How to Make Decisions Under Uncertainty

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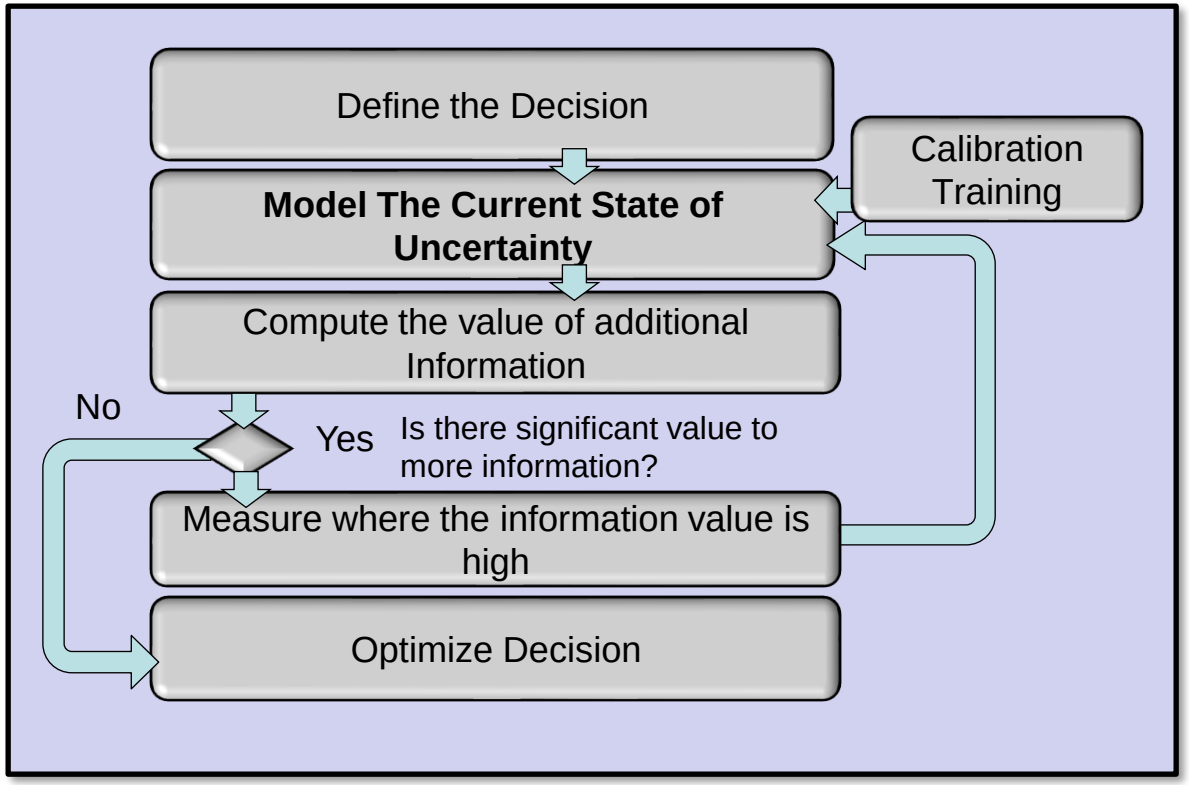
A General Procedure for Measurement

Model The Current State of Uncertainty

AIE quantifies and then optimizes decisions by focusing measurements where it matters most



Model The Current State of Uncertainty

Why Model Your Uncertainty

- **Acknowledging Uncertainty** — Uncertainty should be a big factor in making decisions. Explicitly modeling the uncertainty has large impacts on making decisions.
- **Improved Performance** — People who build Monte Carlo models tend to make better forecasts.
- **Avoid The Measurement Inversion** — When people try to reduce their uncertainty, they measure the wrong things.

