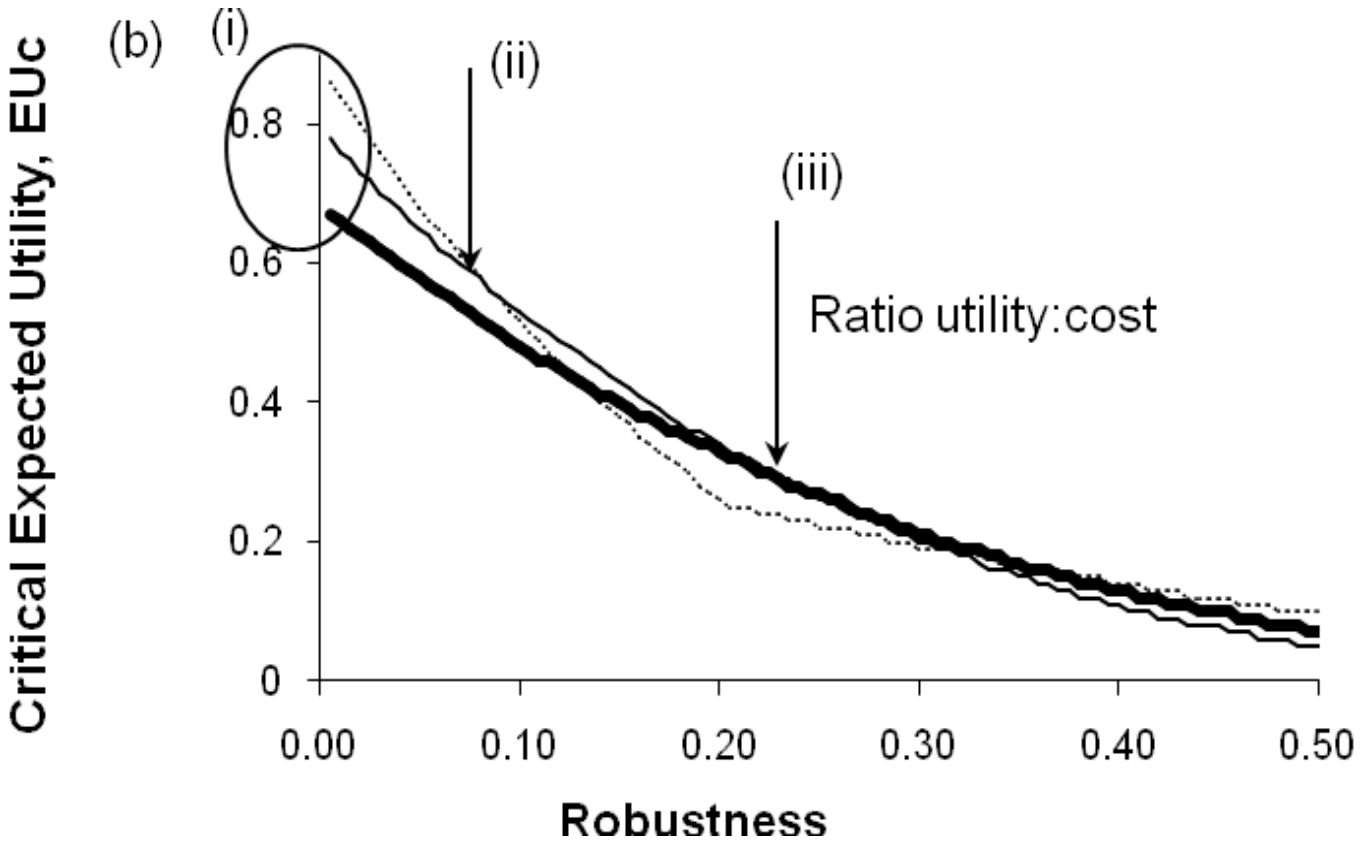

Including search costs

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Robust decisions

Tradeoff between immunity to uncertainty and aspiration for greater utility.

Very demanding aspirations are more vulnerable to uncertainty.

An expectation of maximum utility is maximally vulnerable to uncertainty.

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Exploring ‘severe’ uncertainty. What if my map is ‘really’ terrible?