national center for ontological research
ncor

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Bottom-Up Intelligence Analysis Part 1

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Outline

- Intelligence Analysis on the Ground
- Cognitive Process Ontology
- Model of Cognition
- Argument Ontology

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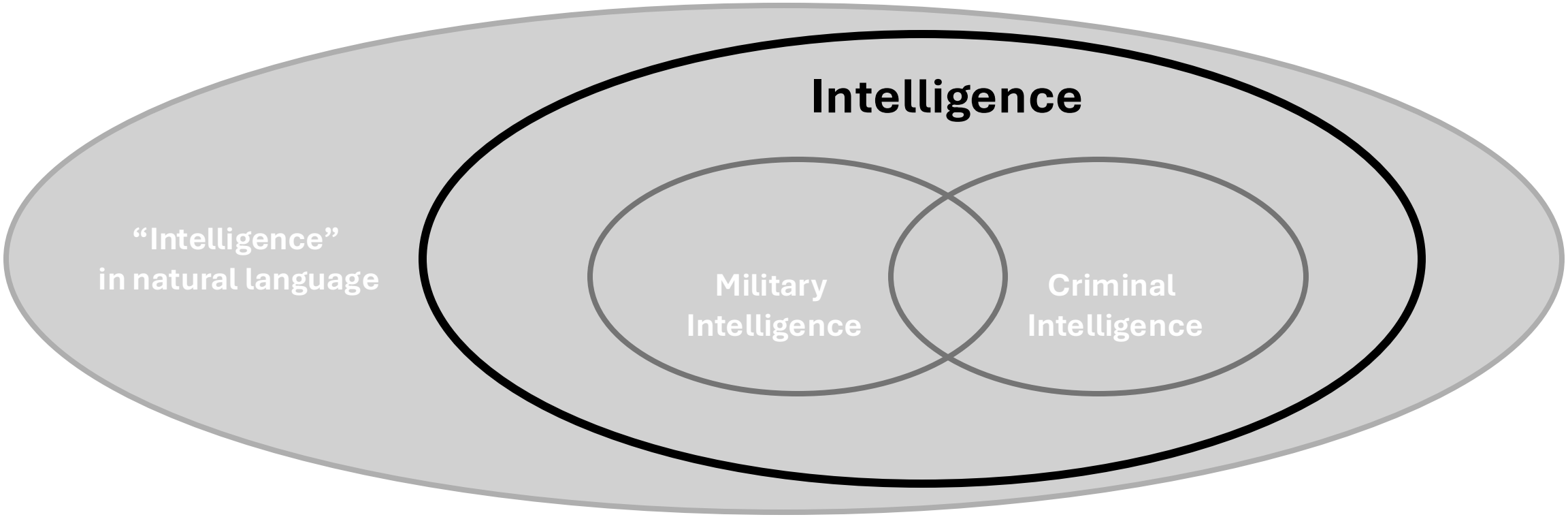
Definition Construction 101

- Let us revisit our aim towards a precise definition of "intelligence", narrow enough to exclude many natural language uses, but broad enough to serve as a common starting point for more specific definitions



Definitions 101

- For any definition there is a term defined – T – and the expression or expressions – E – defining that term

- A definition is a pair <T, E>

- For any definition and any domain, T is true of that domain just in case E is true of that domain

Triangle $=_{def}$ A polygon with three edges and three vertices

Evaluating Definitions

- Evaluating a definition then involves at least two steps:
  - Assume T is true, attempt to find a scenario in which E is not
  - Assume E is true, attempt to find a scenario in which T is not

Triangle $=_{def}$ A polygon with three edges and three vertices

- The preceding is a good definition; any triangle is a polygon with three edges and vertices; any polygon with three edges and vertices is a triangle

Hallmarks of Intelligence

- "Information is the unrefined raw material used to produce finished, focused intelligence."*
- Methodologies are used to produce intelligence, such as the intelligence cycle
- Pursued within the context of an epistemic community

**Scientific Methods of Inquiry for Intelligence Analysis*

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Aboutness

- **Information** is a pattern that **is about** something

- In BFO extensions - such as the Information Artifact Ontology and the Information Entity Ontology - information is represented by the class **Information Content Entity**

- Where the "is about" relation is understood to be primitive:

definition [language: en]

A primitive relationship between an Information Content Entity and some Entity.

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**Scientific Methods of Inquiry for Intelligence Analysis*

Epistemic Communities

- Intelligence analysis is often conducted within an **epistemic community**

- Such communities often share:
  - Normative beliefs about the purpose of their actions
  - Beliefs based on experiences from investigating central problems in their domain
  - Standards of accuracy for analyses in their field of expertise
  - Common community goals

Canadian Security Intelligence Service

Hallmarks of Intelligence

- What distinguishes **evidence** from **information**?

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- Evidence is a type of information
- Which may support or provide justification for some belief
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Epistemic Defeaters

- A **defeater** for a belief or knowledge is evidence that the belief or knowledge is false

- A **rebutting defeater** for proposition P is evidence that ~P is true, e.g. the belief that it is not snowing in Buffalo is rebutted by walking outside

- An **undercutting defeater** for P is evidence against P but not evidence for ~P, e.g. the belief that it is not snowing would be undercut by recognition that one had ingested psychodelics

Hallmarks of Intelligence

- "...it is axiomatic that [intelligence gathering] take[s] place in the context of secrecy."*

- Otherwise, intelligence gathering is not distinguished from academic research, market research, etc.

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- We have described intelligence gathering as, after all, seeking justified beliefs, and this goal is intimately connected with truth

- But truth is not always the **proper target** of intelligence gathering:
  - Seeking truth may undermine crucial, immediate goals
  - A given truth may be misunderstood when nearby falsehoods are not

Not about Truth

- "Intelligence is not about truth."*

- "...we should think of intelligence as a proximate reality. . . . [Intelligence agencies] can rarely be assured that even their best and most considered analysis is true. Their goals are intelligence products that are reliable, unbiased, and honest (that is, free from politicization)"*

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Preliminary Intelligence Definitions

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An Act in which at least one Agent plays a causative role and which is prescribed by some Directive Information Content Entity held by at least one of the Agents.

Preliminary Intelligence Definitions

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Does not require the information in fact promotes relevant interests, but the Directive Information Content Entity must be so directed

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Need not aim to acquire intelligence or evidence

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But must be constrained by interests of relevant parties using reliable standards

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Broad enough to cover both individuals and groups; could be specialized to reflect intelligence cycle planned acts

Preliminary Intelligence Definitions

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- *Covert intelligence gathering* $=_{\text{def}}$ Intelligence gathering that aims to keep information gathering methods and results concealed from all but authorized individuals or collectives.

Preliminary Intelligence Definitions

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Caveat: Neither BFO nor CCO have adopted ICEs bearing roles; this is tentative

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- *Evidence* $=_{\text{def}}$ An information content entity that bears an evidence role.

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- *Intelligence* $=_{\text{def}}$ Evidence that is the output of intelligence gathering.

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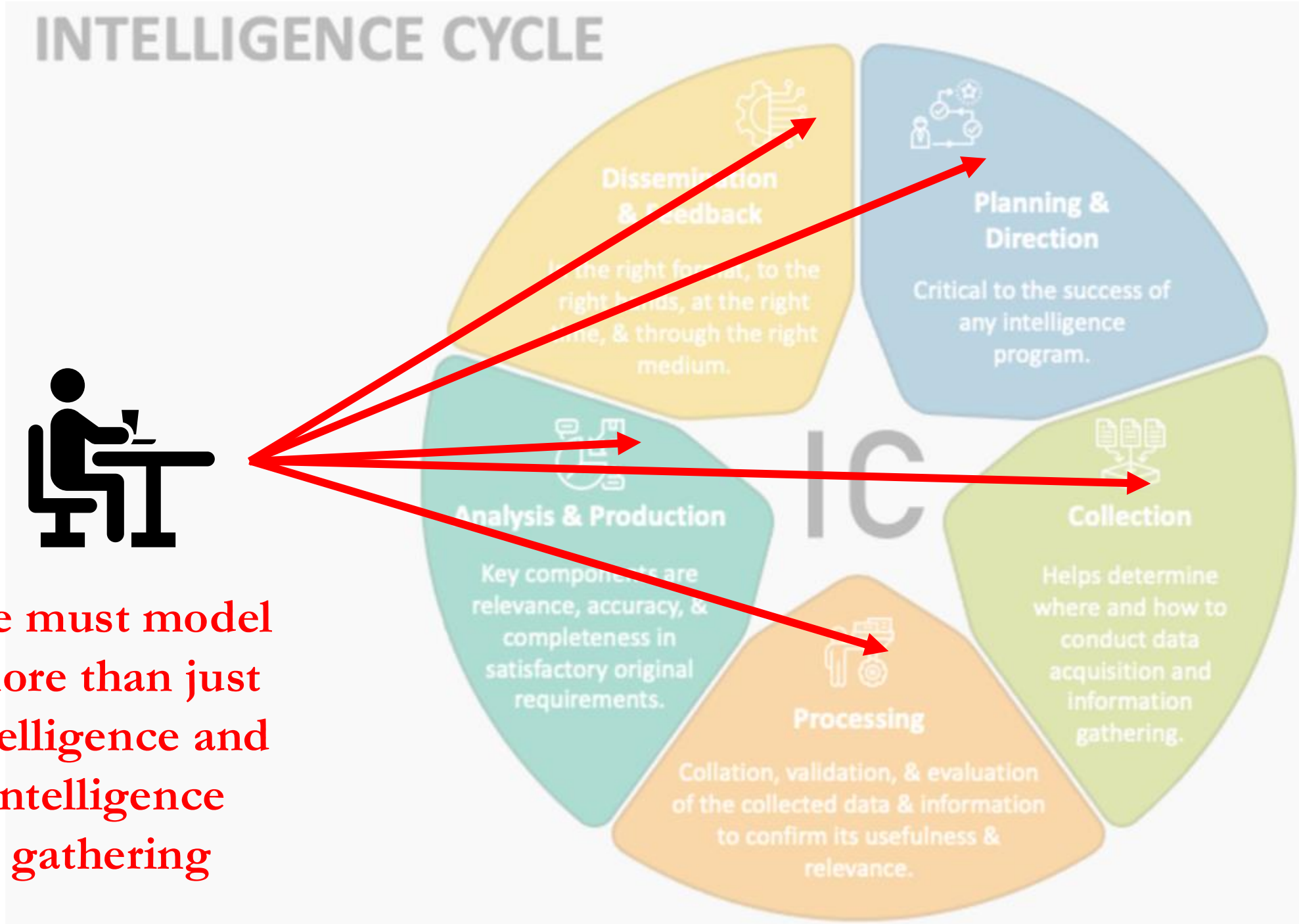
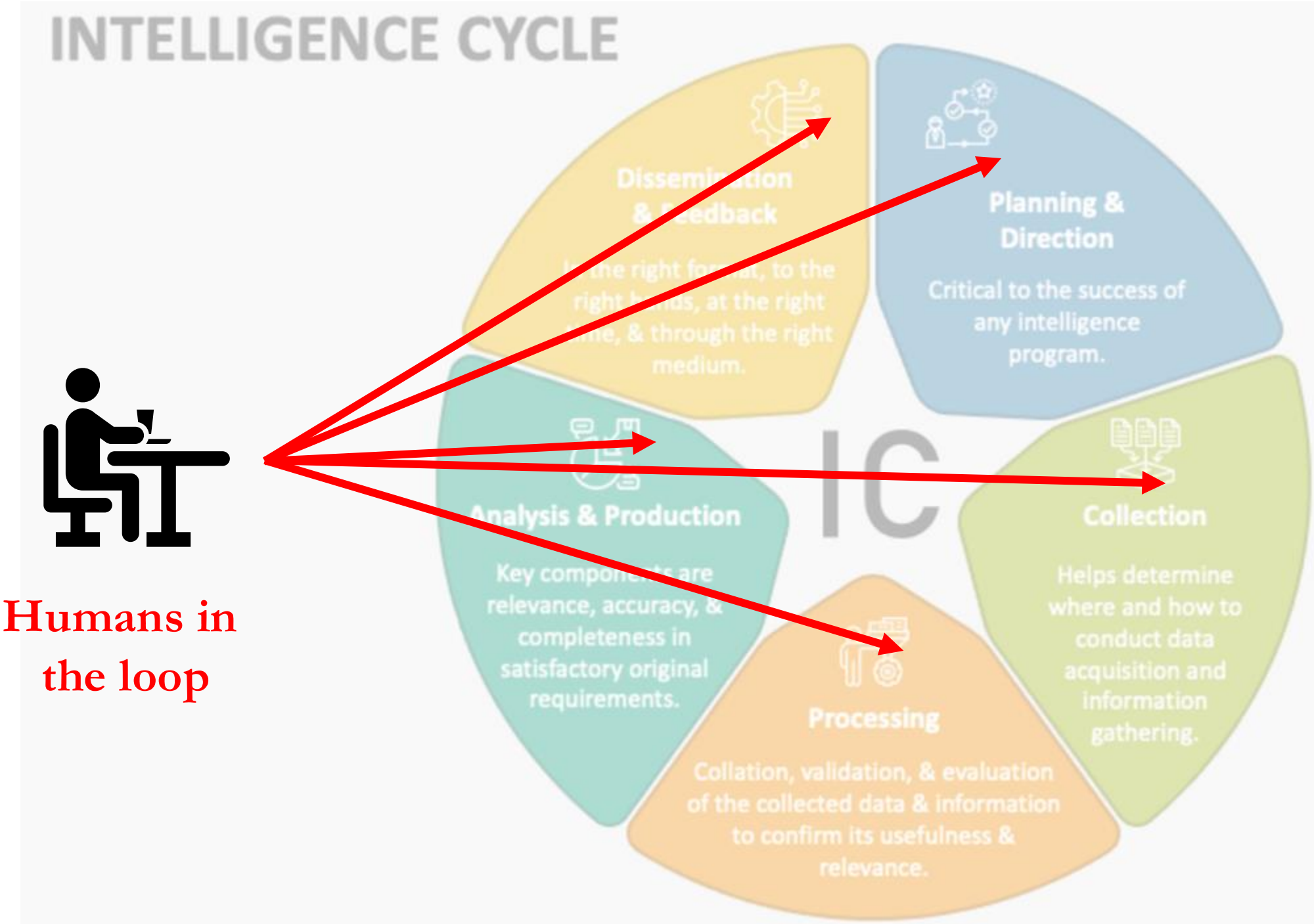
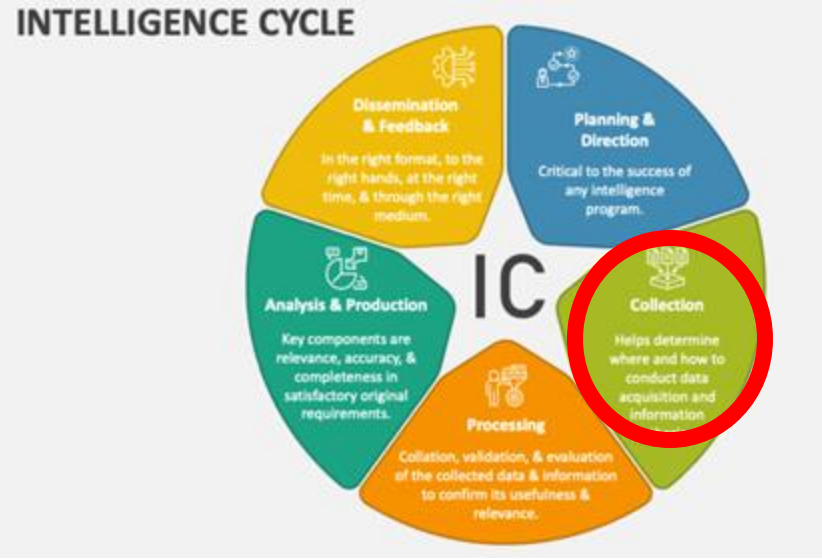