Model The Current State of Uncertainty

Modeling the UBDM System

1. The clarification discovered that the reason for the measurement was to make a decision about the UBDM system.

2. After we've clarified the decision, we identify variables relevant to the UBDM system:

- $5 million initial investment
- 25% reduction in time spent on document management
- 1,000 staff w/average loaded salary of $90,000 currently spent 15% of time in document management

Compute the Value of Additional Information

The Value of Information

The Formula For The Value of Information:

$$EVI = \sum_{i=1}^{k} p(r_i) \max\left[\sum_{j=1}^{z} V_{1,j}\, p(\Theta_j|r_i), \sum_{j=1}^{z} V_{2,j}\, p(\Theta_j|r_i), \ldots \sum_{j=1}^{z} V_{l,j}\, p(\Theta_j|r_i),\right] - EV^*$$

OR, in its simplest form:

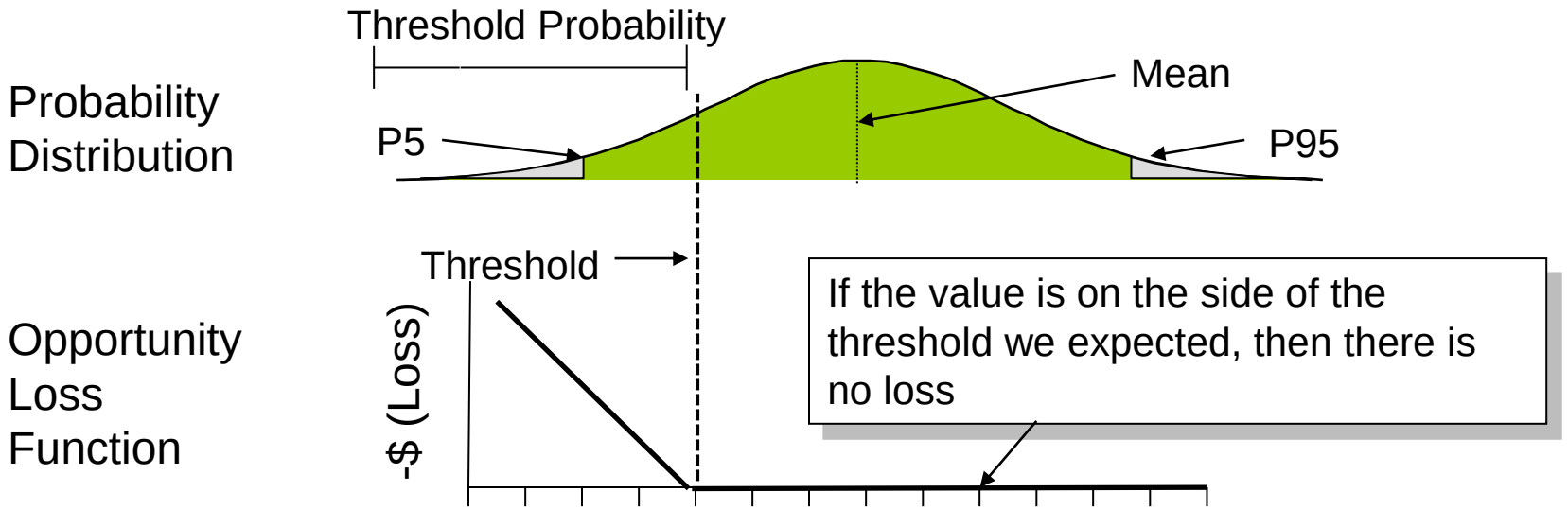
"The cost of being wrong times the chance of being wrong"

The formula for the value of information has been around for almost 60 years. It is widely used in many parts of industry and government as part of the "decision analysis" methods — but still mostly unheard of in the parts of business where it might do the most good.

Compute the Value of Additional Information

Information Value w/Ranges

- Estimate a range and distribution of hours/week spent on task
- There is a point below which investment would lose money
- The less time spent below that point, the greater the loss

