



Uncertainty, Variability and Weight of Evidence: How Well Do We Know Environmental Risks?

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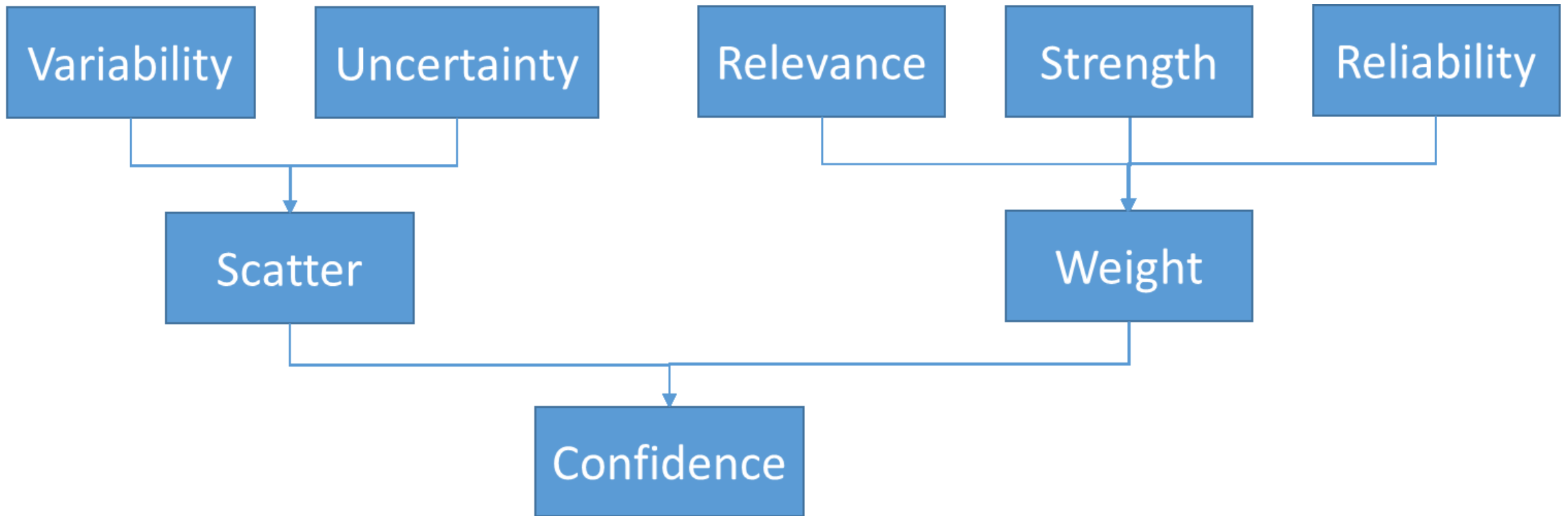
EFSA Scientific Conference, Milan, Italy

The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency

What do decision makers & stakeholders need?

- Qualitative information
 - Does this chemical cause cancer?
 - Is this ecosystem impaired?
 - What is the cause of observed effects?
- Quantitative information
 - What concentration is protective?
 - How much salmon habitat would be lost?
 - How long will natural remediation require?
- Confidence in both

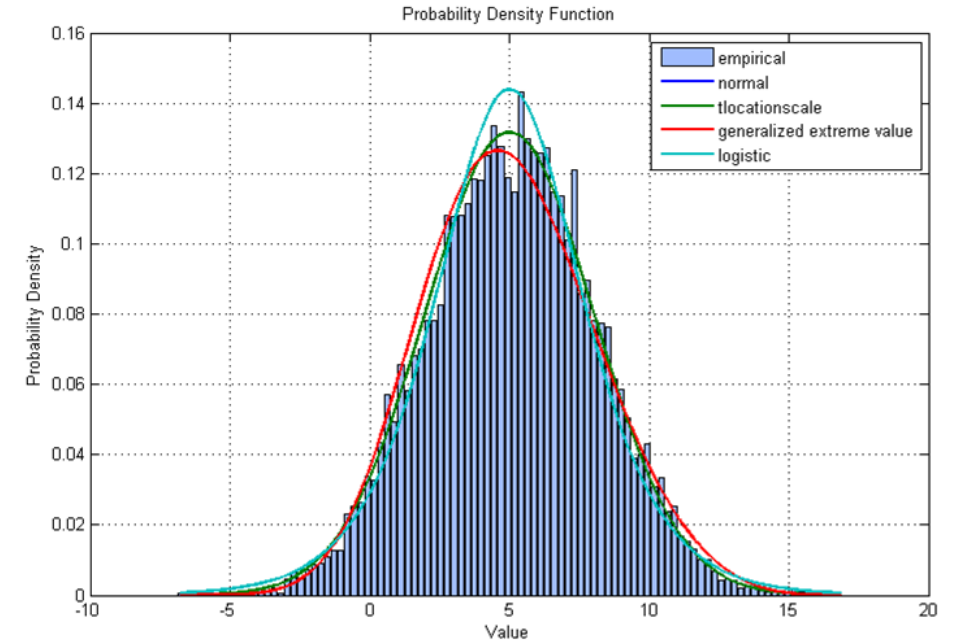
What is Confidence?



What is Scatter?

Anything expressed as a numerical distribution

- Variability
 - natural variation in some quantity
 - Cannot be reduced
- Uncertainty
 - Incomplete or imprecise data
 - Can be reduced
- Degree of belief
 - Subsumes variability and uncertainty for subjectivists
 - If you were betting on the teratogenicity of a chemical in use, What odds would you accept?



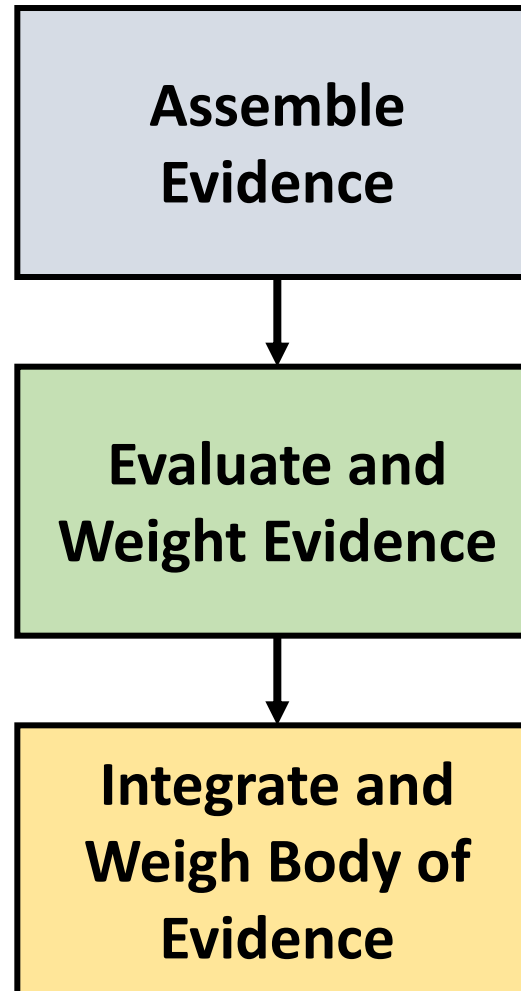
This is statistics—controversial but familiar

What is weight of evidence?