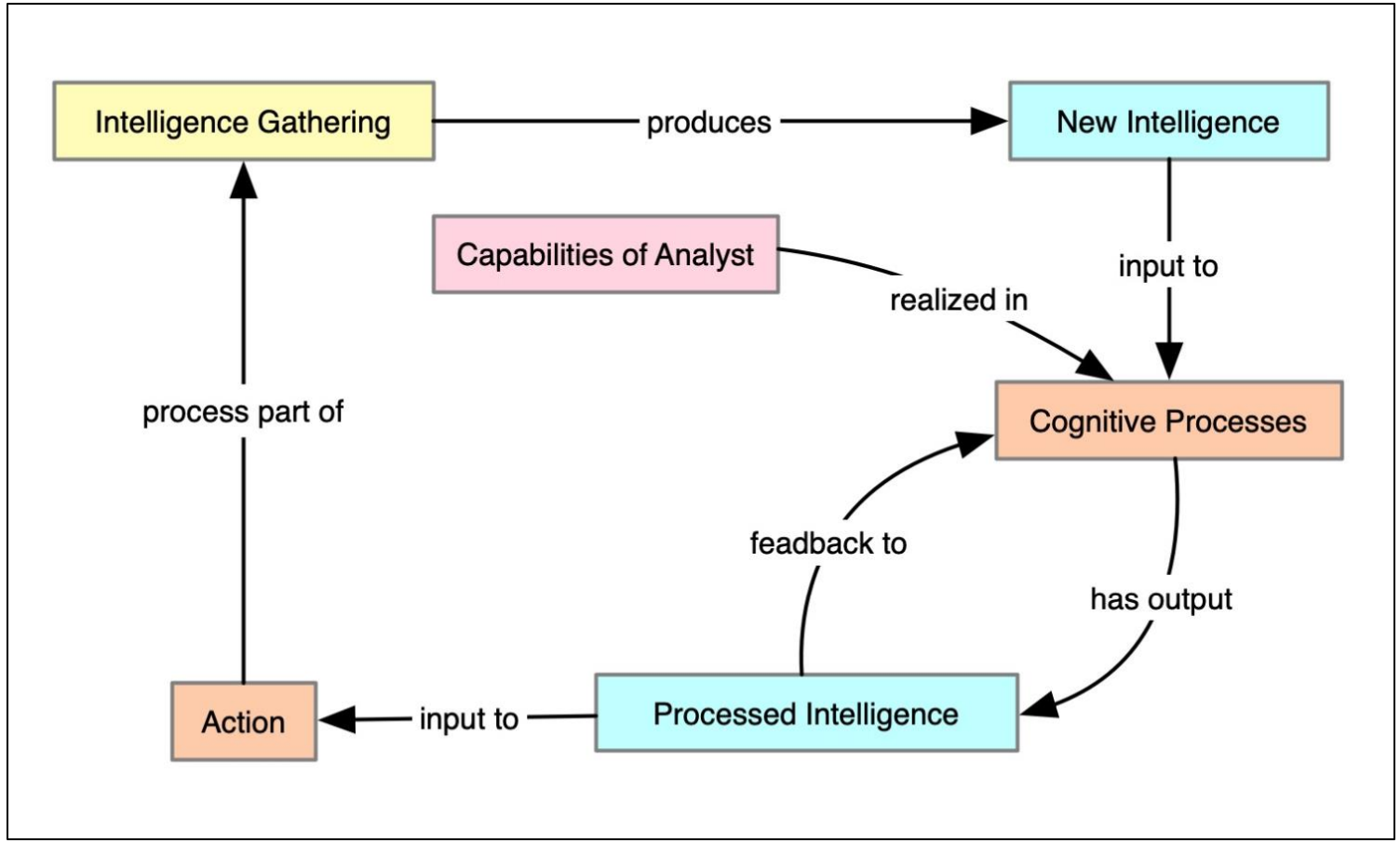
We must model more than just intelligence and intelligence gathering


INTELLIGENCE CYCLE
Planning & Direction
Critical to the success of any intelligence program.
Collection
Helps determine where and how to conduct data acquisition and information gathering.
Processing
Collation, validation, & evaluation of the collected data & information to confirm its usefulness & relevance.
Analysis & Production
Key components are relevance, accuracy, & completeness in satisfactory original requirements.
IC
Humans in the loop

Cognitive Process Ontology

- Ontology reflecting aspects of the intelligence cycle





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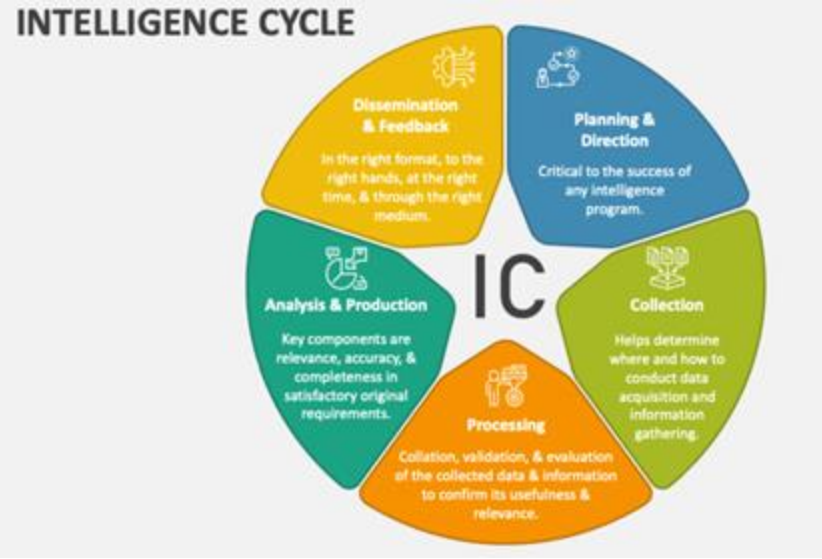

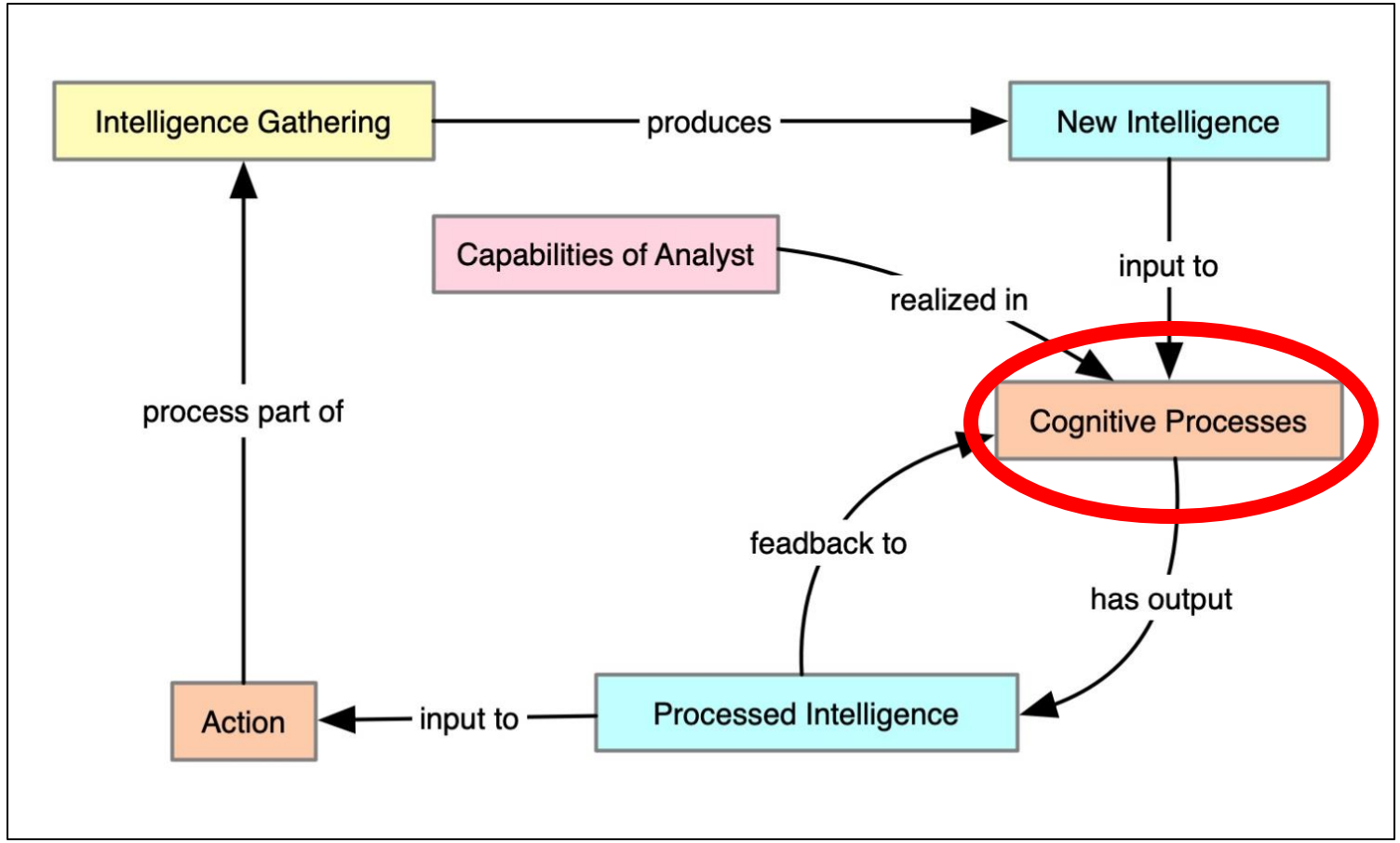

Cognitive Process Ontology

- *Cognitive Process* $=_{\text{def}}$ Mental Process that creates, modifies or has as participant some cognitive representation.

- *Investigative Process* $=_{\text{def}}$ Cognitive Process whose agent intends to establish or confirm that some portion of reality exists or does not exist.

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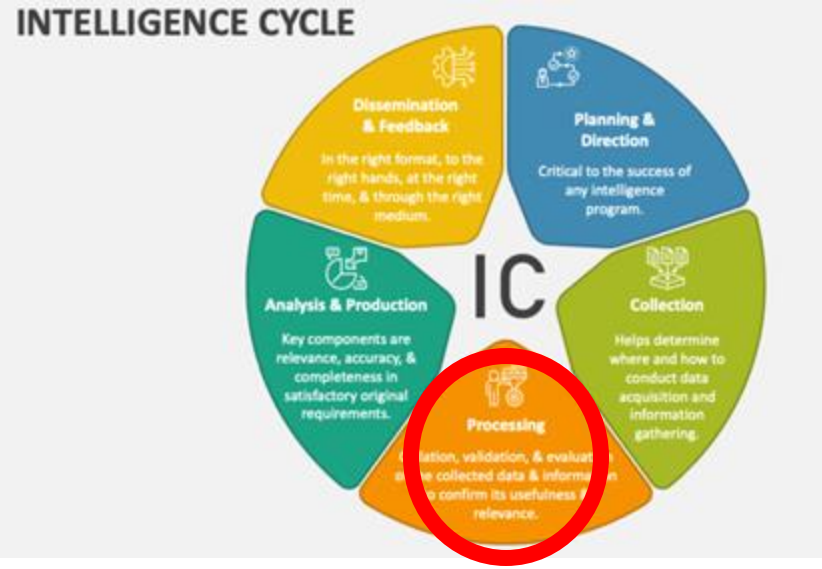

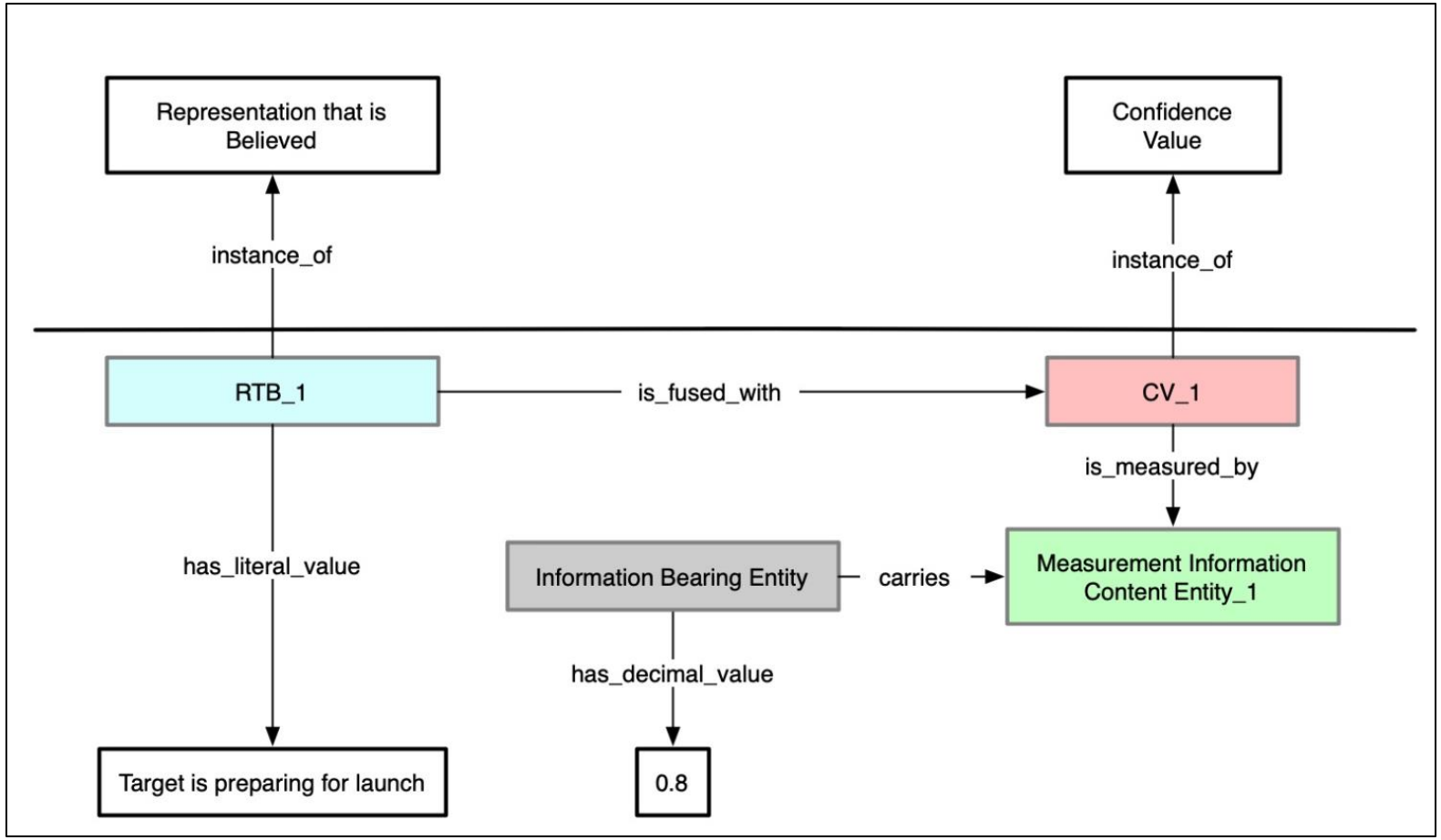

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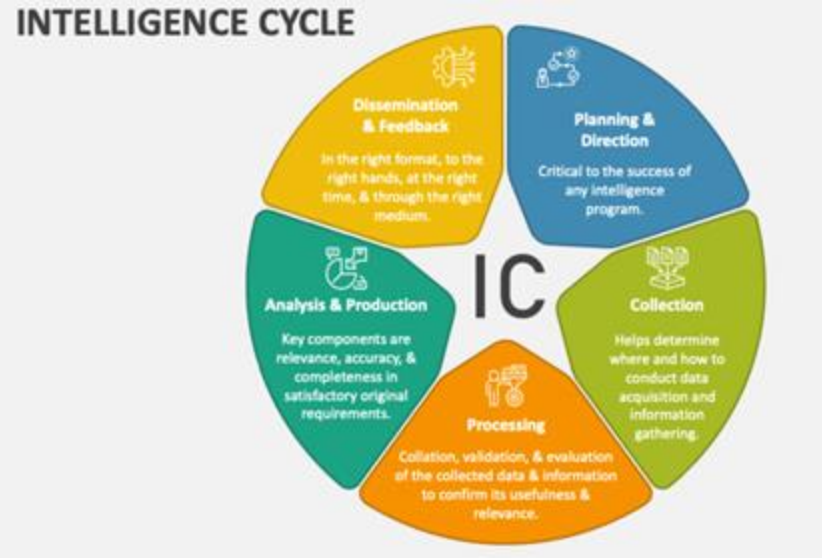