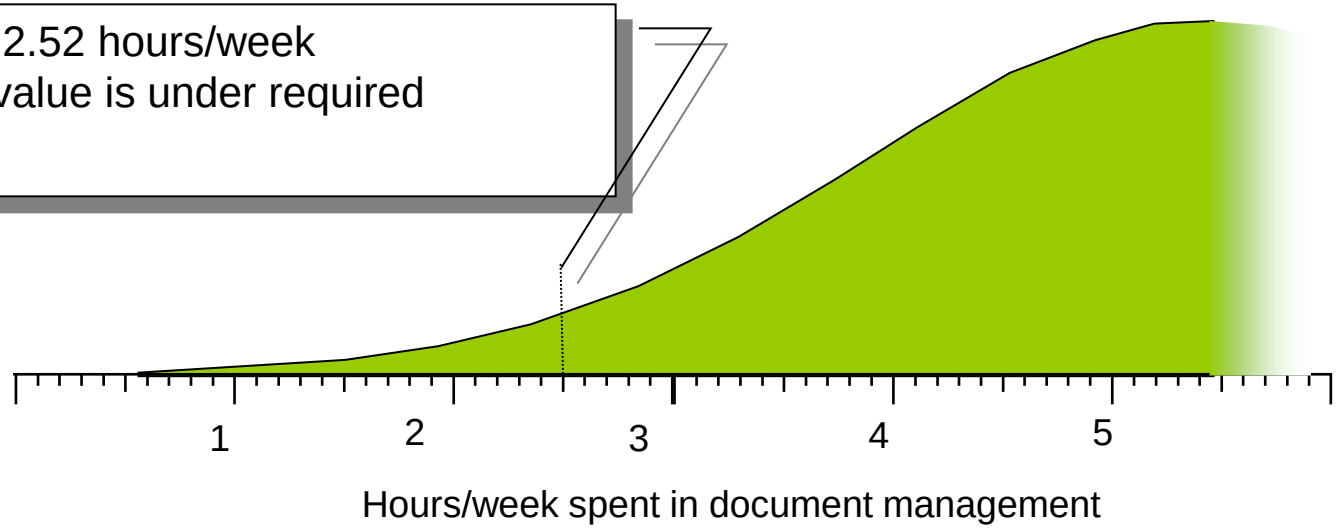


Compute the Value of Additional Information

Normal Distribution Information Value

- The “expected value” of the variable is the mean of the range of possible values.
- A threshold is a point where the value just begins to make some difference in a decision — a breakeven.
- The expected value is on one side of the threshold.
- If the true value is on the opposite side of the threshold from the mean then the best decision would have been different then one based on the mean.
- The “Threshold Probability” is the chance that this variable could have a value that would change the decision.

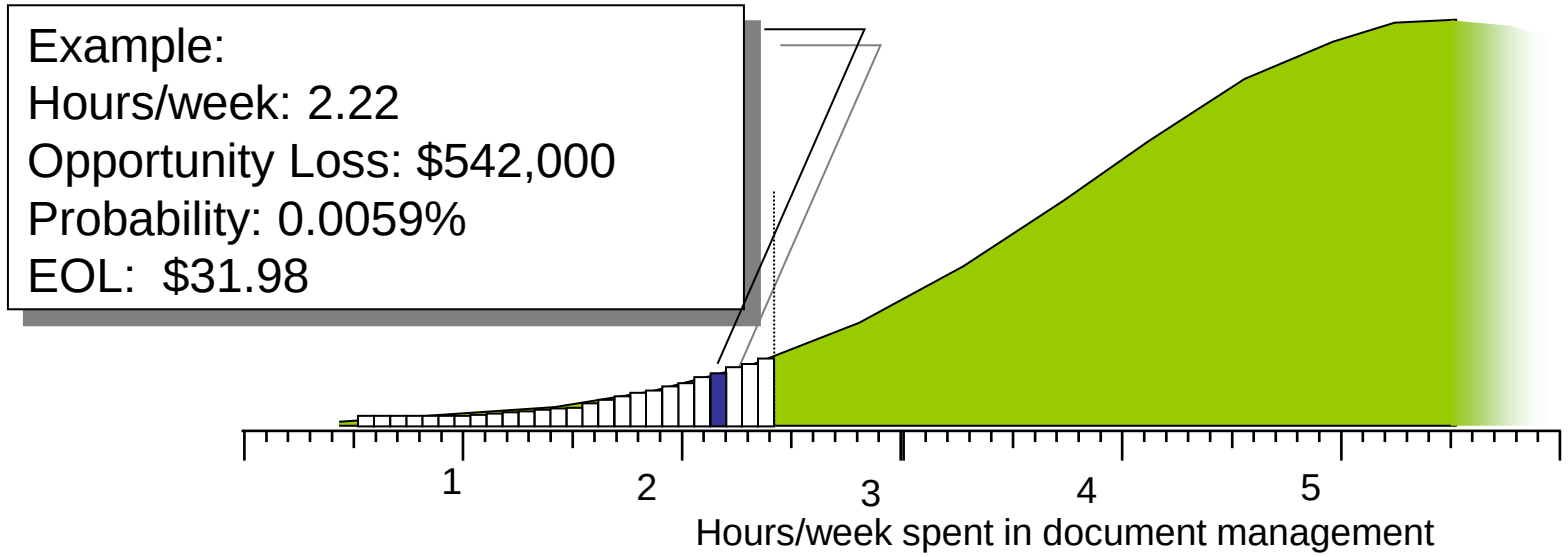
Example Threshold: 2.52 hours/week
Probability that true value is under required threshold: 6.5%