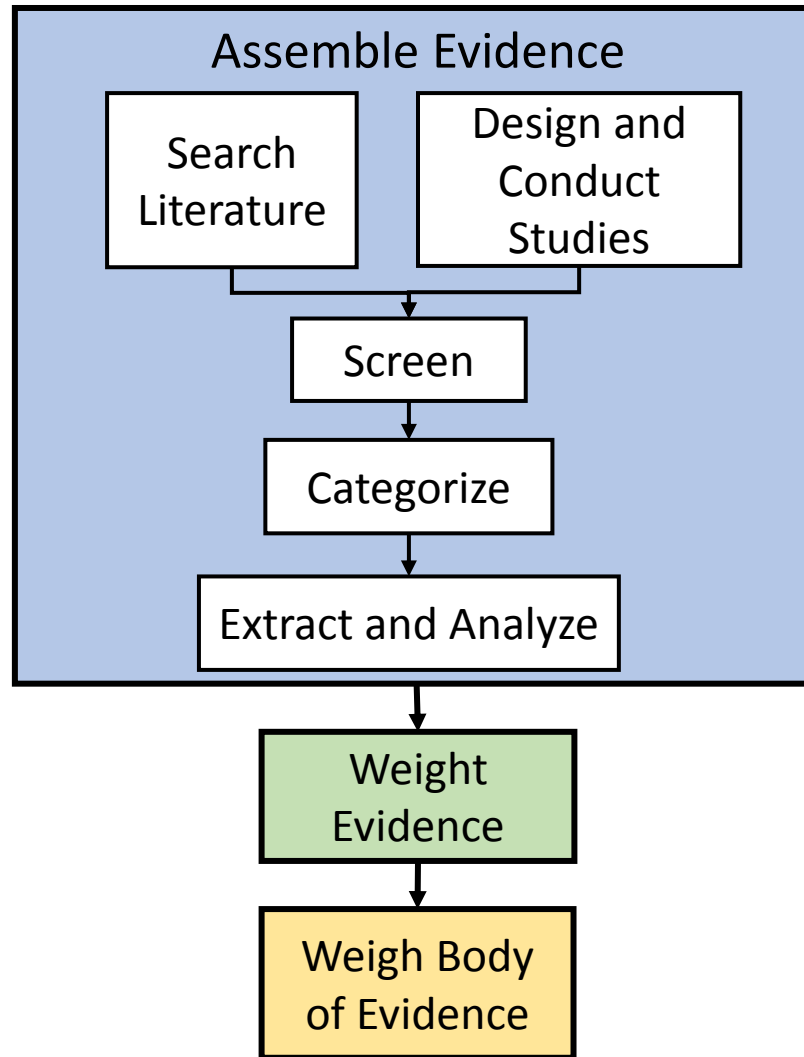
- Metaphor based on the scales of justice
- The influence evidence should have on an inference
 - The weight of a piece of evidence dropped in a pan
- A summary interpretation of multiple pieces of evidence
 - The weight of the body of evidence in one pan relative to the other
- An inferential approach that uses this concept
 - Often simply an expert narrative
 - We are trying to make it more formal, transparent and defensible



How do we weigh evidence?