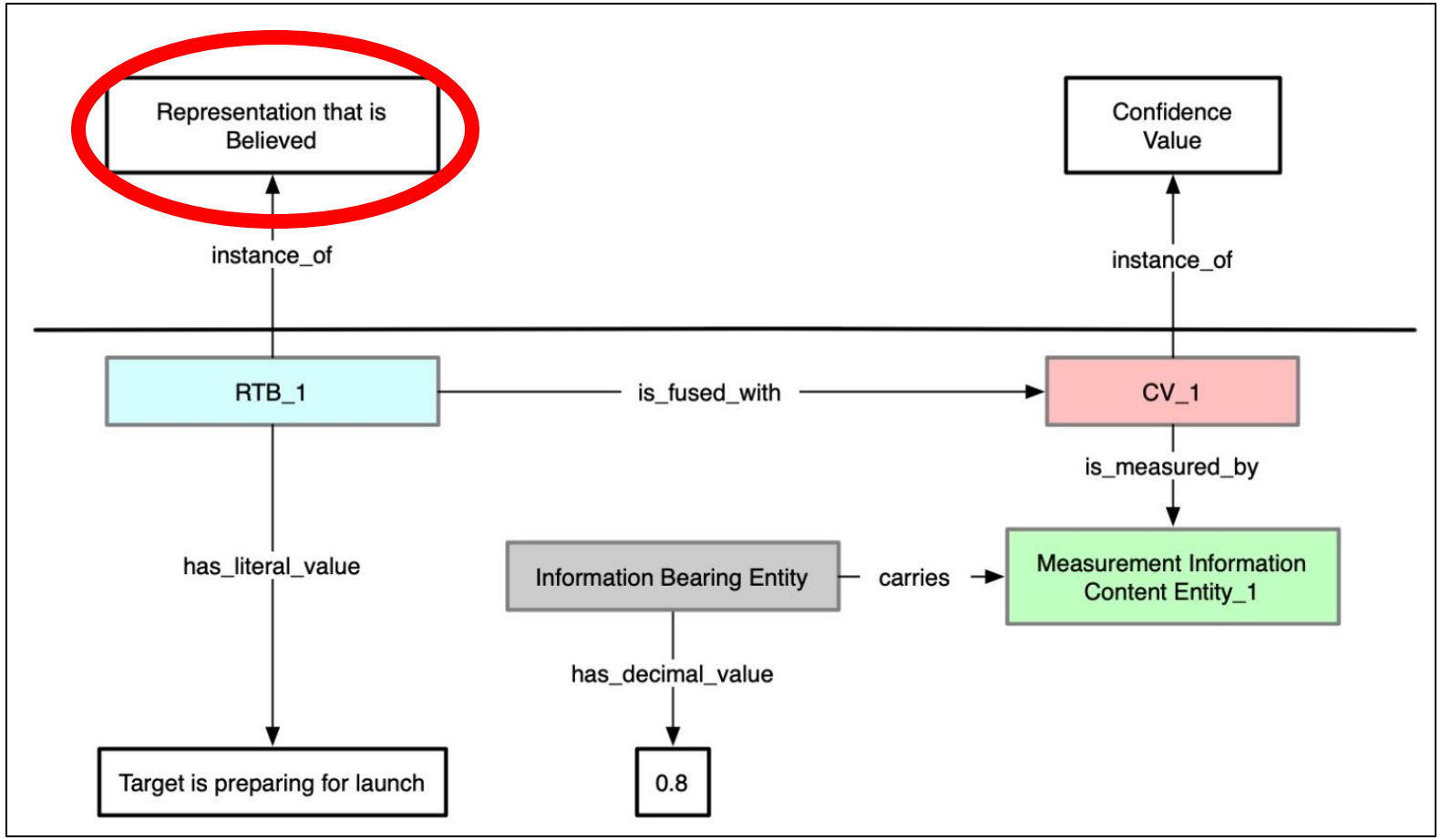

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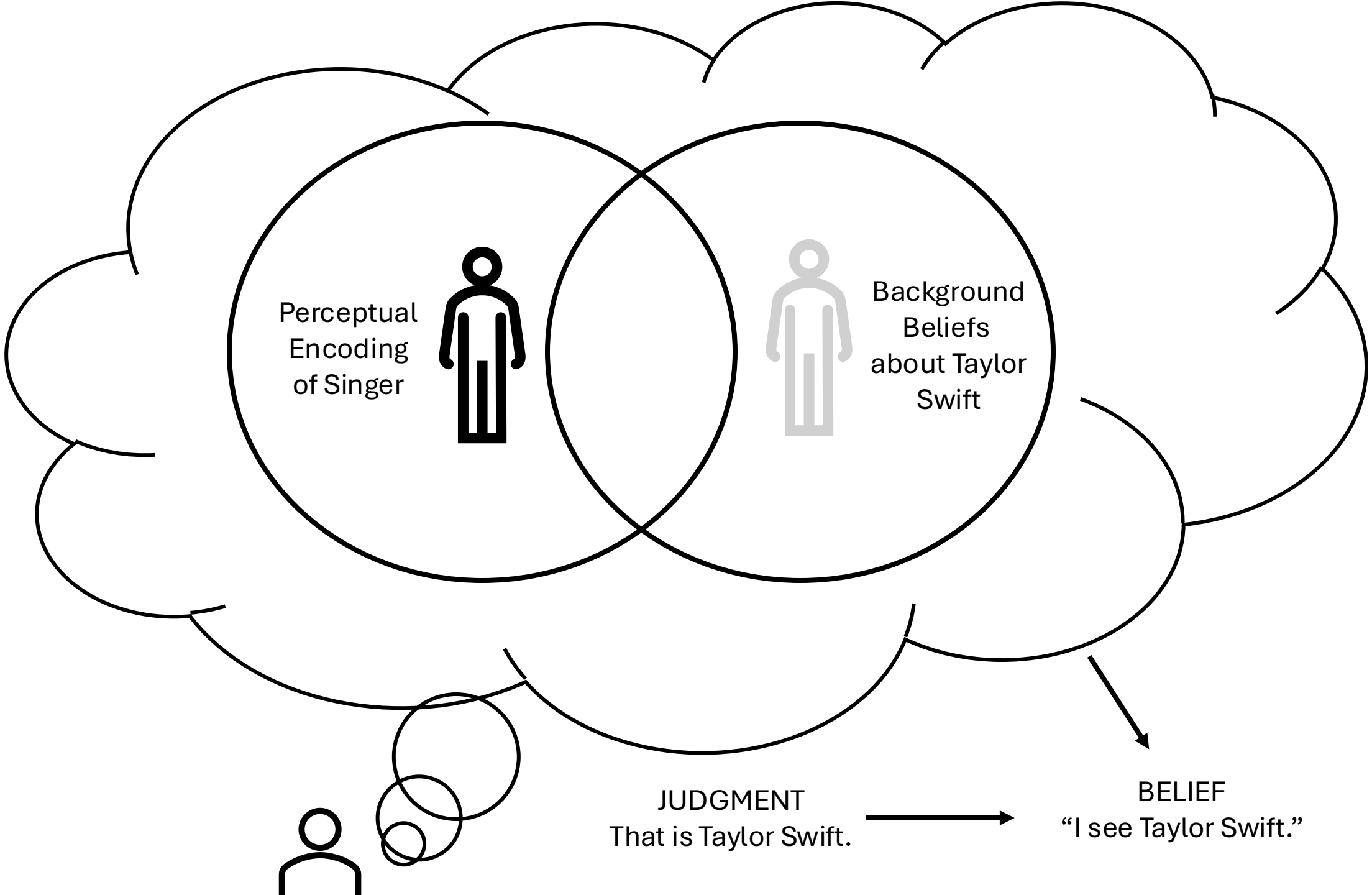
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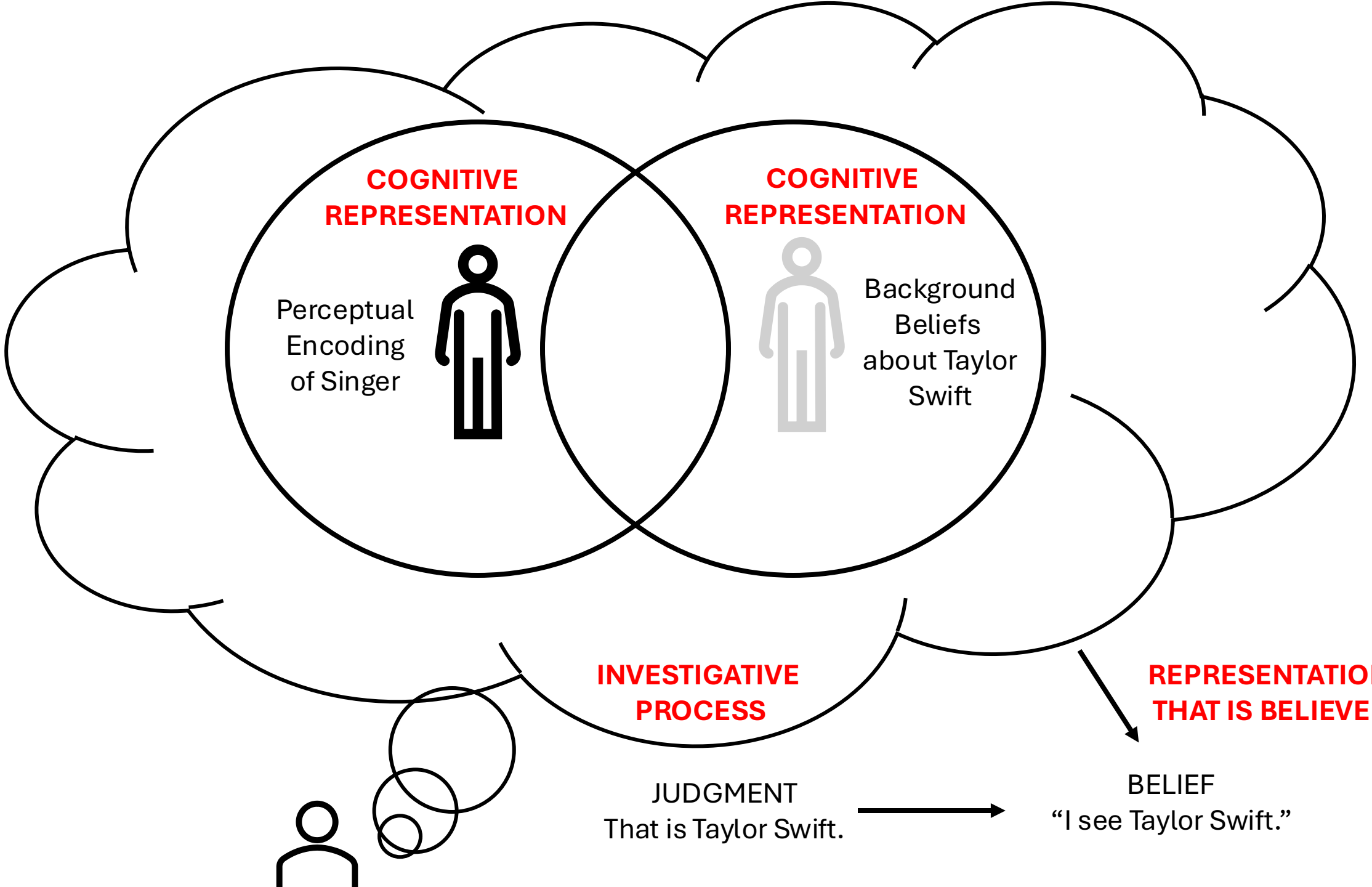
JUDGMENT
That is Taylor Swift.
BELIEF
“I see Taylor Swift.”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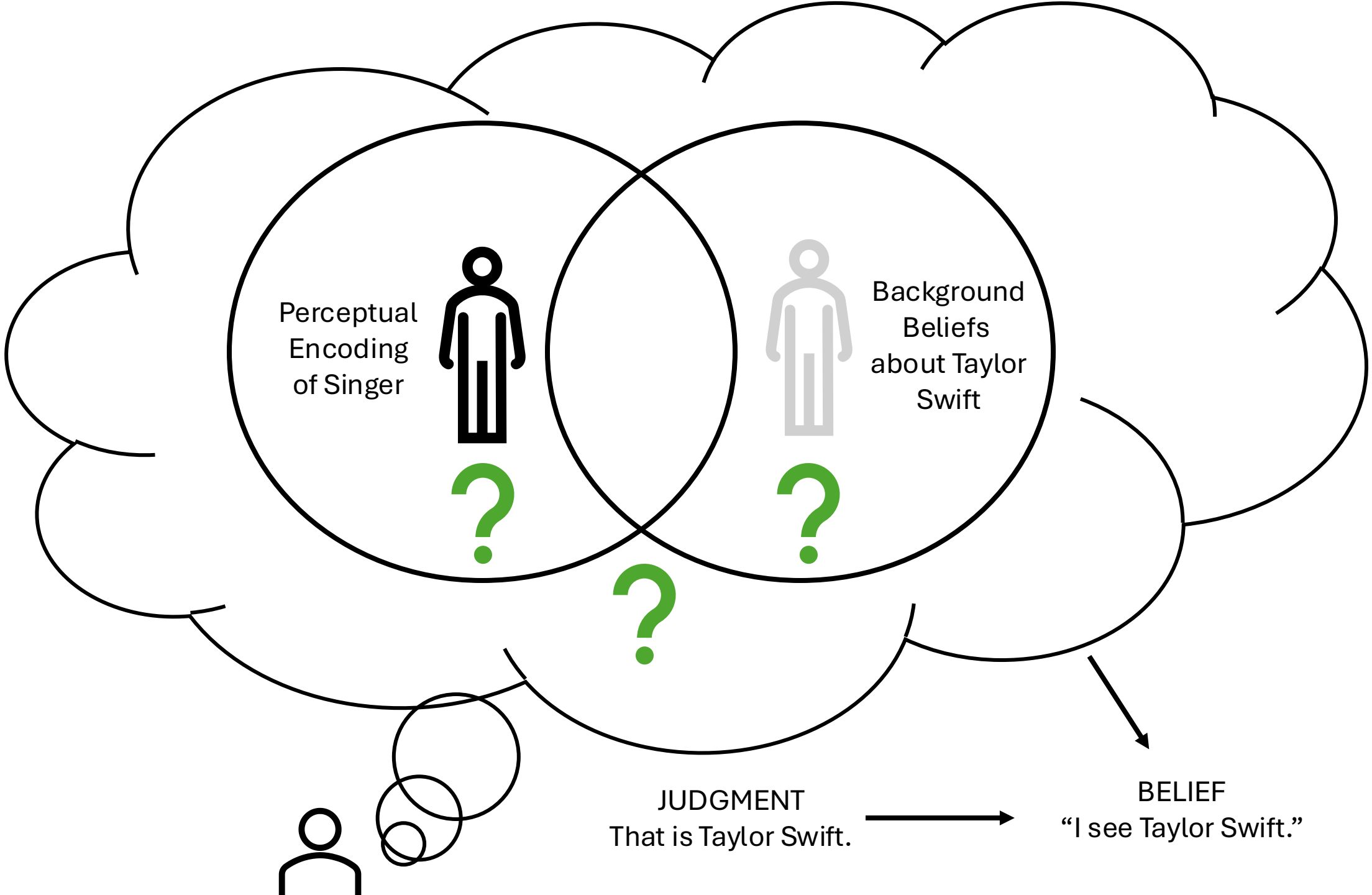
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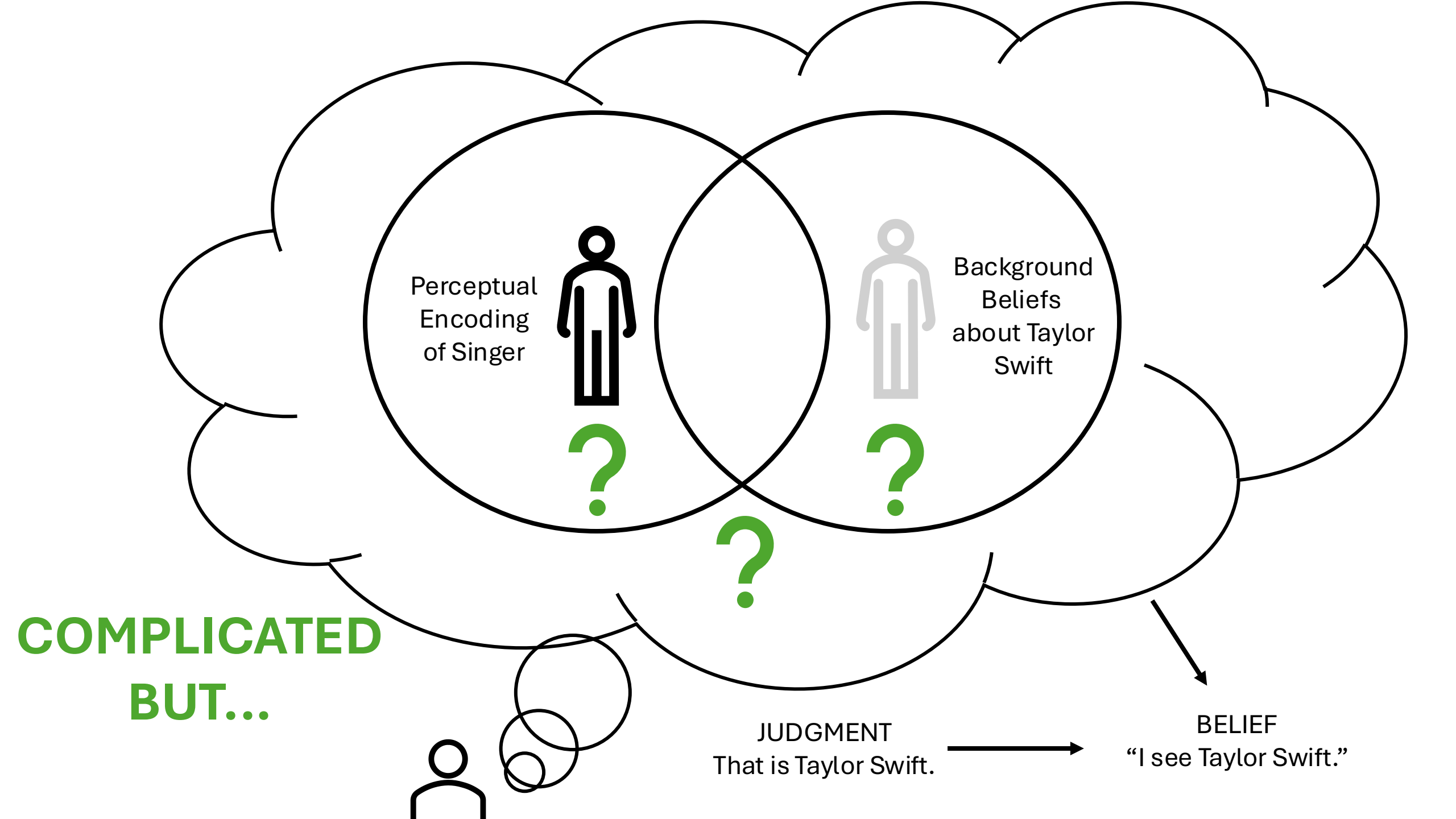
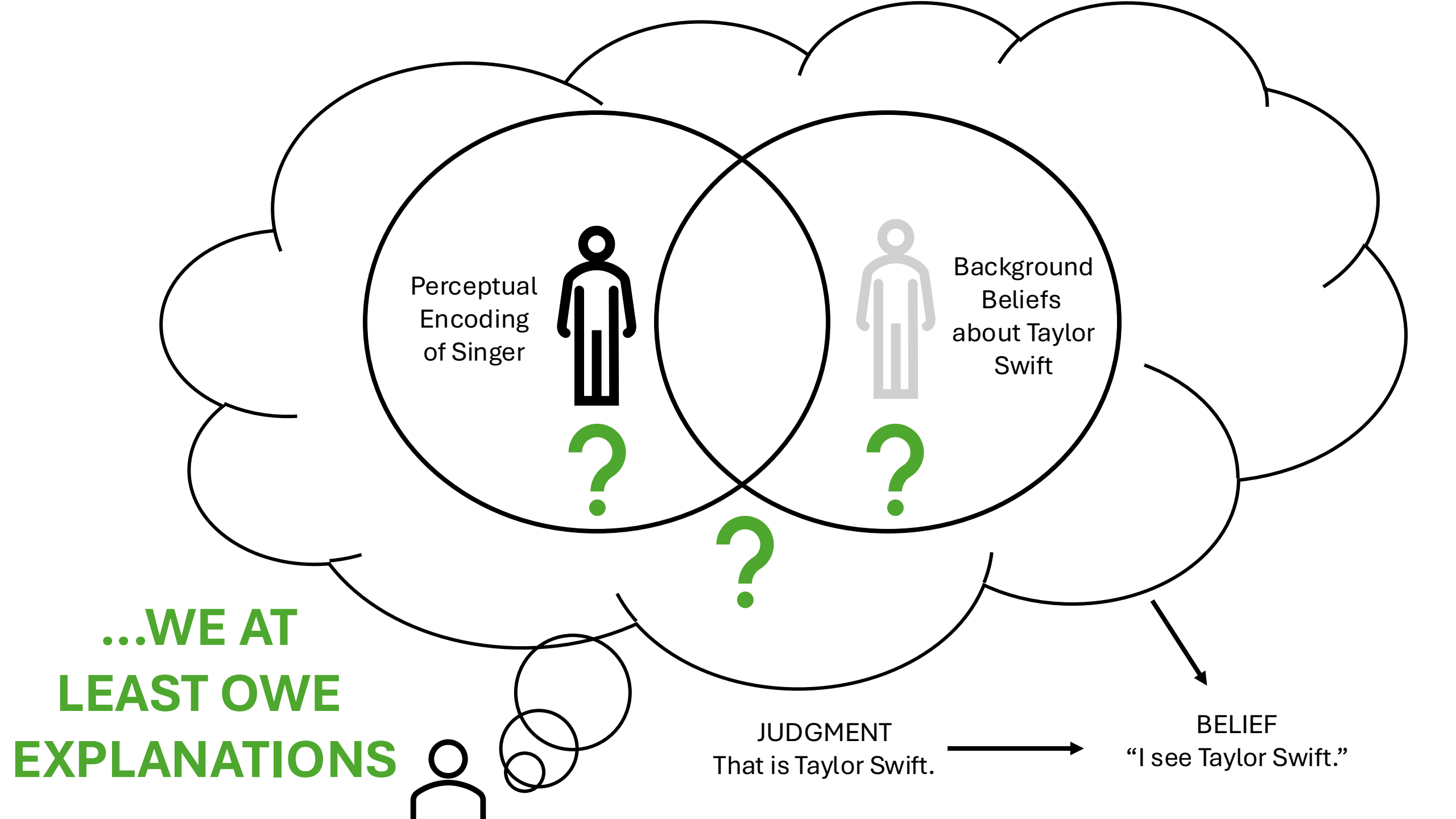


