

Properties of the Value of Information

- The expected value of information is nonnegative

$$\forall \mathbf{e}, E_j \quad VPI_{\mathbf{e}}(E_j) \geq 0$$

- This is because in the worst case one could simply ignore the information and act as if it was not available
- That is, the agent can take action α instead of the action $\alpha_{e_{jk}}$

In this case the expected utility (for the worst case when we ignore the evidence) will be

$$\sum_k P(E_j = e_{jk} | \mathbf{e}) EU(\alpha | \mathbf{e}, E_j = e_{jk}) = EU(\alpha | \mathbf{e})$$

- If the agent considers the evidence E_j and takes action $\alpha_{e_{jk}}$

$$EU(\alpha_{e_{jk}}|E, E_j = e_{jk}) \geq EU(\alpha|E, E_j = e_{jk})$$

- Thus,

$$VPI_{\mathbf{e}}(E_j) = \left(\sum_k P(E_j = e_{jk}|\mathbf{e}) \underbrace{EU(\alpha_{e_{jk}}|\mathbf{e}, E_j = e_{jk})}_{\text{best action } e_{jk} \text{ after accounting for the value } e_{jk} \text{ for the evidence.}} \right) - \underbrace{EU(\alpha|\mathbf{e})}_{\text{without the evidence.}} \geq 0$$

- Therefore, $\forall \mathbf{e}, E_j \quad VPI_{\mathbf{e}}(E_j) \geq 0$

\mathbf{e} : current state
 E_j : new evidence
 averaged improvement over VPI
 $E_j = e_{jk}$

- The result holds on expected value and not actual value

averaged improvement over VPI

$$E_j = E_{jk}$$

- The result holds on expected value and not actual value
- Additional information can easily lead to a plan that turns out to be worse than the original plan if the information happens to be misleading.

- VPI is not additive

$$\underline{\underline{VPI_e(E_j, E_k)}} \neq \underline{\underline{VPI_e(E_j)}} + \underline{\underline{VPI_e(E_k)}}$$

- VPI is order independent

$$\underline{\underline{VPI_e(E_j, E_k)}} = \underline{\underline{VPI_e(E_j)}} + \underline{\underline{VPI_{e,e_j}(E_k)}} = \underline{\underline{VPI_e(E_k)}} + \underline{\underline{VPI_{e,e_k}(E_j)}}$$

$$\underline{\underline{e \cdot E_j \cdot E_k}}$$

$$\underline{\underline{e \cdot E_k \cdot E_j}}$$

function INFORMATION-GATHERING-AGENT($percept$) **returns** an *action*
persistent: D , a decision network

integrate $percept$ into D

$j \leftarrow$ the value that maximizes $VPI(E_j) / Cost(E_j)$

if $VPI(E_j) > Cost(E_j)$

return REQUEST(E_j)

else return the best action from D

gather/request for E_j



Simple ;
Complex.

episodic environment -
sequential decision making.

Policy

X sequence of actions
 $A_1 A_2 A_3 A_4 \dots A$

\mathcal{A}^0