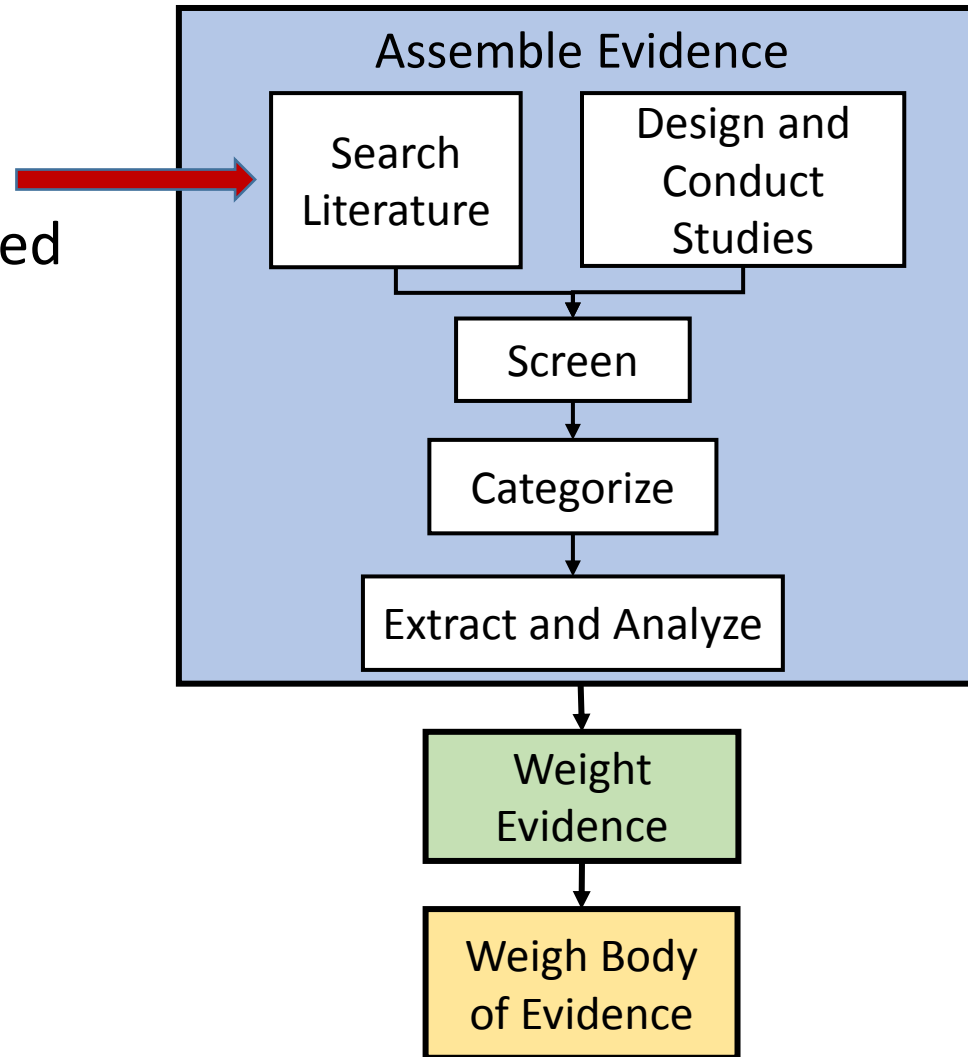


Assembling evidence

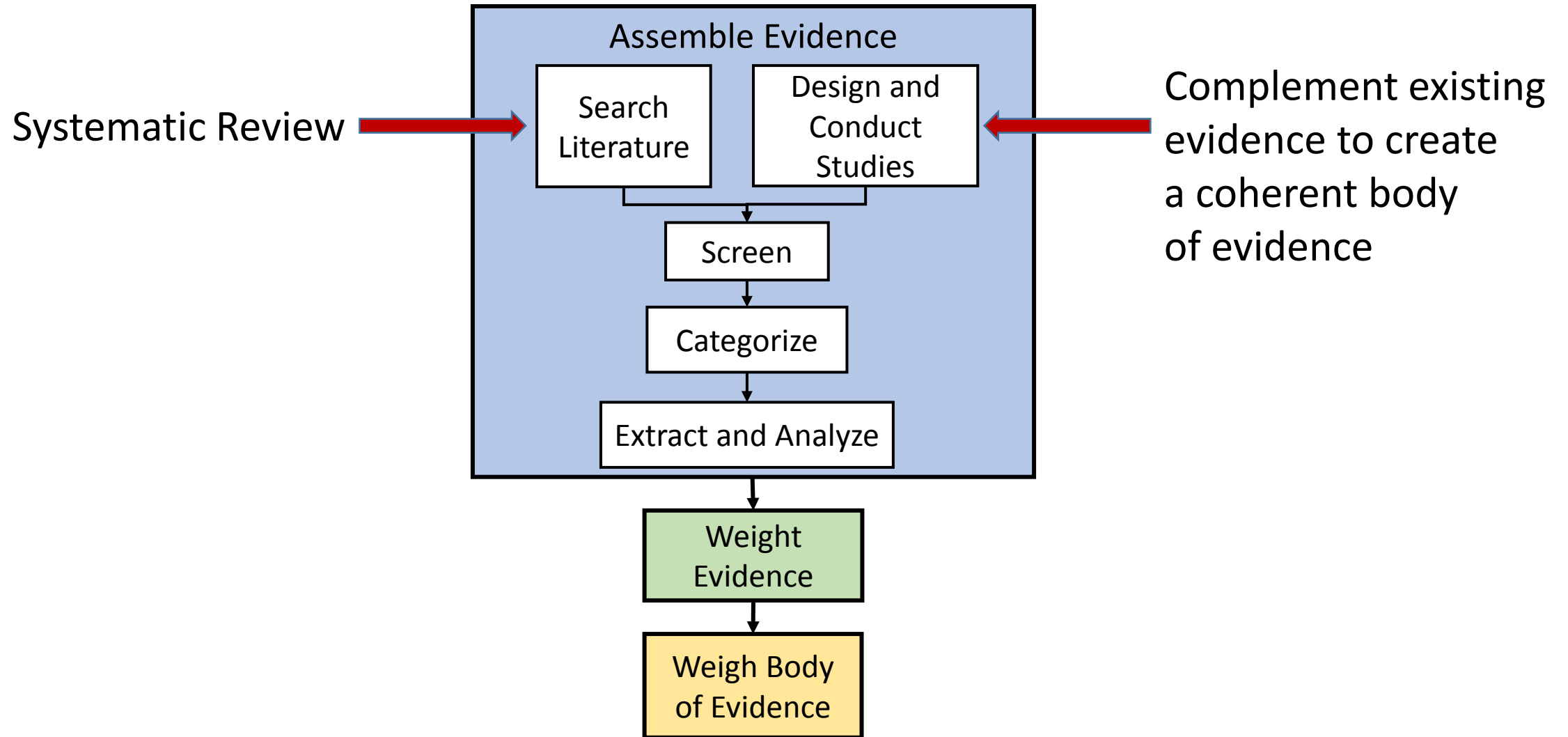


Assembling evidence

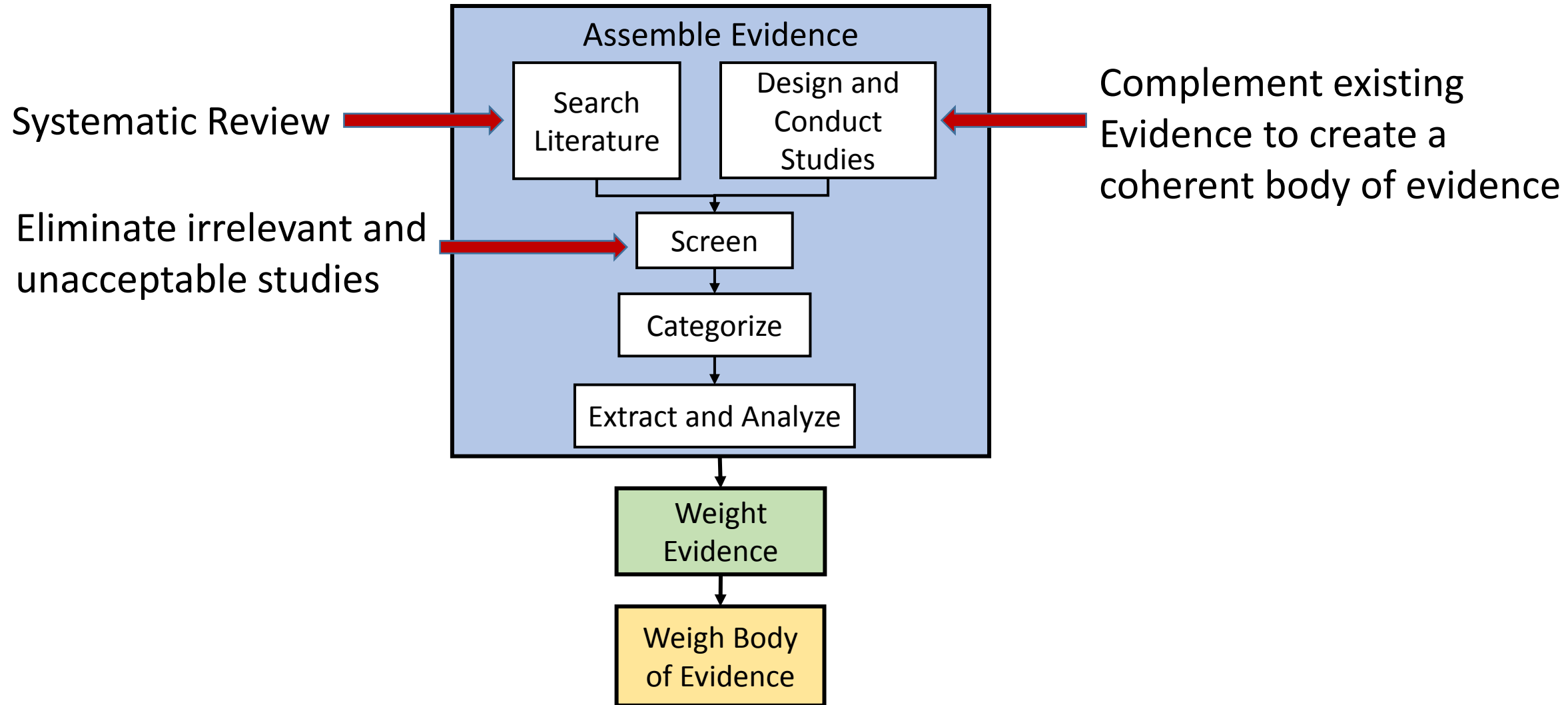
Systematic Review