COMPLICATED BUT…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Attention

- We're surrounded by a booming, buzzing, manifold of stimuli in our perceptual systems; too much stimuli to recognize at any given time

- We restrict our attention to some parts of this perceptual manifold, whether it be visual, auditory, olfactory, etc. at any given time

Perceptual Encoding

- We restrict attention, often ignore parts of our perceptual manifold

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- Suppose I'm looking for cufflinks before leaving for a show, but I can't find them in my drawer

Perceptual Encoding

- We restrict attention, often ignore parts of our perceptual manifold

- Suppose I'm looking for cufflinks before leaving for a show, but I can't find them in my drawer

- Later, on the way to the show, I realize that *in fact* I *did* see them in the corner of the drawer, but I didn't *recognize* that I saw them…

Perceptual Encoding

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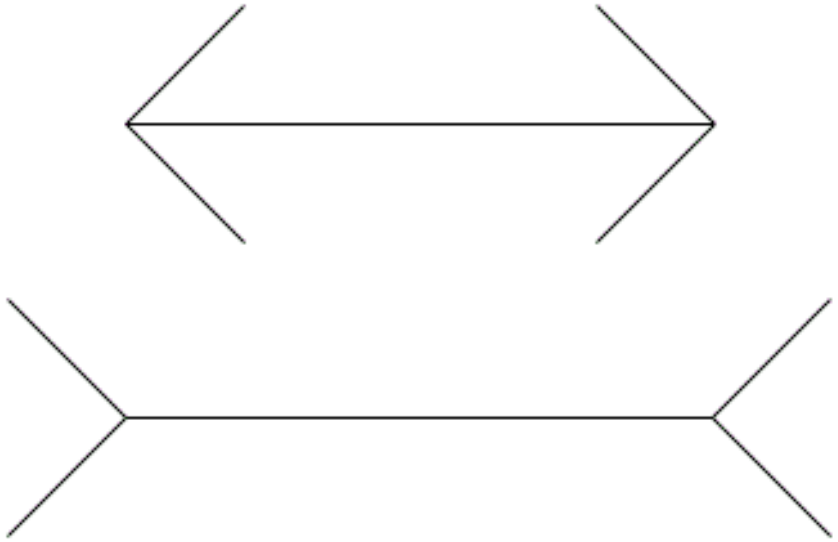

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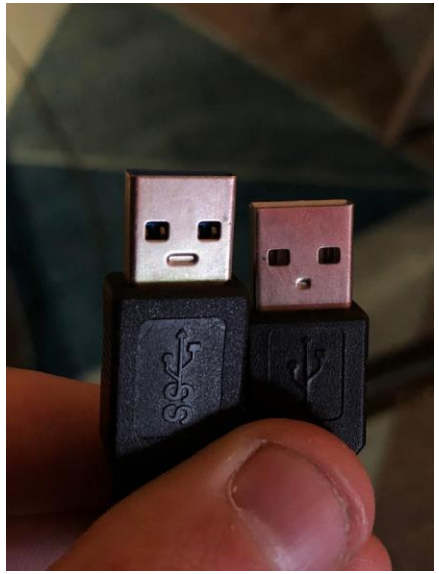

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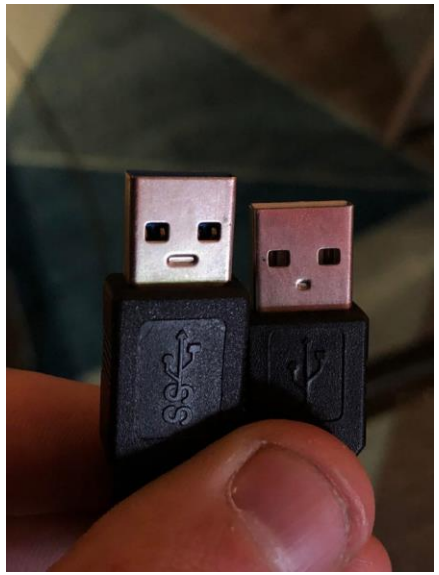

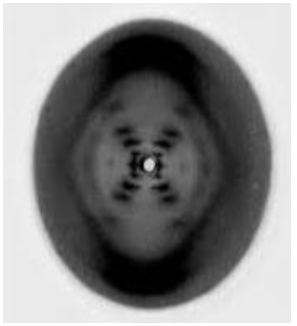

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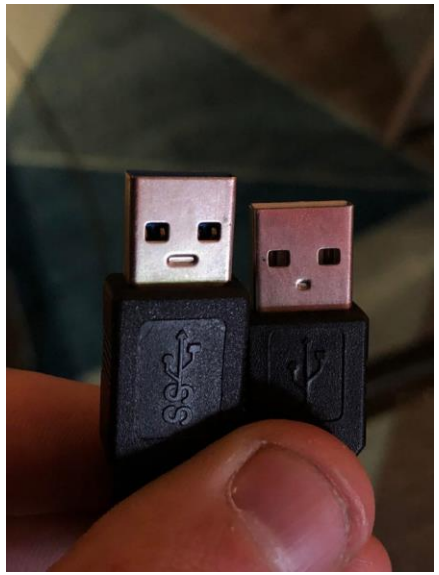

