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.
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.
Red Imported Fire Ants
Decisions under risk

\[
\begin{align*}
\text{States} & \quad s_1 & s_2 & \cdots & s_n \\
p_1 & v_{11} & v_{12} & \cdots & v_{1m} \\
p_2 & v_{21} & v_{22} & \cdots & v_{2m} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
p_n & v_{n1} & v_{n2} & \cdots & v_{nm} \\
\end{align*}
\]

\[
\max(E) = \max_{j=1,\ldots,m} \left\{ \sum_{i=1}^{n} p_i v_{ij} \right\}
\]
Decisions under risk

**Map_Locations**
- Correct: 90.0
- Incorrect: 10.0

**Search_Effort**
- High: 0.67356
- Moderate: 0.77632
- Low: 0.86100

**Treatment**
- Helicopter: 70.0
- Easy Terrain: 20.0
- Difficult Terrain: 10.0

**Infestation**
- Located: 45.6
- Not Located: 54.4

**Eradication**
- Successful: 43.1
- Part success: 15.4
- Unsuccessful: 41.6

**Utility**
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.
Process model and performance measure

### Eradication

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<th>Eradication</th>
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NOTE1

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

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

\[
\left| \frac{p_j - \tilde{p}_j}{\tilde{p}_j} \right| \leq \alpha
\]
Ignoring search costs
Including search costs
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.
Exploring ‘severe’ uncertainty. What if my map is ‘really’ terrible?