thorough and unbiased



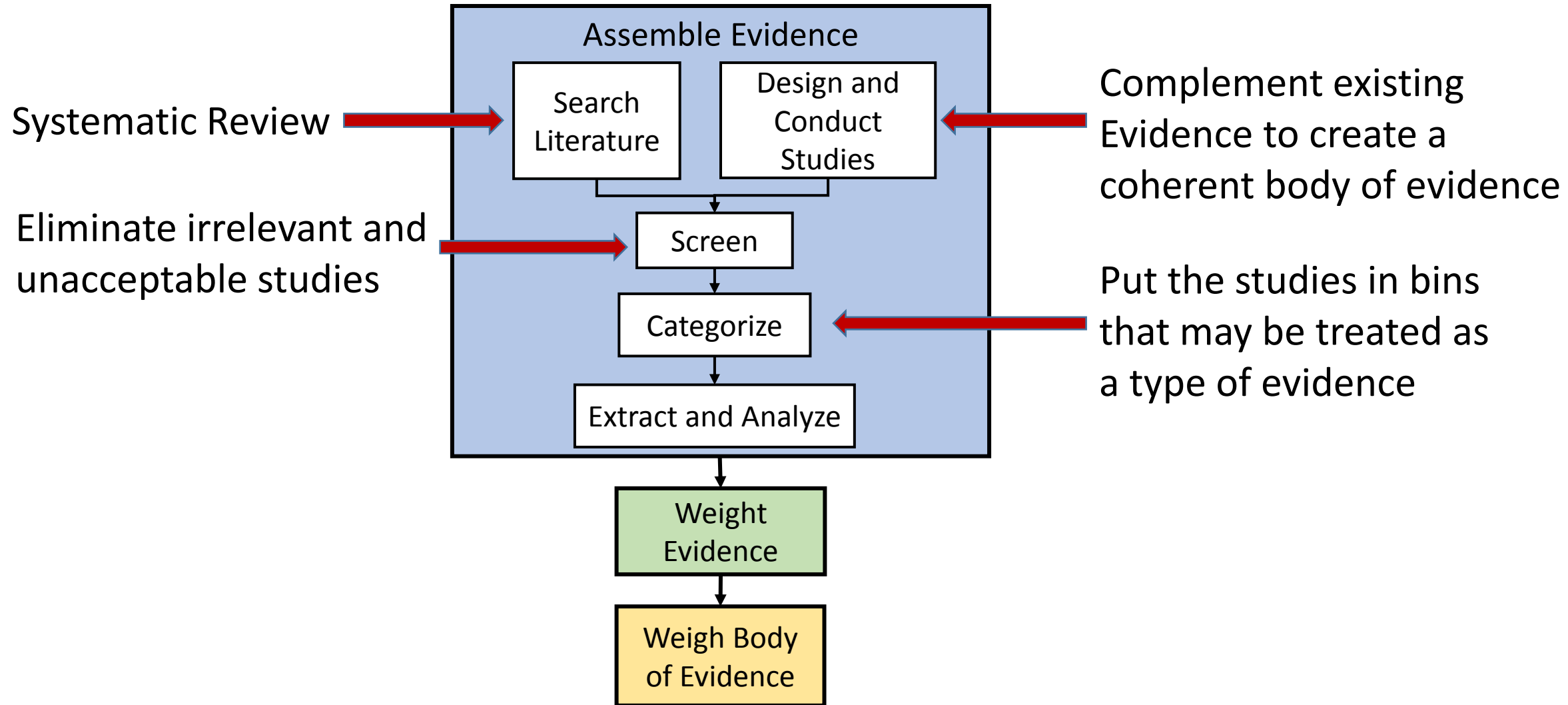
Assembling evidence



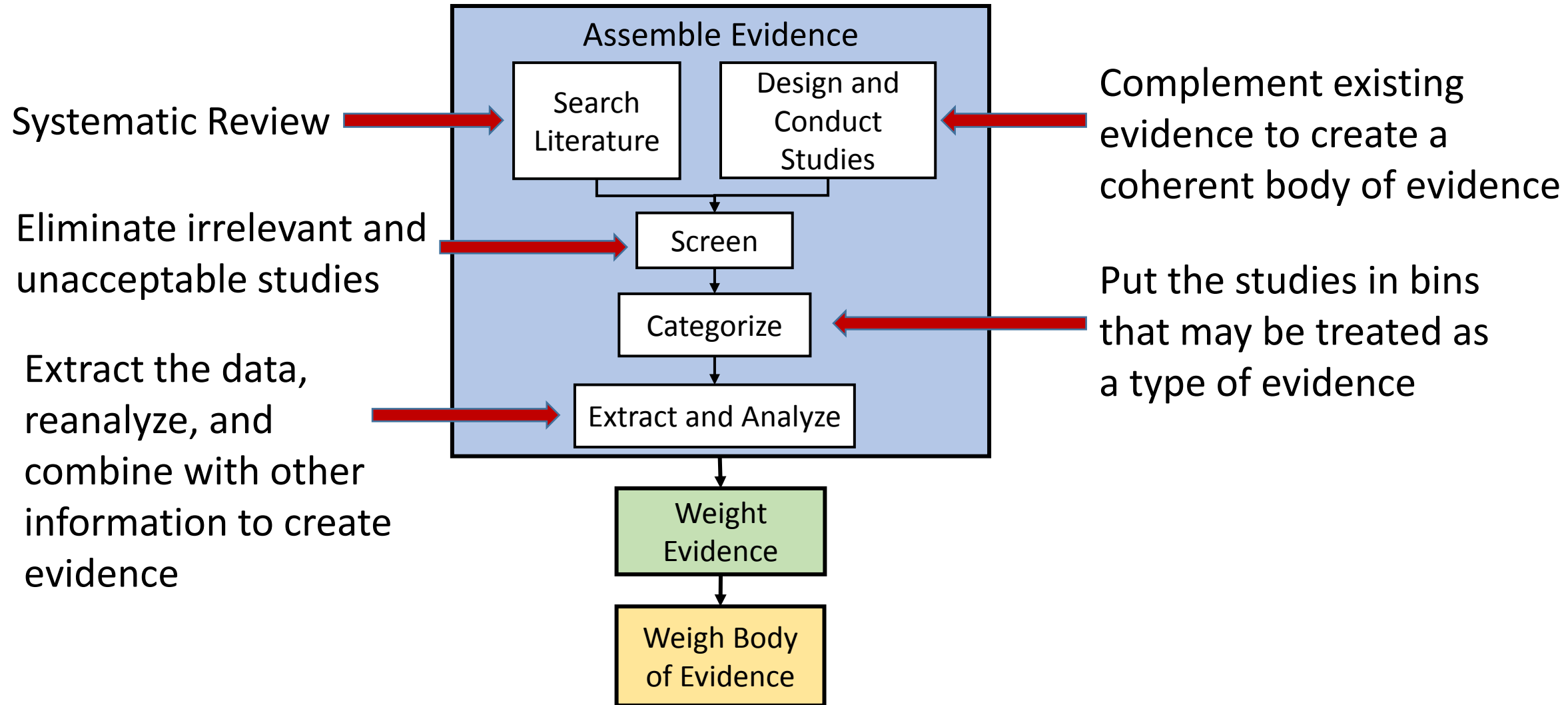
Assembling evidence



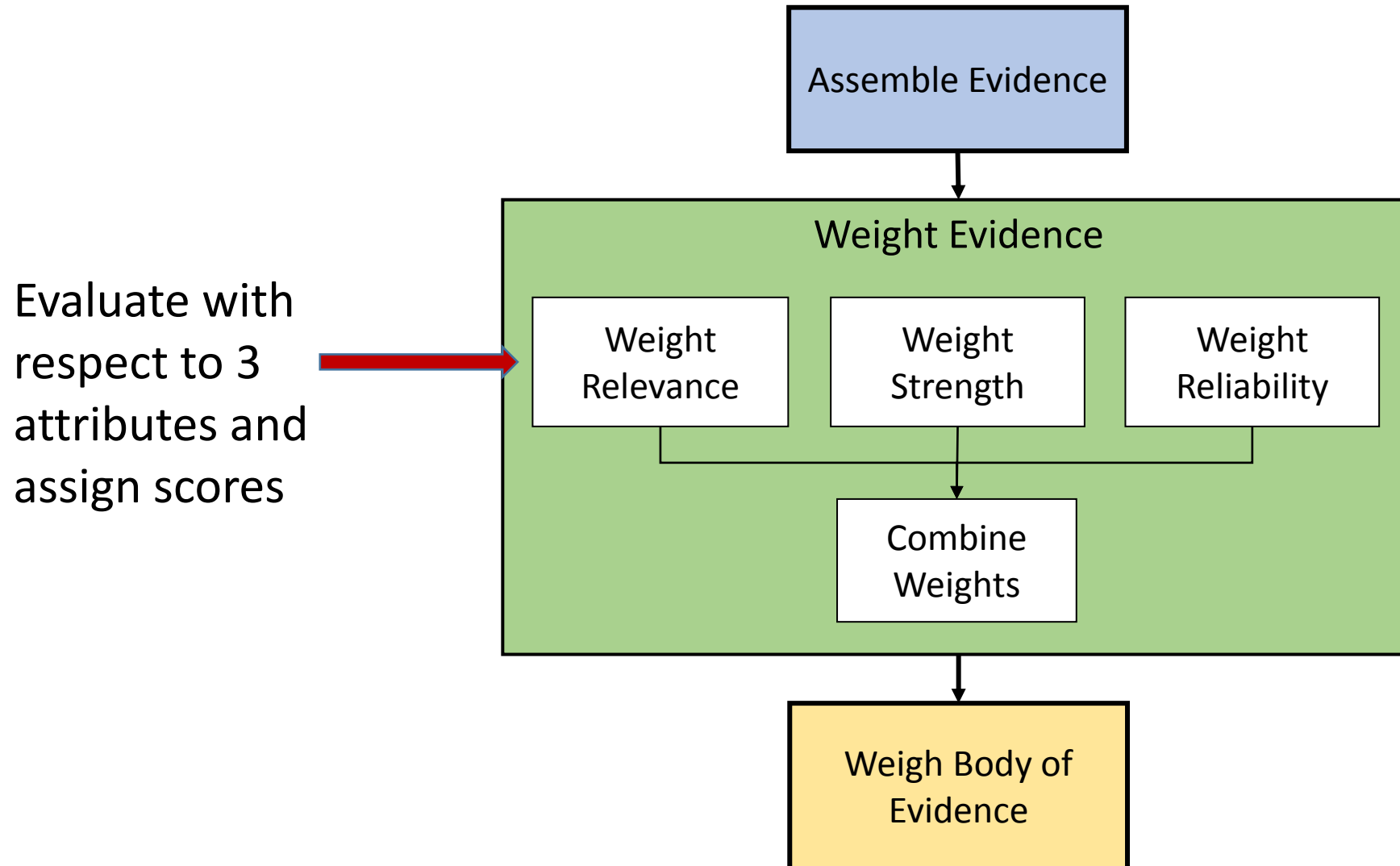