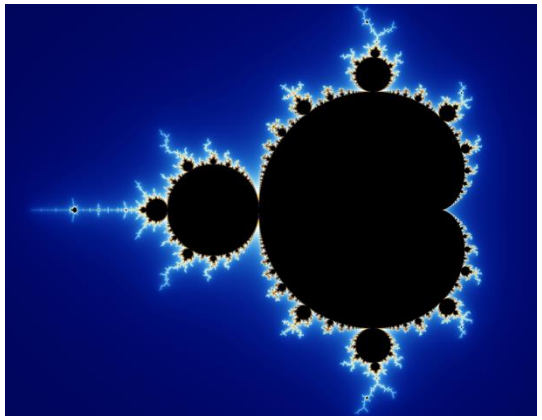

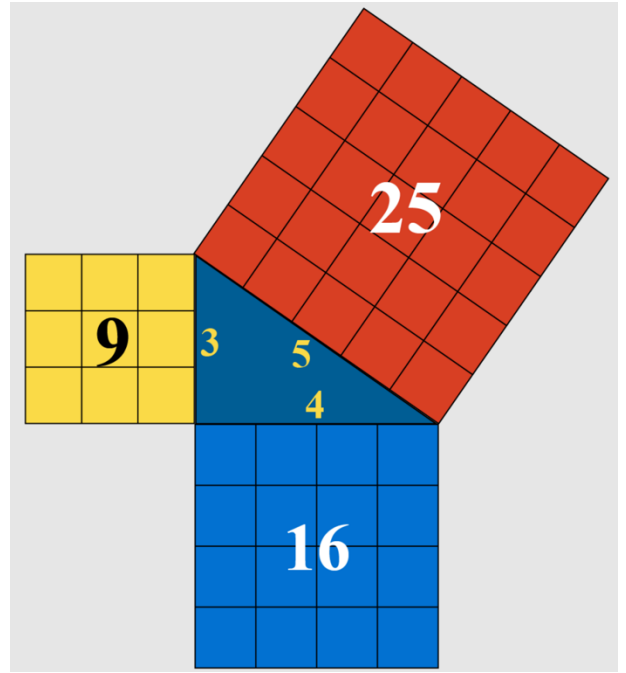

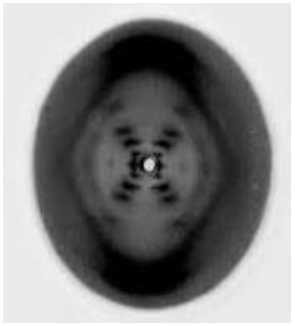

Pattern Recognition Training

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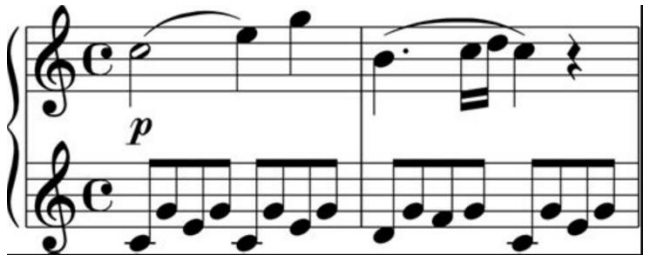

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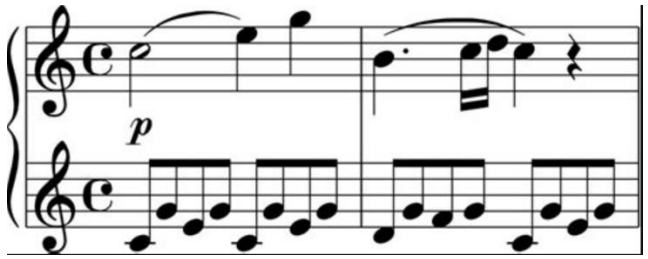

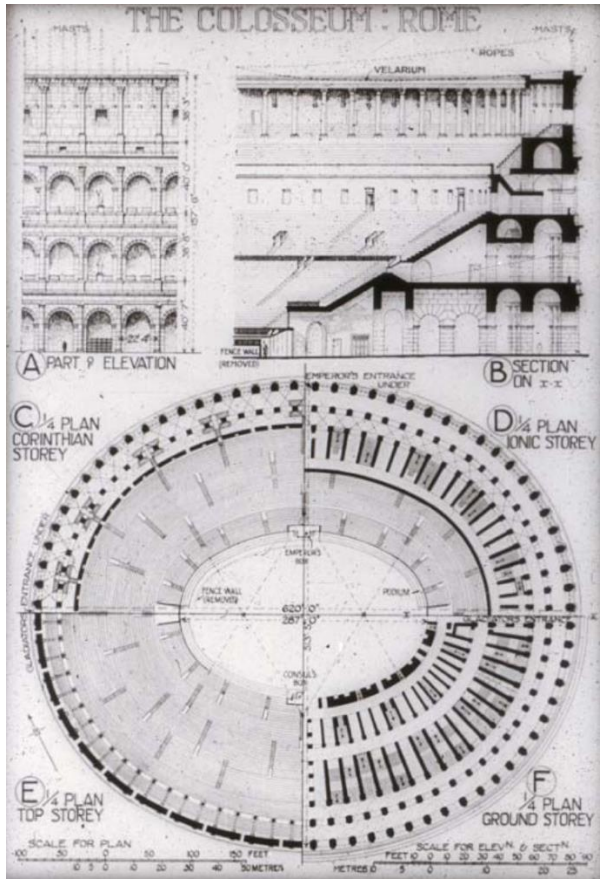

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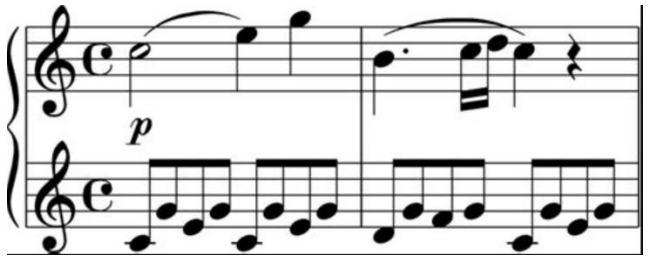

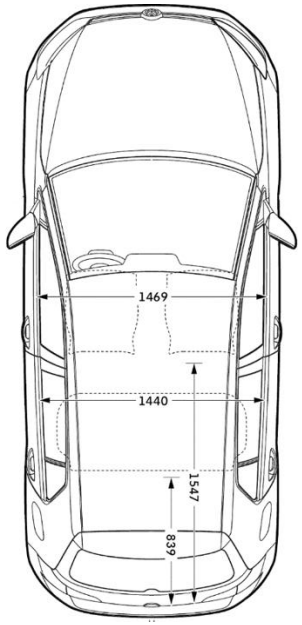

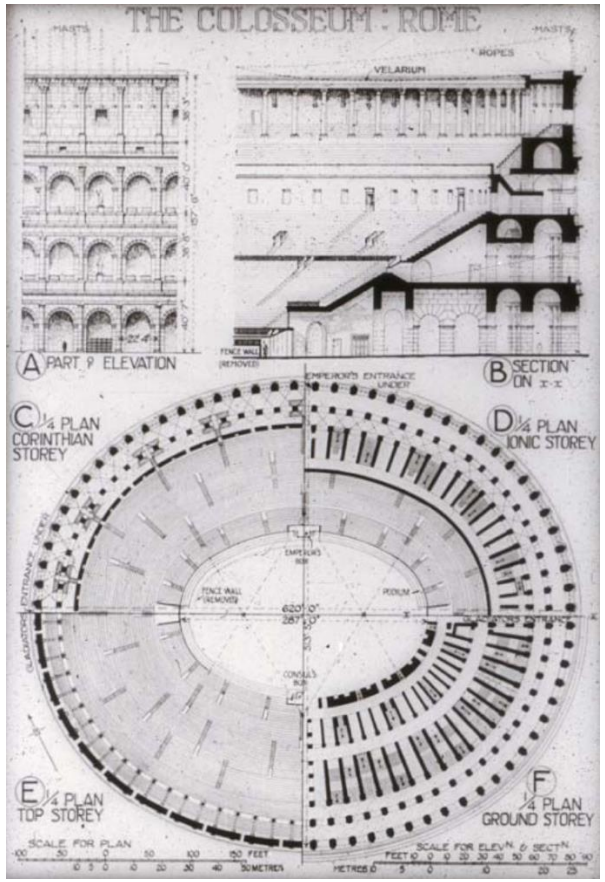

Pattern Recognition Training

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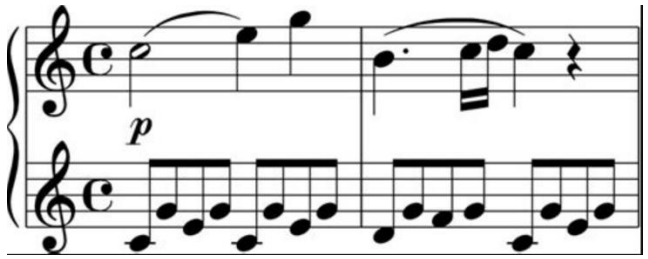

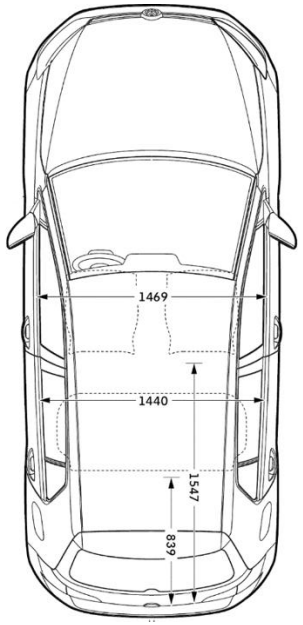

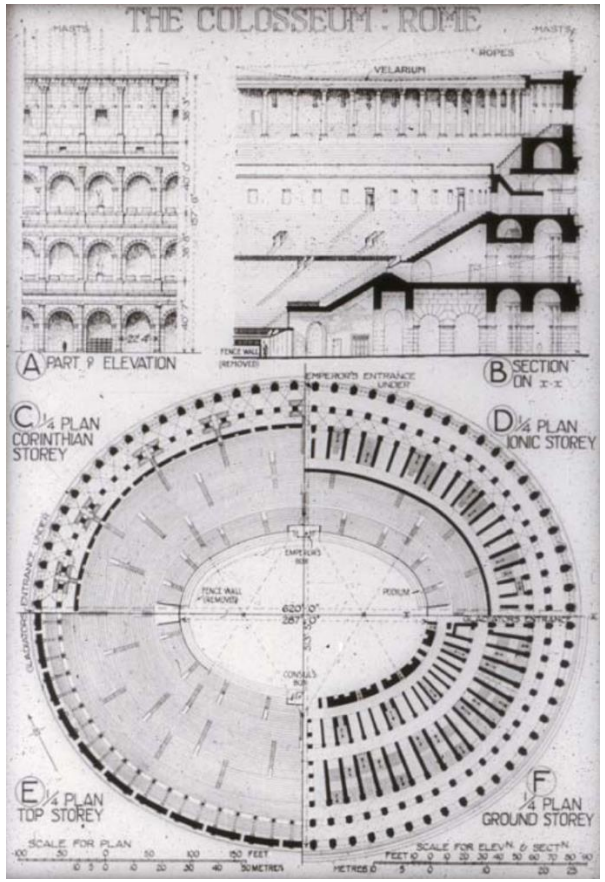

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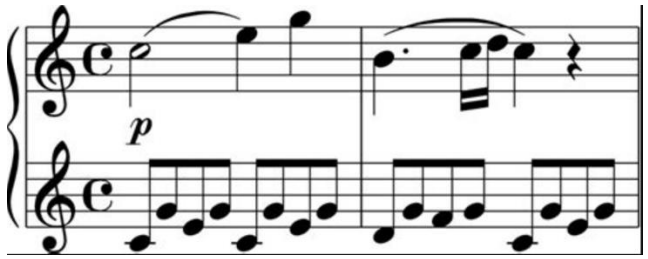
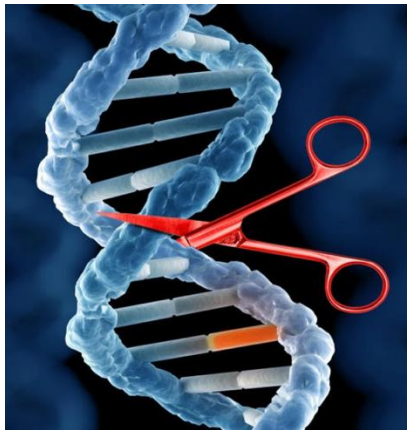
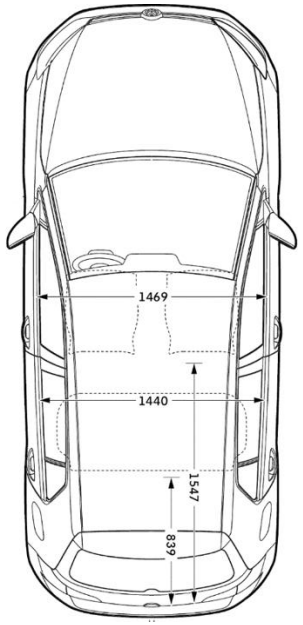
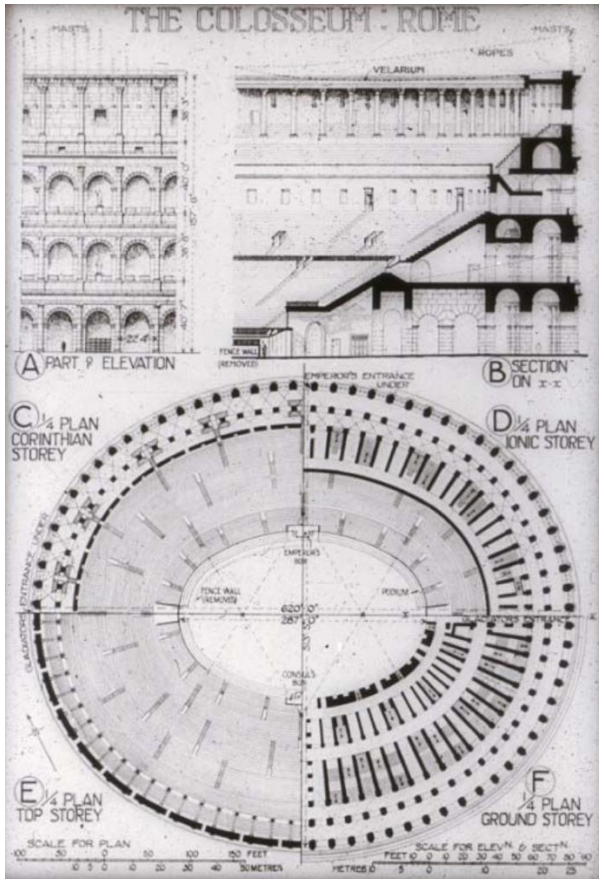