Compute the Value of Additional Information

Normal Distribution Value of Information Analysis (VIA)

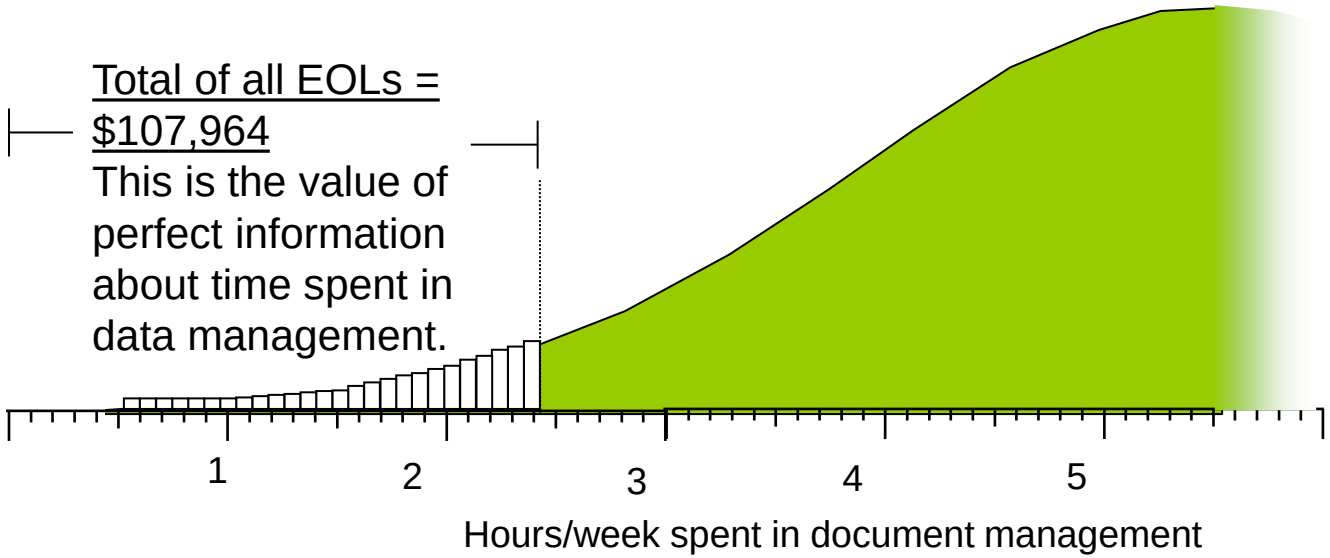
- The curve on the other side of the threshold is divided up into hundreds of “slices.”
- Each slice has an assigned quantity (such as a potential productivity improvement) and a probability of occurrence.
- For each assigned quantity, there is an Opportunity Loss.
- Each slice’s Opportunity Loss is multiplied by probability to compute its Expected Opportunity Loss.



Compute the Value of Additional Information

Normal Distribution VIA (Continued)

- Total EOL for all slices equals the EOL for the variable.
- Since EOL=0 with perfect information, then the Expected Value of Perfect Information (EVPI) = sum(EOLs)
- Even though perfect information is not usually practical, this method gives us an upper bound for the information value, which can be useful by itself.
- Many of the EVPIs in a business case will be zero.
- We do this with a macro in Excel but it can also be estimated.



Compute the Value of Additional Information

The Measurement Inversion

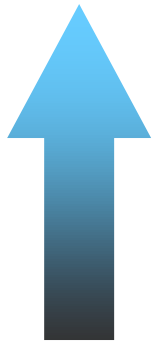
In a business case, the economic value of measuring a variable is usually inversely proportional to the measurement attention it typically gets.