Assembling evidence



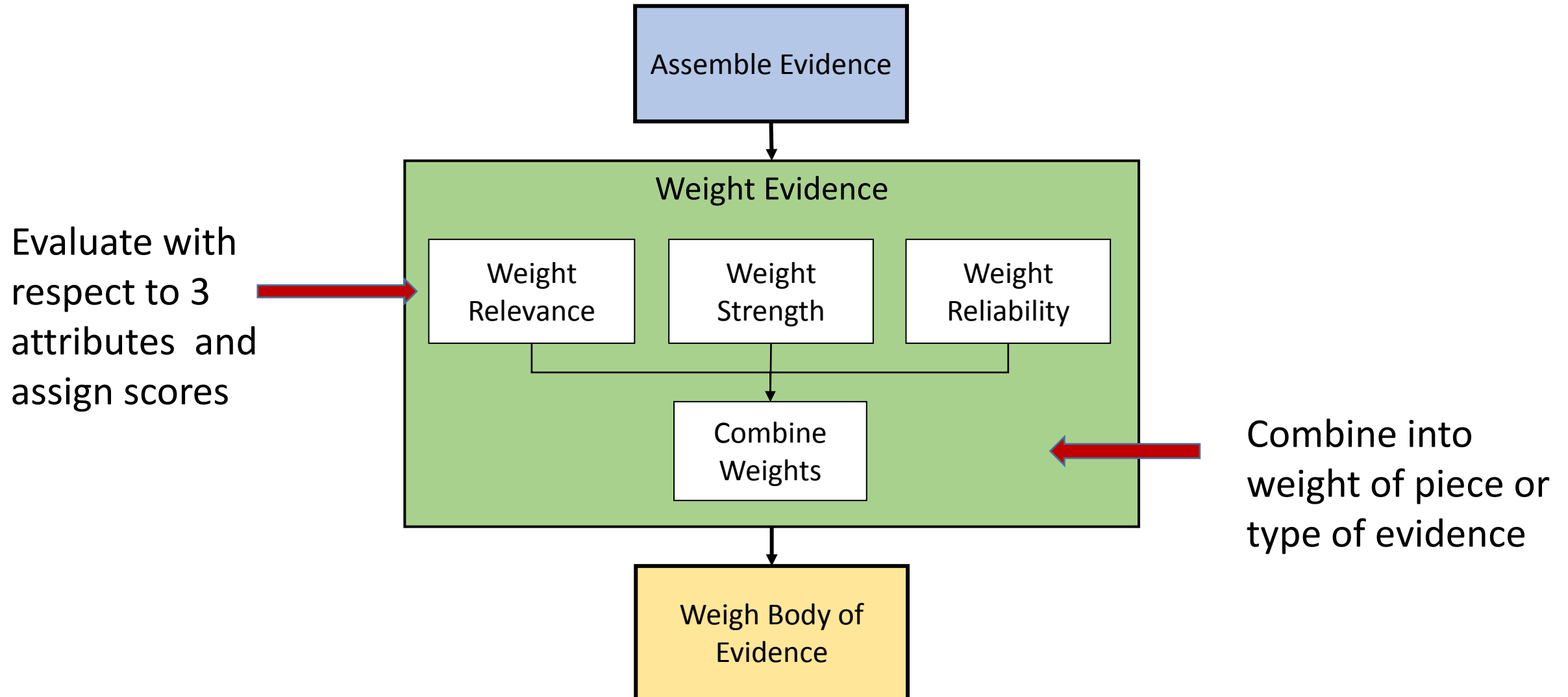
Assembling evidence



Weighting evidence

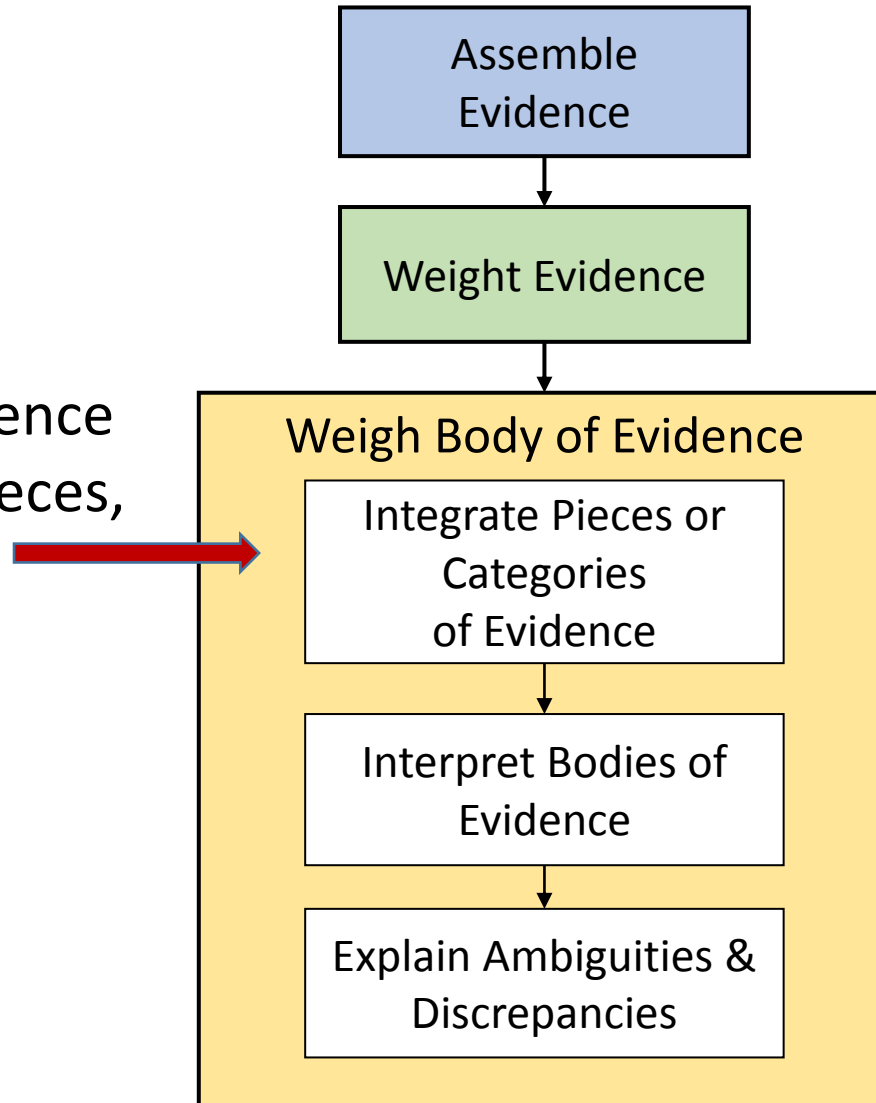


Weighting evidence