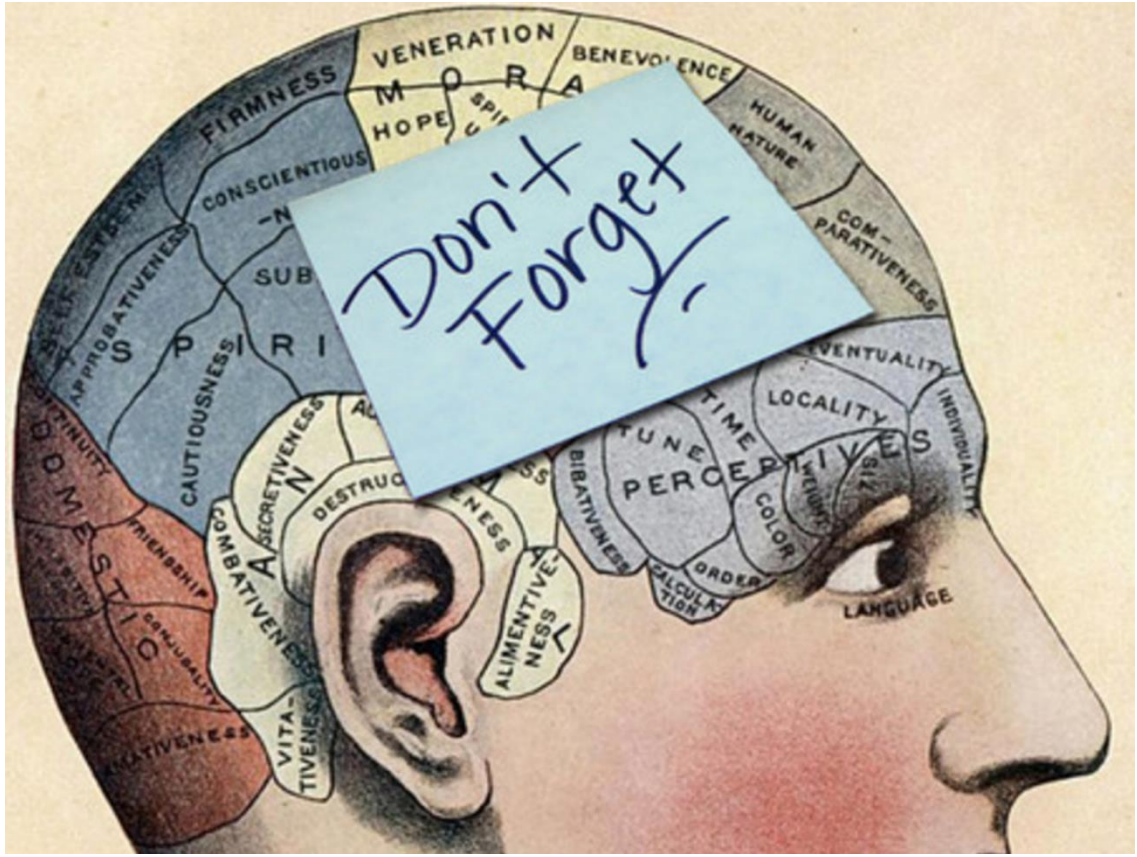






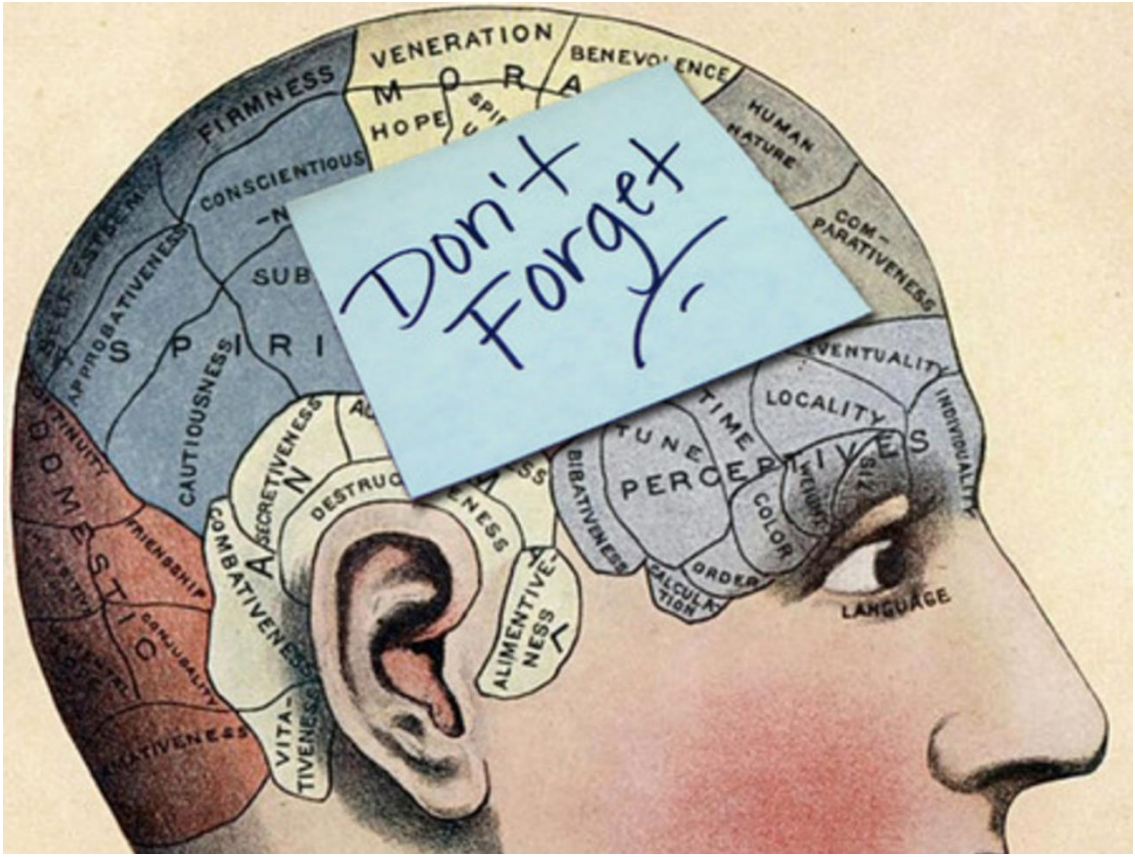
Memory

- Added to this, we also have limited:
  - Working memory
  - Short term memory
  - Long-term memory



Memory

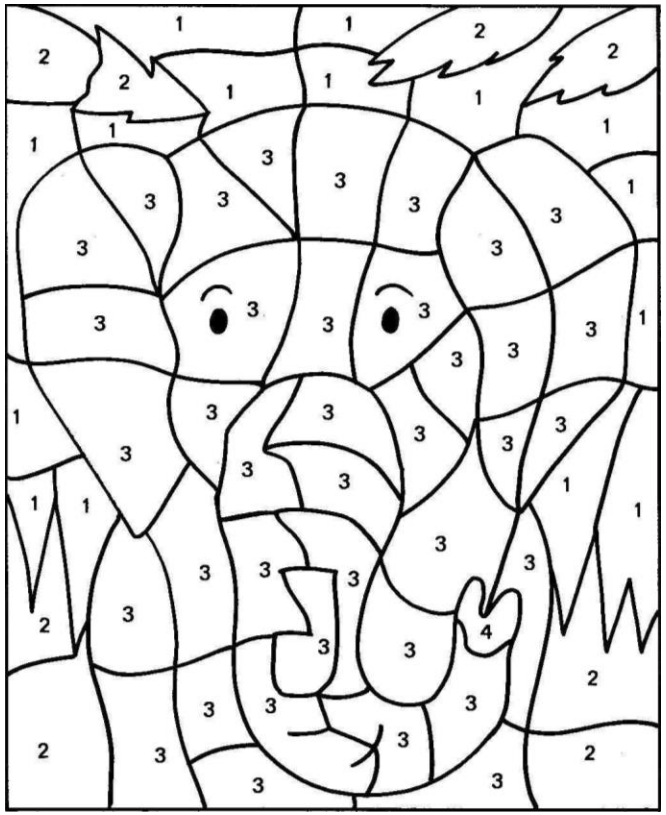
- Added to this, we also have limited:
  - Working memory
  - Short term memory
  - Long-term memory
- Rather than attempt to memorize everything we attend to in our perceptual field, we *name* things and *refer* to them later



Divide & Conquer

- Naming is a *divide-and-conquer* heuristic that is useful for entities with limited memory like us; it allows us to break down complex information into digestible parts

Grid Method

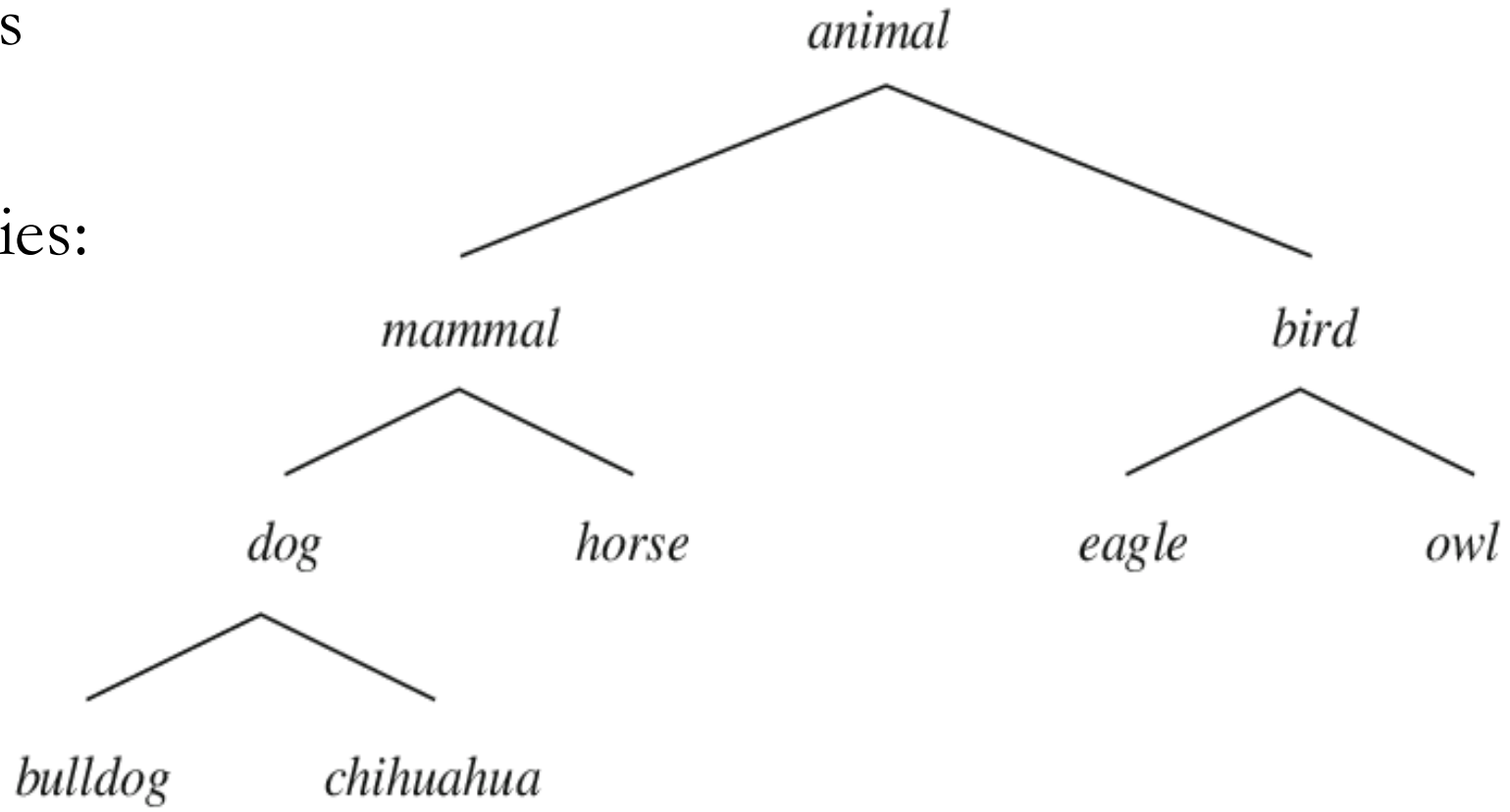


Paint by Numbers

Conceptual Hierarchies

- Terms we use carry *logical relationships* to other terms

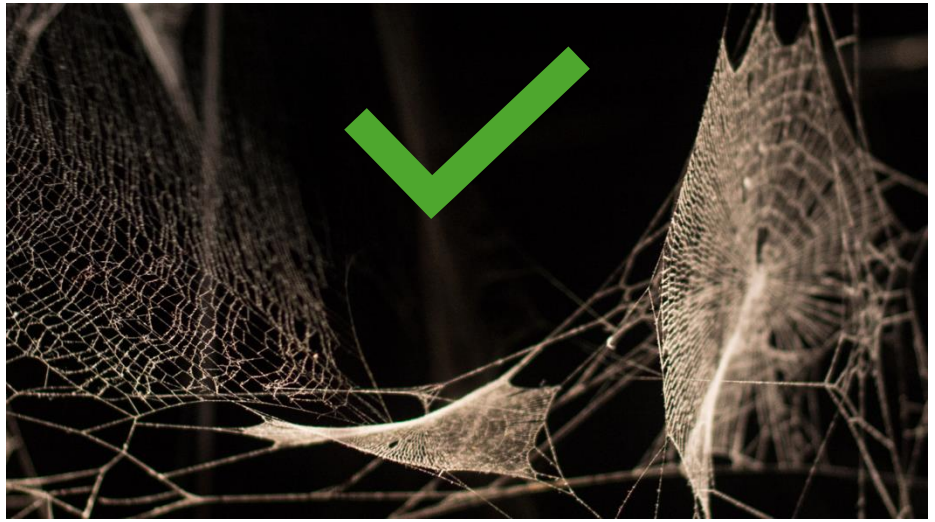
- For example, "dog" implies:
  - "mammal"
  - "often a pet"
  - "typically has a tail"
  - "not a bird"



Cognitive Webs

- Naming parts of your perceptual manifold to which you attend, results in conceptual hierarchies, give rise to *cognitive webs*

- Not merely webs of belief as, say, Quine suggested, but interconnected webs of beliefs, desires, knowledge, hopes, wishes, etc.



Webs of Beliefs and Desires

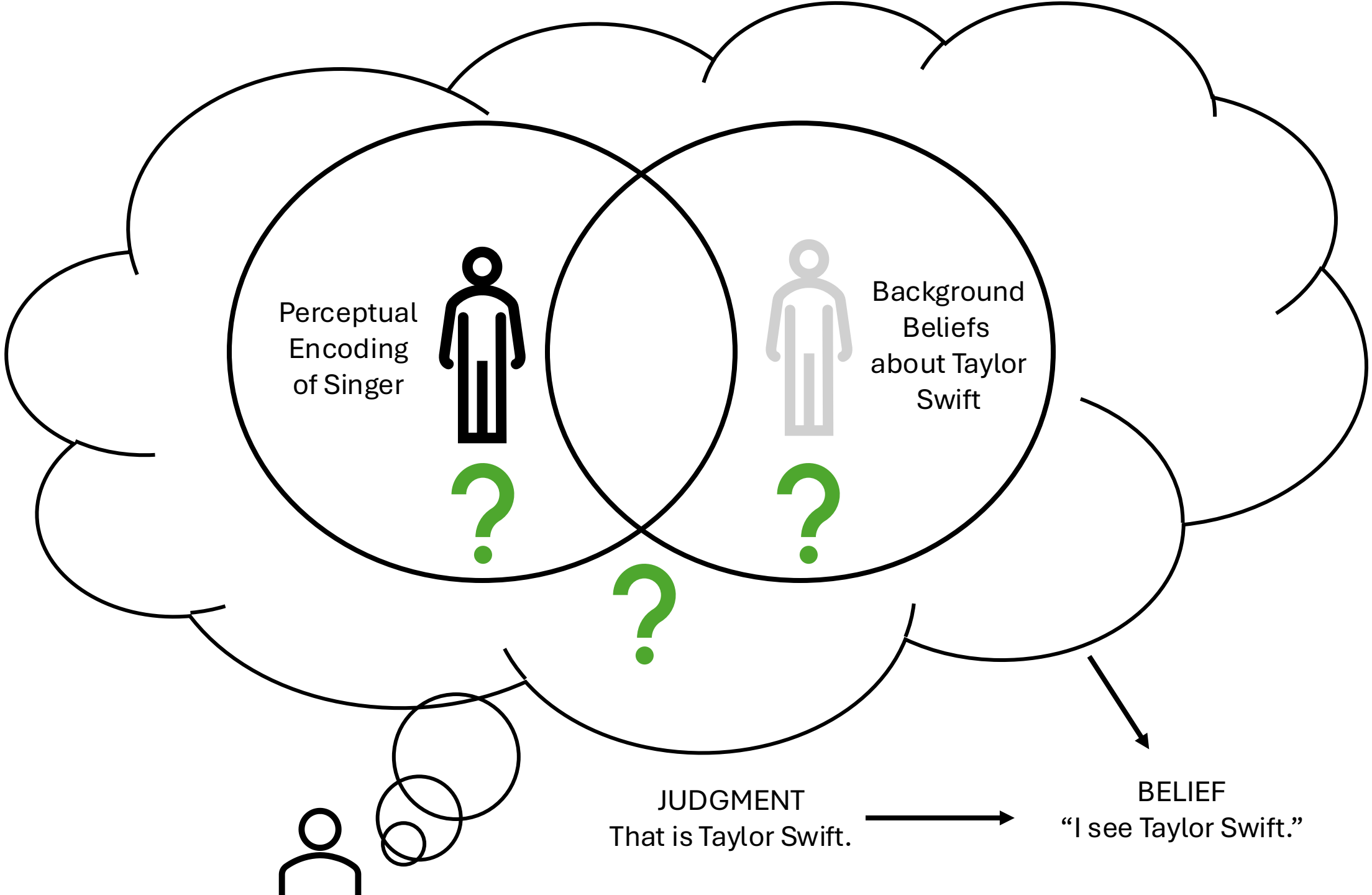
- You believe "2+2=4" and "John Beverley is bald"
- Disbelieving "2+2=4" would require disbelieving a *lot of* other things too
- Assuming you desire to live, no longer desiring that would require changing a lot of other desires you have
- Fewer desires would need to be changed if you no longer desired to eat peaches