Lowest Information Value

Highest Information Value

- Initial cost
- Long-term costs
- Cost-saving benefit other than labor productivity
- Labor productivity
- Revenue enhancement
- Technology adoption rate
- Project completion

Most Measured



Least Measured

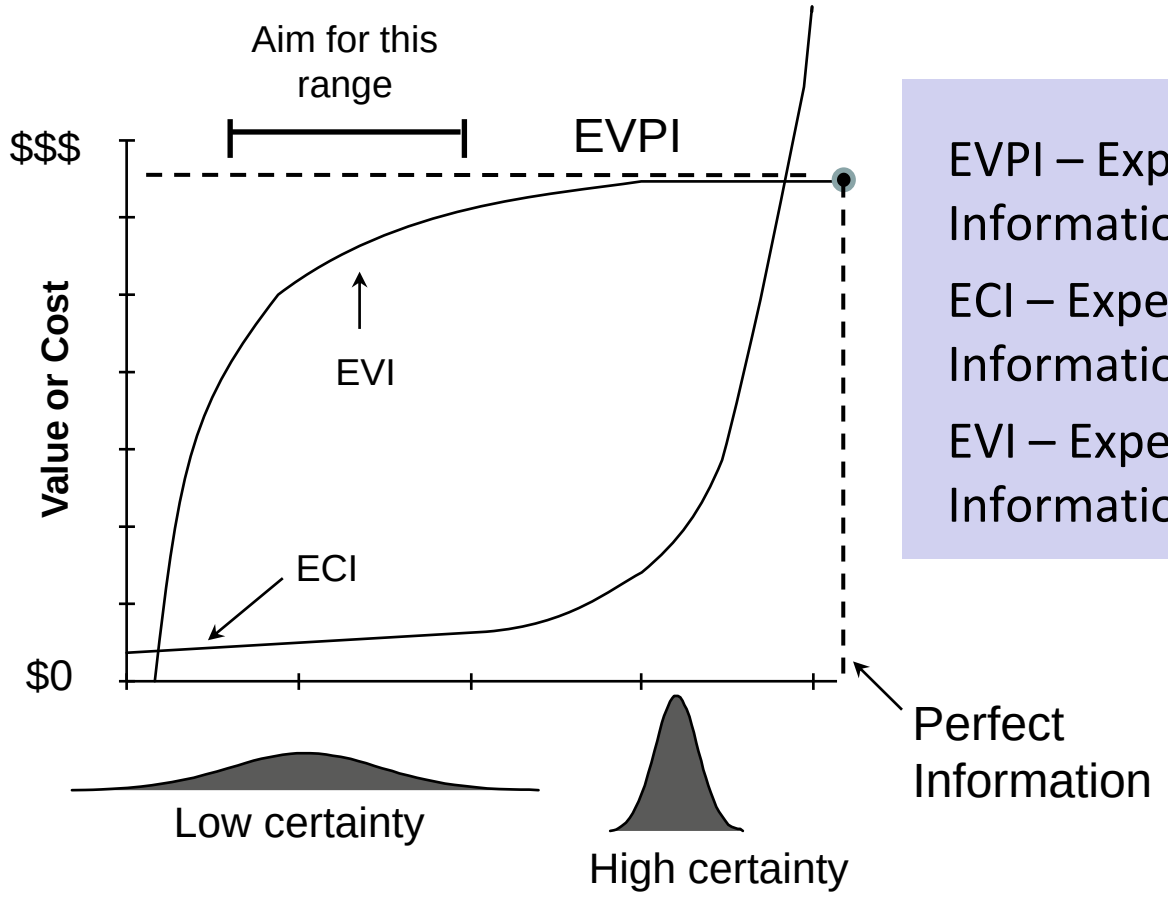
Compute the Value of Additional Information

Real Examples of Measurement Inversion

Subject	What they would have measured	What they needed to measure
New Procurement System for Government	Detailed “time and motion” study of procurement process	The price savings from using reverse auctions
Battlefield Fuel Forecasting	Chance of enemy contact, forecasts vehicle maintenance	The difference in mileage between paved and gravel roads
Risks of flooding in mining operations	Drilling test holes all over the mine	How much water the main pumps can handle
Market for new pharmaceutical products	The adoption rate of the new drug in all global regions	The duration of phase 1 testing, chance of a particular clinical outcome
Impact of pesticides regulation	The value of saving endangered species	Whether pesticides regulation ever saves any endangered species
IT security	People who attended training, external threats	Internal theft incidents

Compute the Value of Additional Information

Increasing Value & Cost of Info.