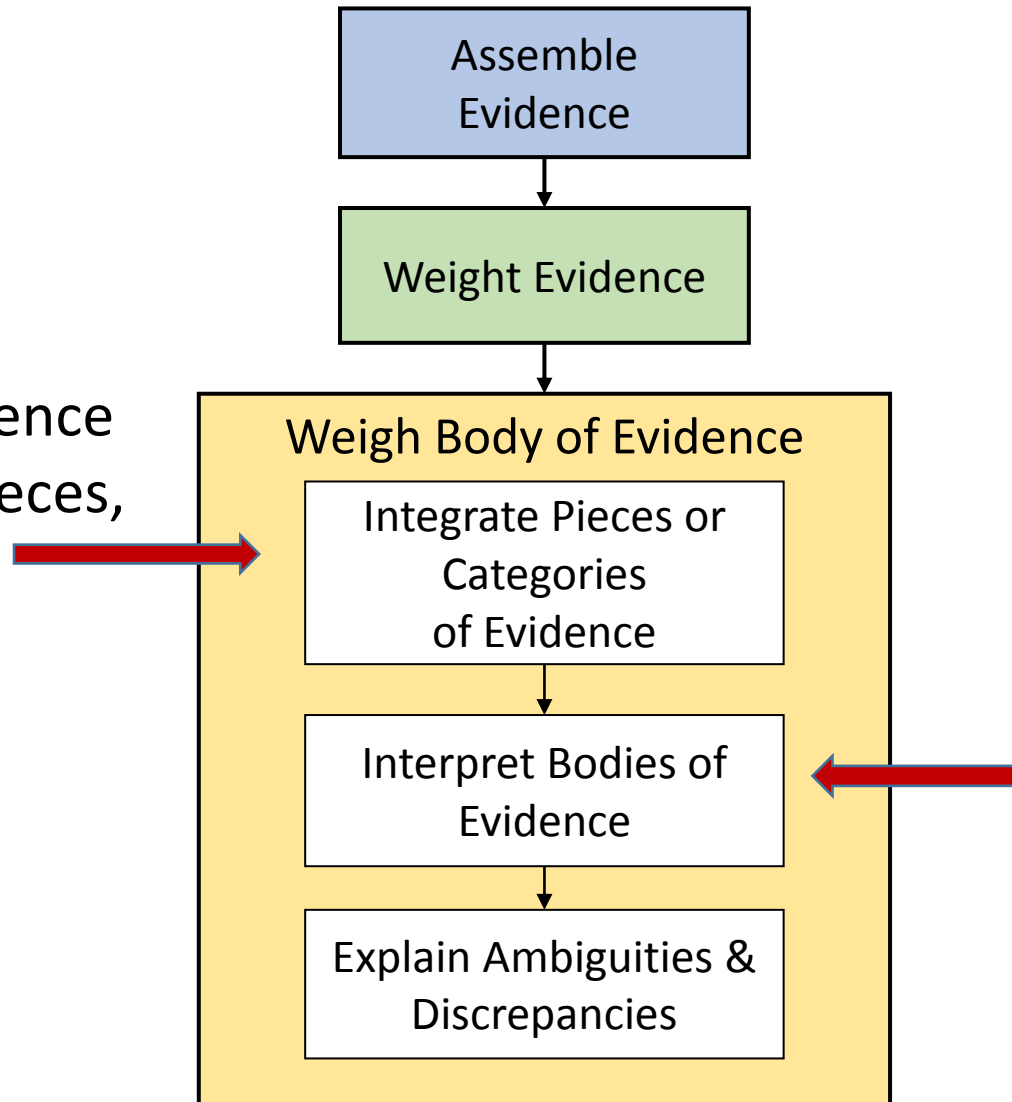
Weighing bodies of evidence

Determine the overall weight of the body of evidence based on the weights of pieces, or types of evidence and consistency