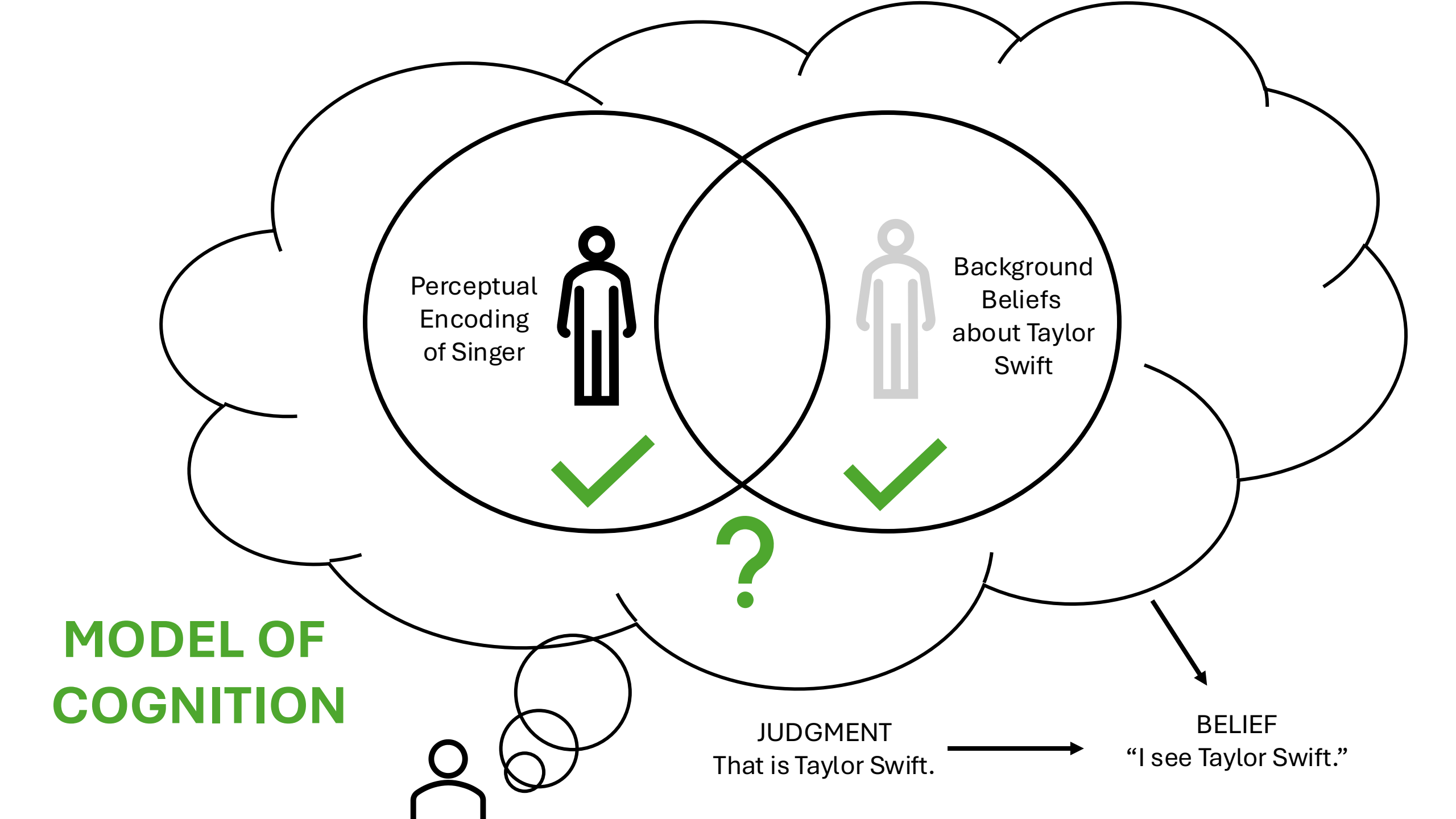
Behaviors

- Attention to a portion of your perceptual manifold coupled with naming results in hierarchies of concepts, which inform webs of beliefs and desires…

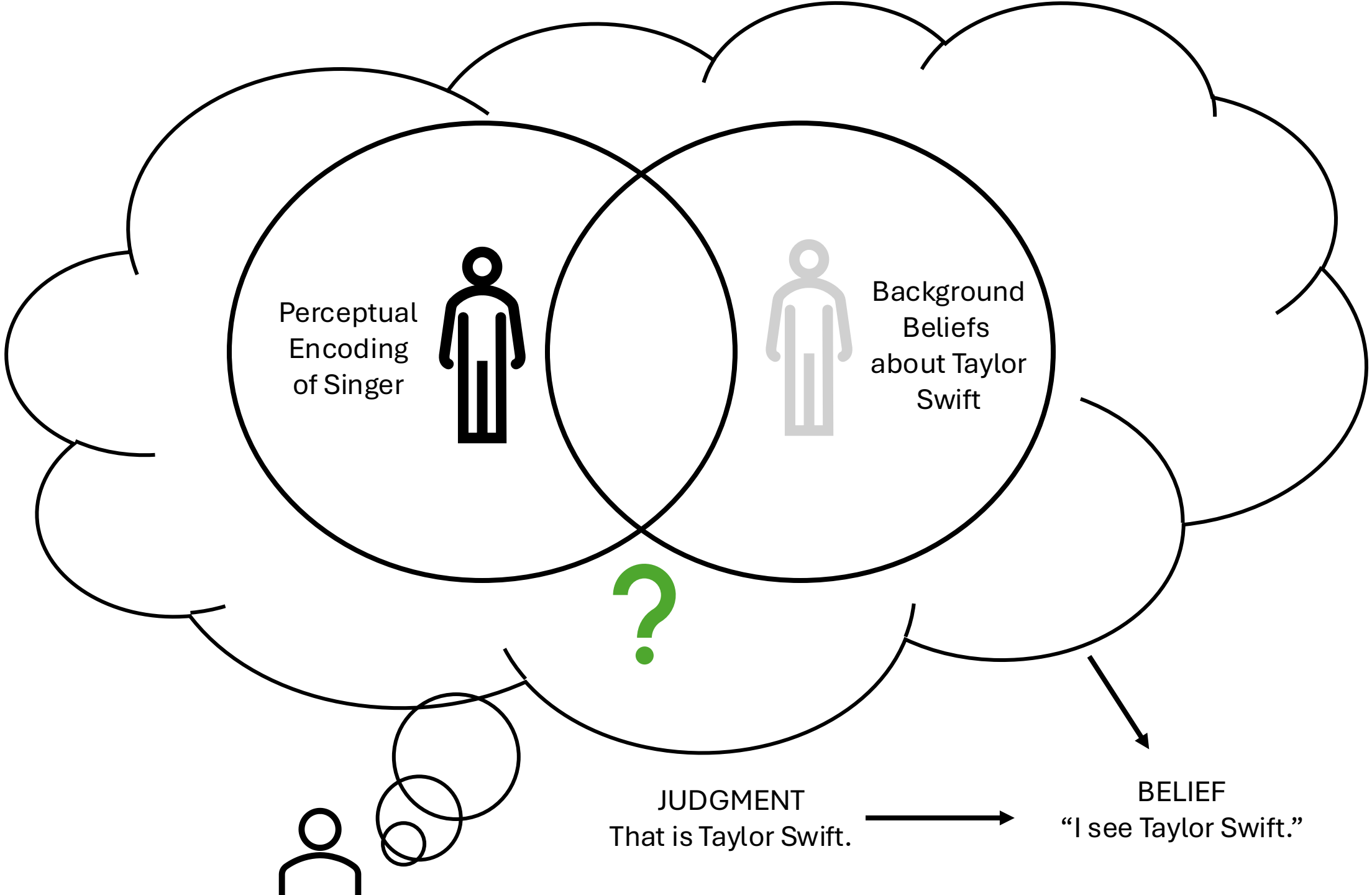
- And these webs inform *behavior*

- You reach for the glass of water because you perceive it as potable and you desire to no longer be thirsty


Perceptual Encoding of Singer
Background Beliefs about Taylor Swift
JUDGMENT
That is Taylor Swift.
BELIEF
“I see Taylor Swift.”



MODEL OF COGNITION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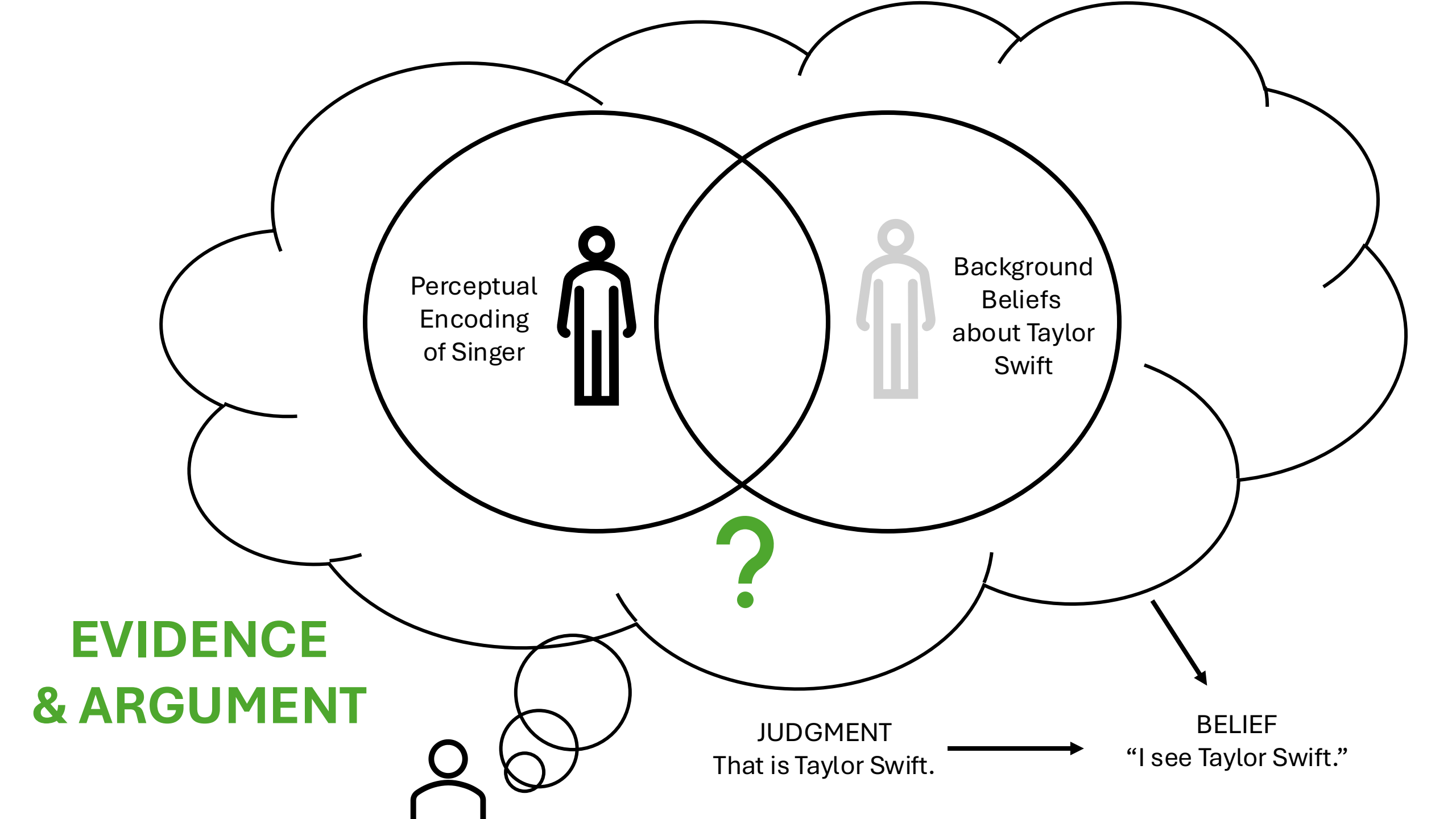
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Outline

- Intelligence Analysis on the Ground
- Cognitive Process Ontology
- Model of Cognition
- Argument Ontology

Intersecting Interests

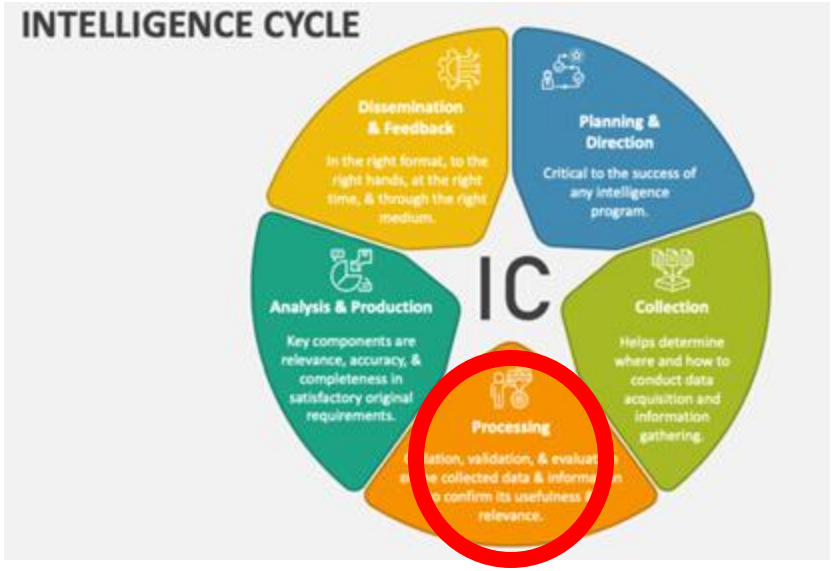
- Arguments are **fundamentally** used for **persuasion**