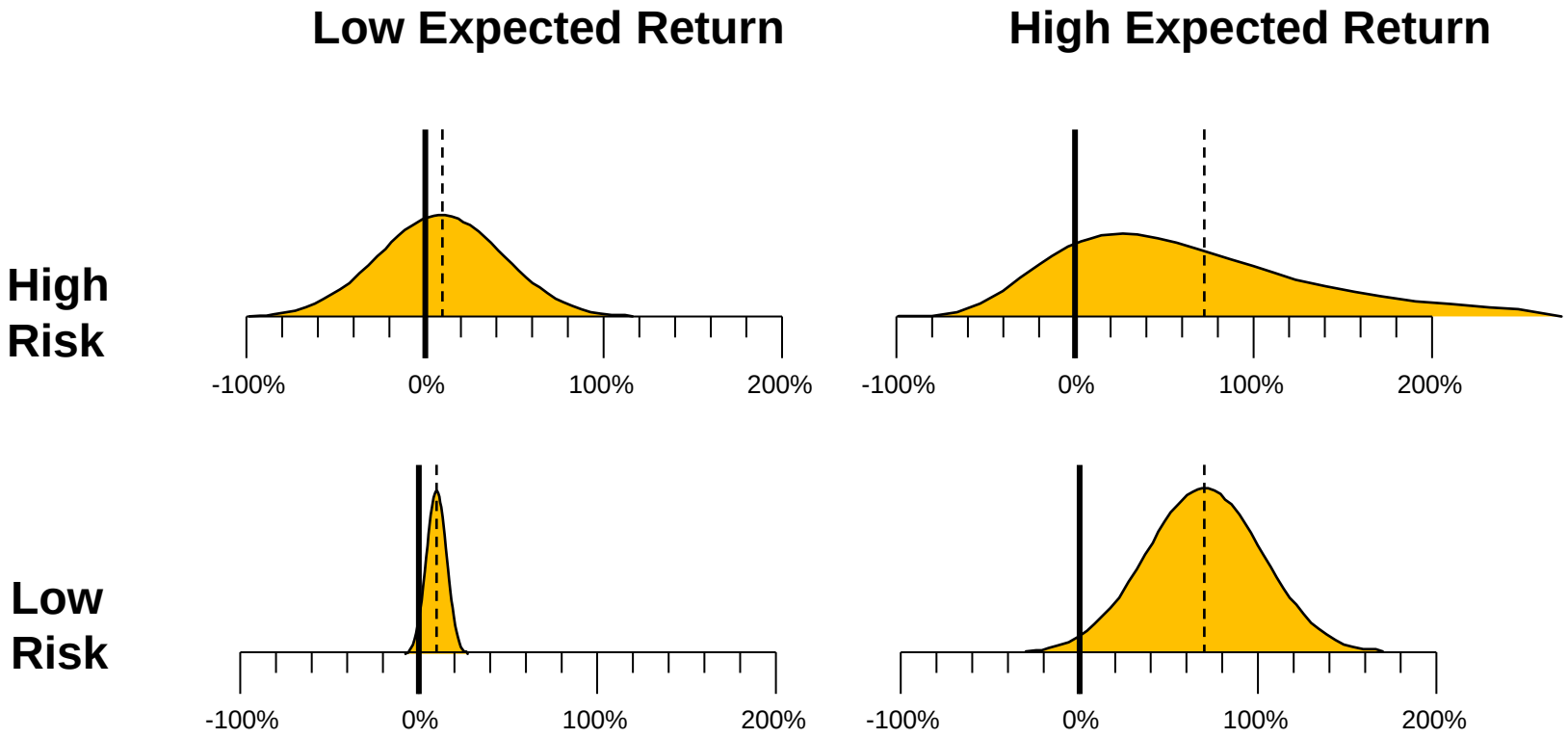
EVPI – Expected Value of Perfect Information

ECI – Expected Cost of Information

EVI – Expected Value of Information

Optimize the Decision

Various Risks & Returns



Optimize the Decision

Expert Inconsistency in Estimates & Risks

Studies have shown that estimates are affected by “anchoring” — previous exposure to unrelated numbers affects your estimates.

Studies have also shown risk aversion changes due to what should be irrelevant external factors, including:

Factor	Risk Aversion
Being around smiling people	↓
Recalling an event causing fear	↑
Recalling an event causing anger	↓
A recent win in an unrelated decision	↓
A recent loss in an unrelated decision	↑

The result is that experts cannot reproduce even their own judgments consistently — introducing a random variation to their judgment.

Questions?

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