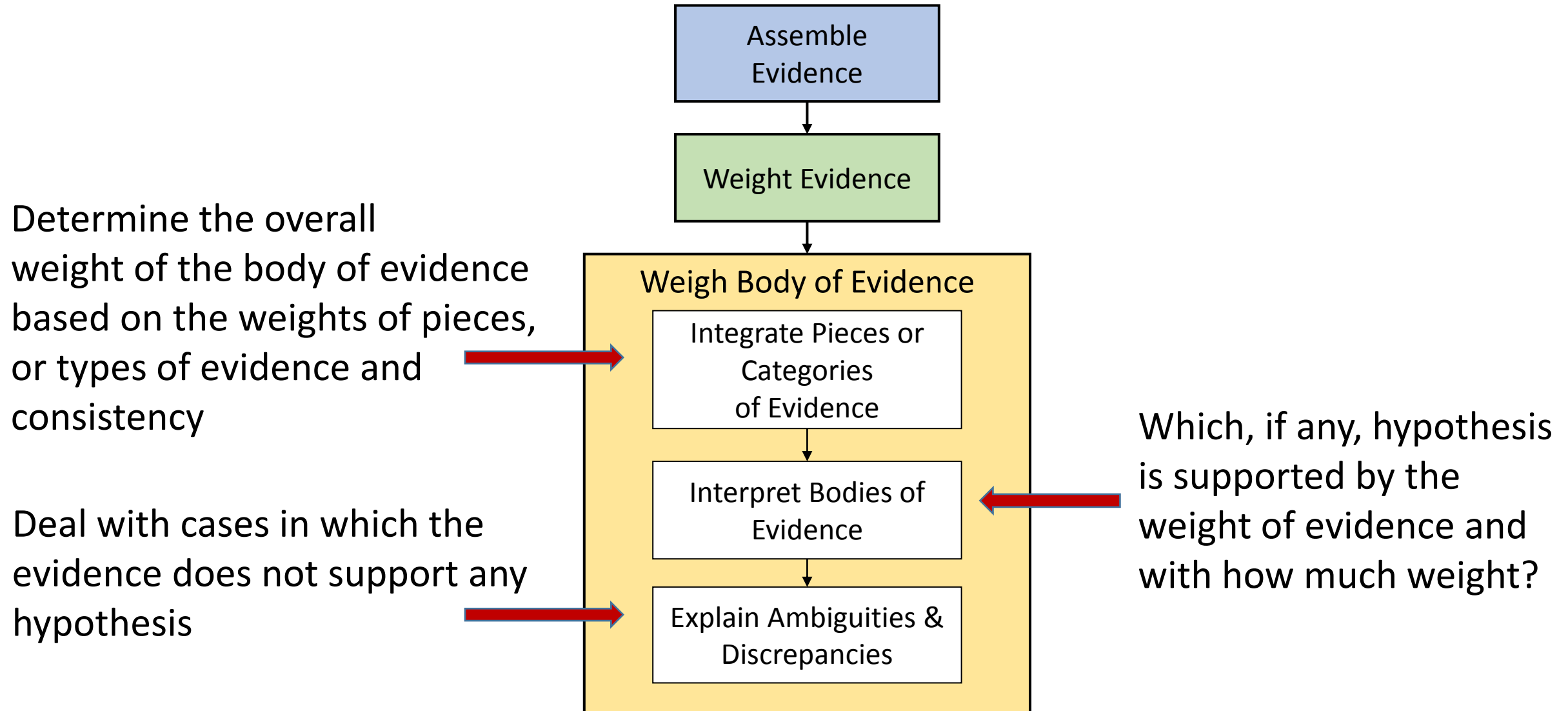
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Which, if any, hypothesis is supported by the weight of evidence and with how much weight?

Weighing bodies of evidence

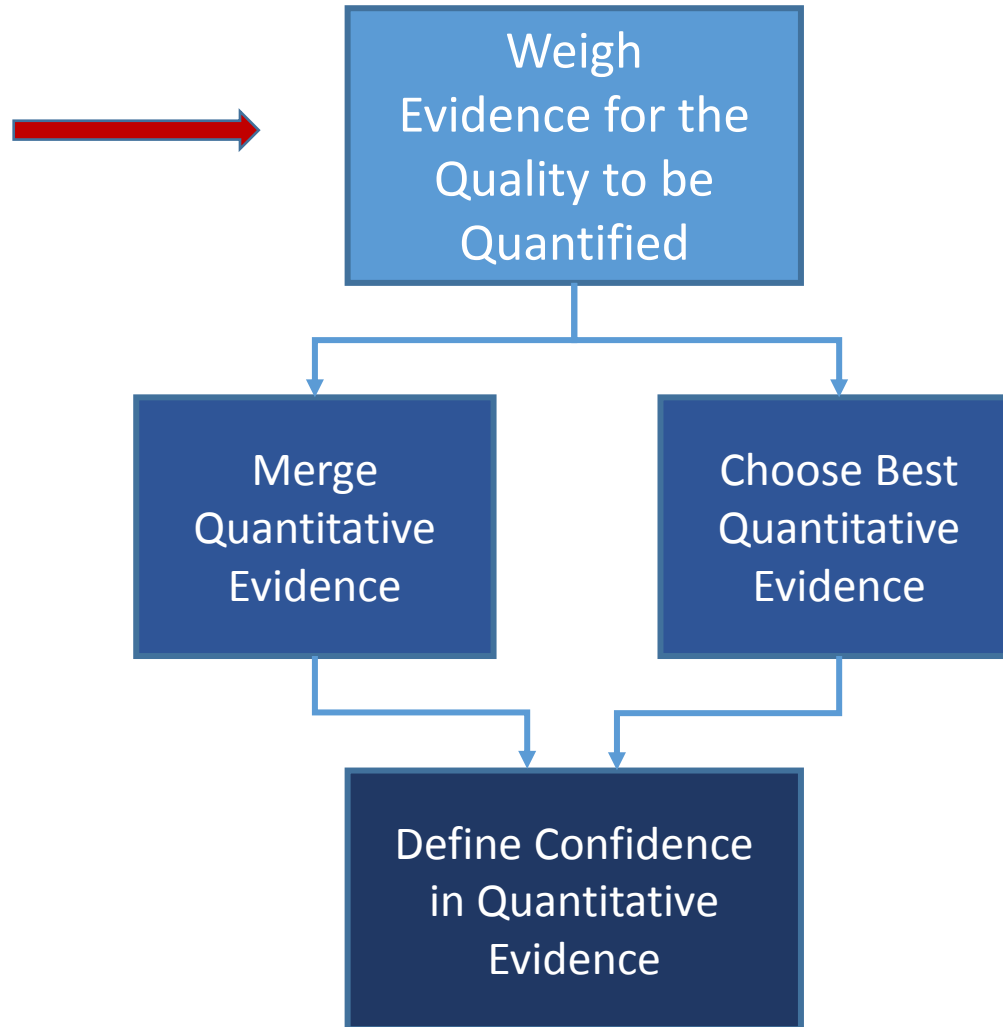


Expressing qualitative results

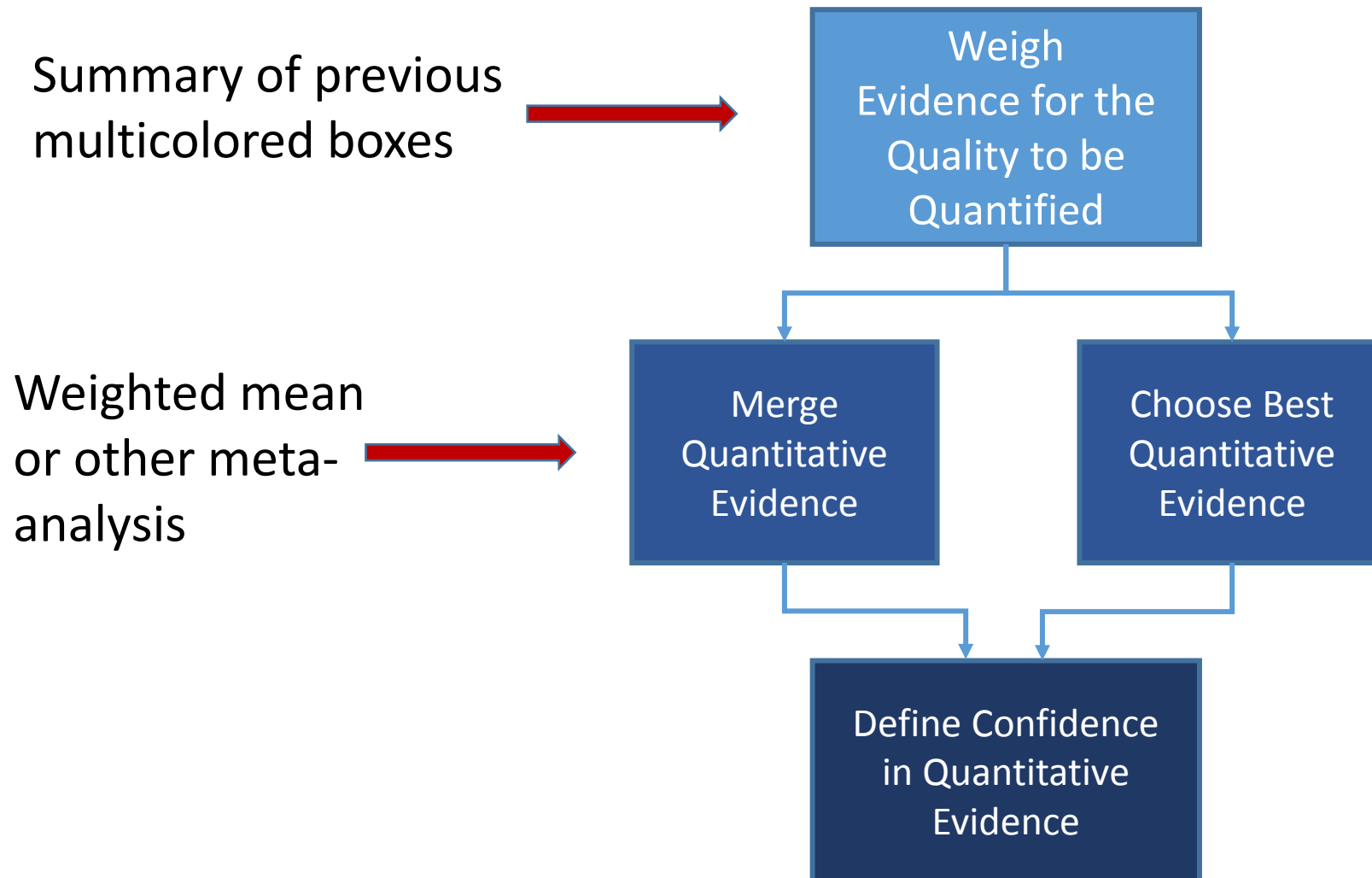
- Example Conclusion
 - Example Weight
- The chemical is a vertebrate teratogen
- High relevance
- Moderate strength
- Moderate reliability
- High consistency

Linking qualitative to quantitative results

Summary of previous
multicolored boxes



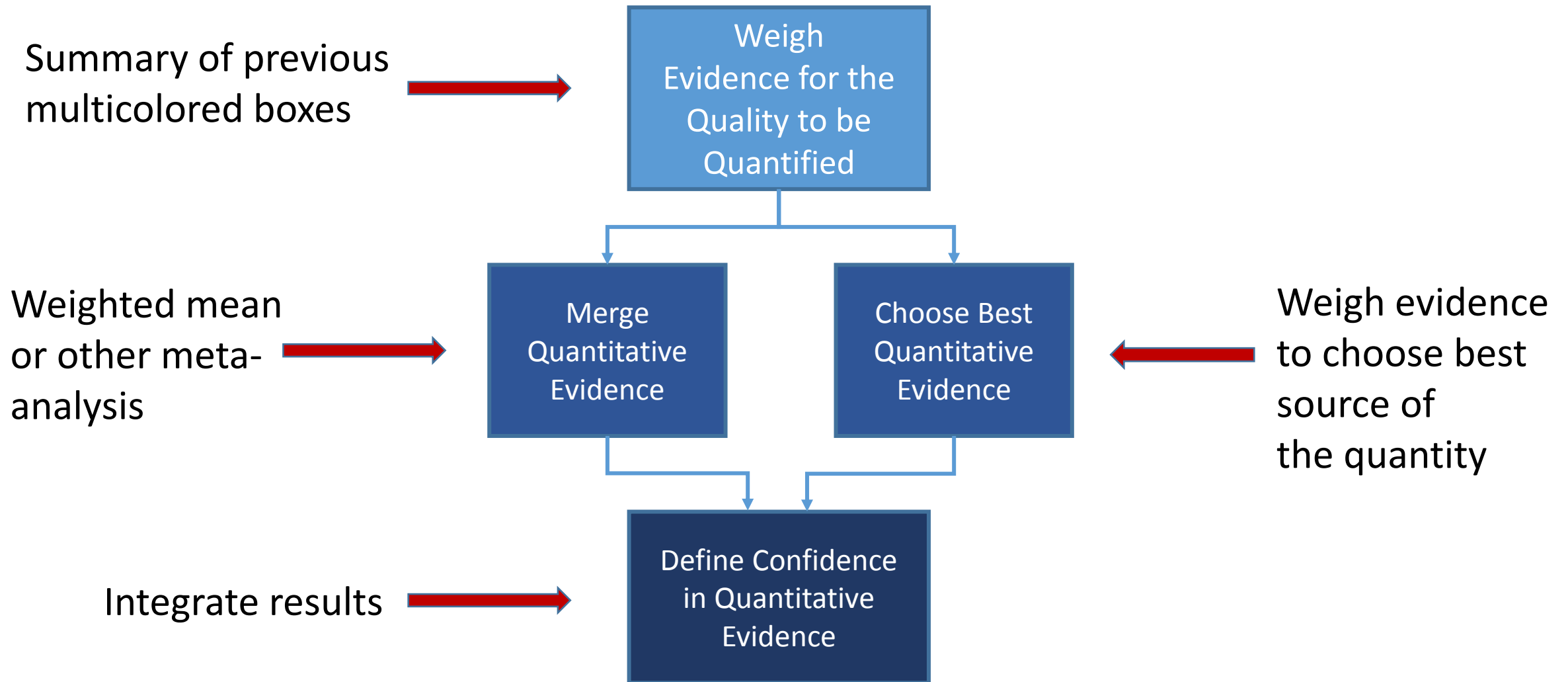
Linking qualitative to quantitative results



Linking qualitative to quantitative results



Linking qualitative to quantitative results



Expressing quantitative results

- Quality Protection from deformities
- Number 22
- Units mg/L
- Scatter ± 3
- Weight Moderate

Each has supporting information and detail, but this is the basic information

(tip of the hat to Ravetz and Funtowicz's NUSAP system)

Summary

- Formal weighing of evidence can
 - Provide greater utility of results
 - Increase defensibility
 - Increase transparency
- With flexibility and adaption to purpose,
 - WoE need not be onerous
- In combination with conventional statistics
 - WoE can convey confidence in results

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