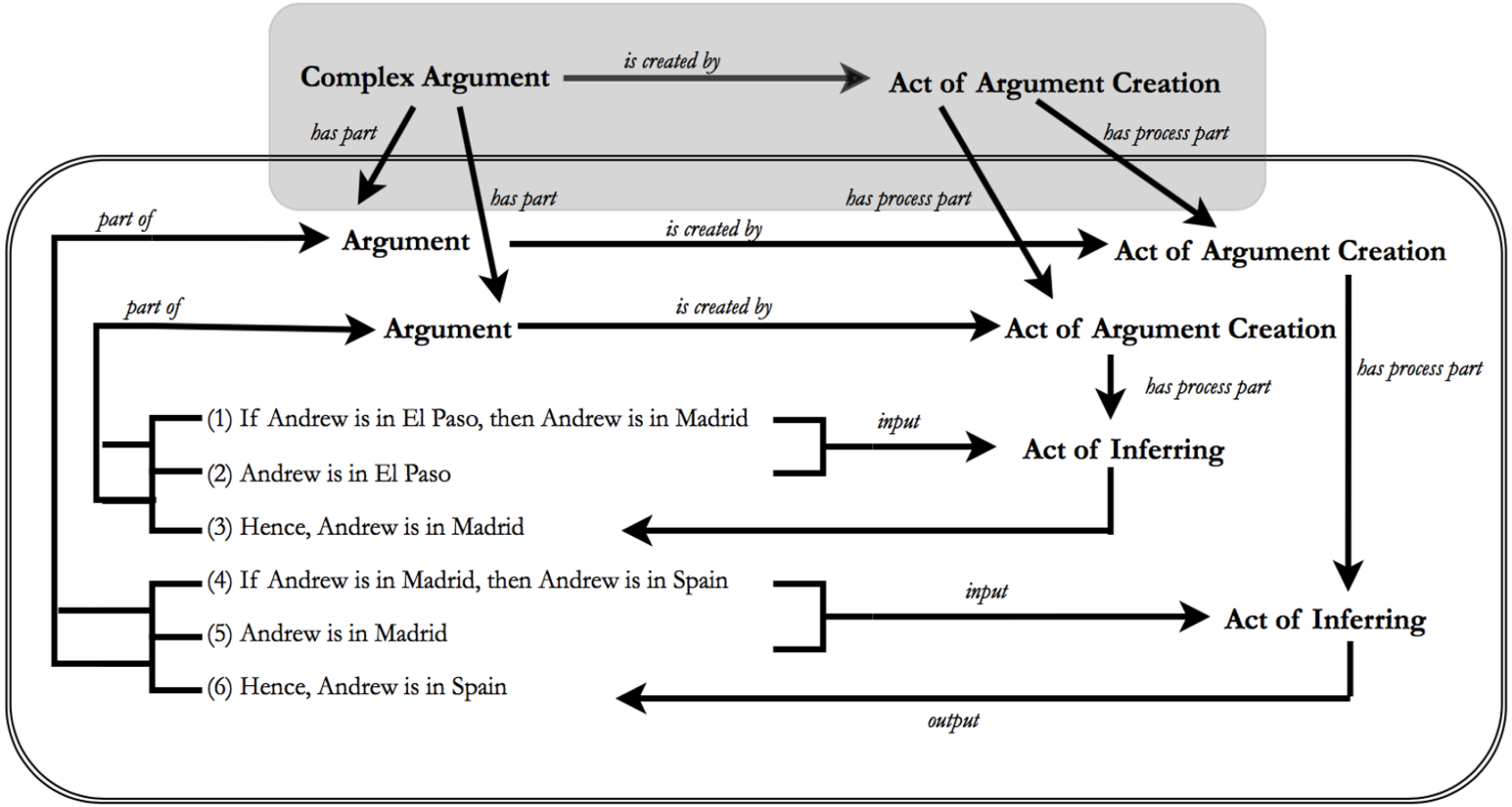
- Here is another point at which intelligence analysis dovetails with **ontologies**

Intersecting Interests

- Arguments are **fundamentally** used for **persuasion**
- Here is another point at which intelligence analysis dovetails with **ontologies**
- Ontologies provide an avenue for:
  - **Explainability** – Tracking the uses of evidence
  - **Traceability** – Tracking the impacts of evidence on other evidence

Arguments in the Intelligence Cycle

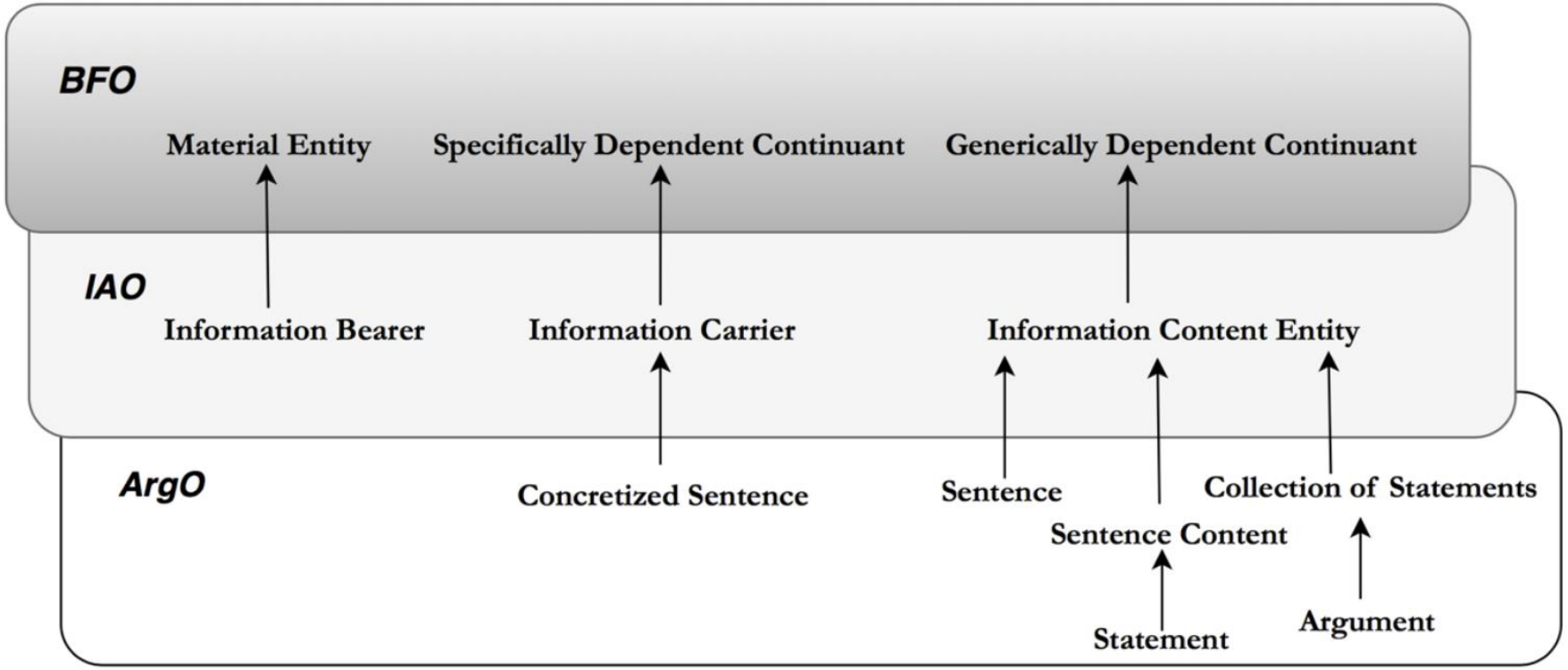




Argument Ontology Best Practices

- An ontology should accurately represent entities and relationships within its stated scope:
    - Distinguish sentences from their contents
    - Distinguish sentence contents from what they are about
    - Distinguish sentence contents from their roles within arguments
    - Permit representation of multiple sentence and content types
    - Depict complex arguments

ARGO: The Argument Ontology



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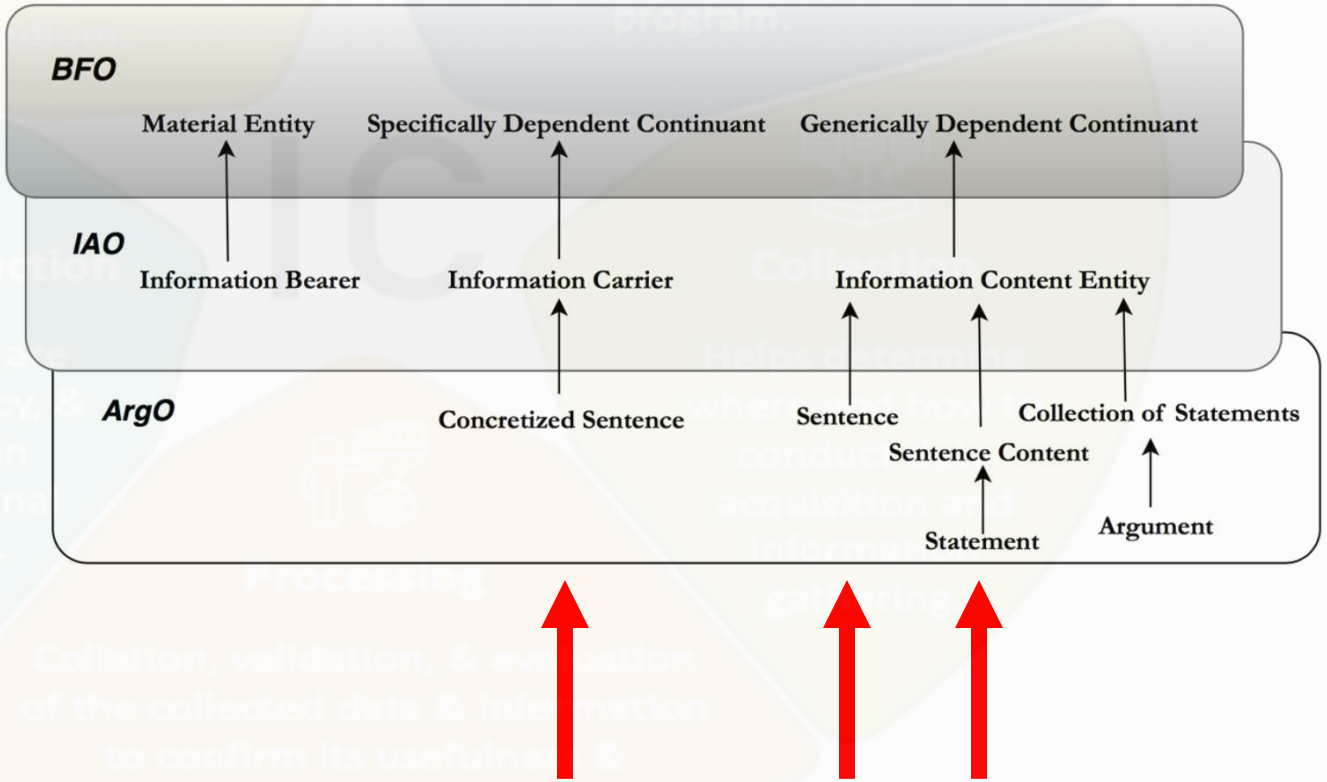

Sentences and Content

- An **expression** consists of patterns of character shapes in a language, such as the string of characters comprising this clause

- A **concretized sentence** is a subclass of **expression**, instances of which satisfy some conventional rules of grammar

- Both are distinct from **statement**, a subclass of **information content entity** whose instances are the contents of **concretized sentences**

- The **concretized sentence** "Susan is happy" expresses the **statement** that Susan is happy, which is plausibly about Susan's jocularity

Argument Ontology Best Practices

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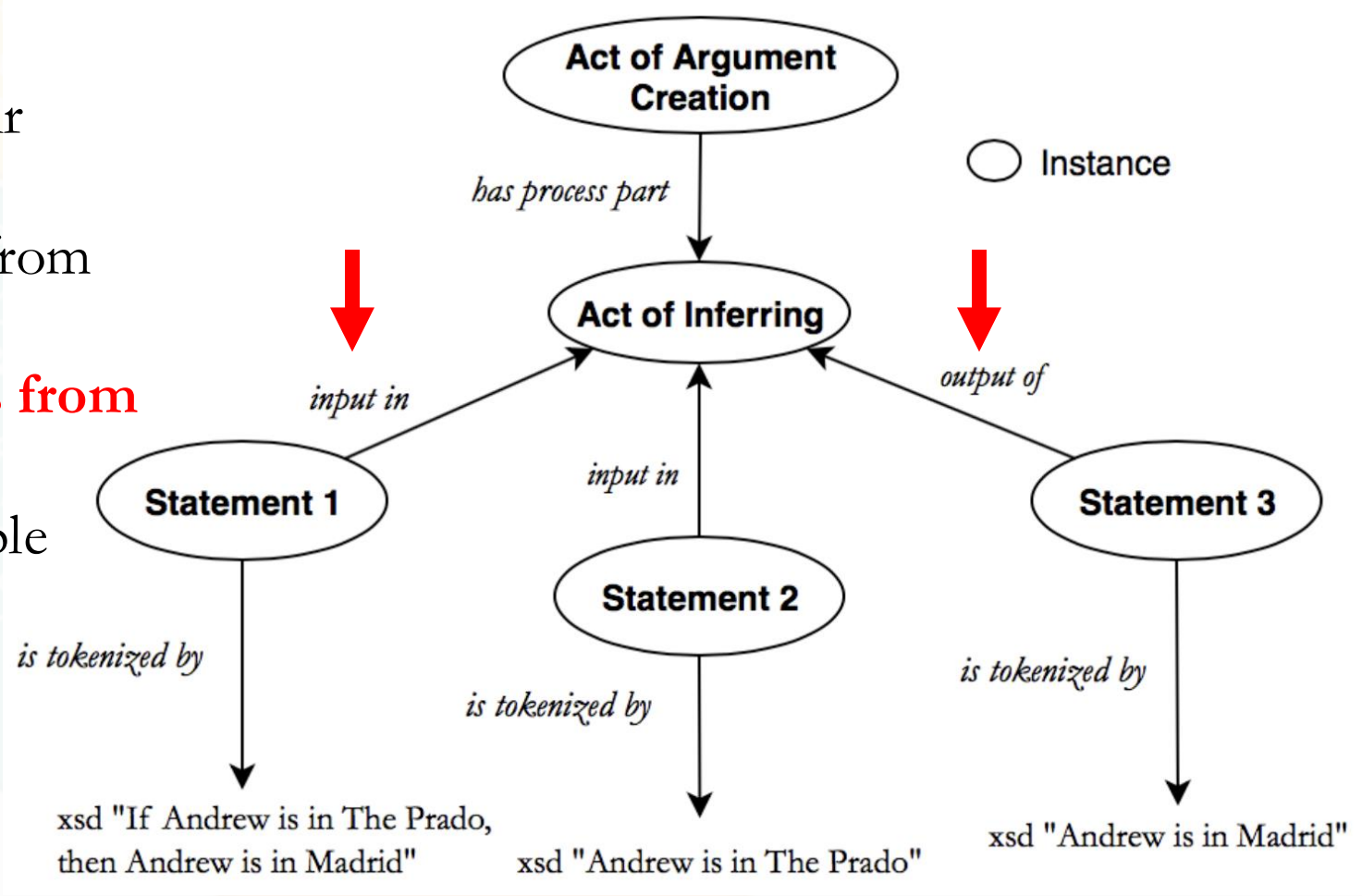

Premise, Supposition, Conclusion

- **Arguments** are ordered collections of **statements** involving **premises**, **suppositions** and a single **conclusion**
- A **premise** is a **statement** in a relation to an **argument** as the affirmed input of an **act of inferring**
- A **conclusion** is a **statement** part of an argument that is the output of an **act of inferring**
- **Suppositions** are inputs to **act of accepting** in which an agent entertains a statement as true or false independent of belief or evidence

Argument Ontology Best Practices

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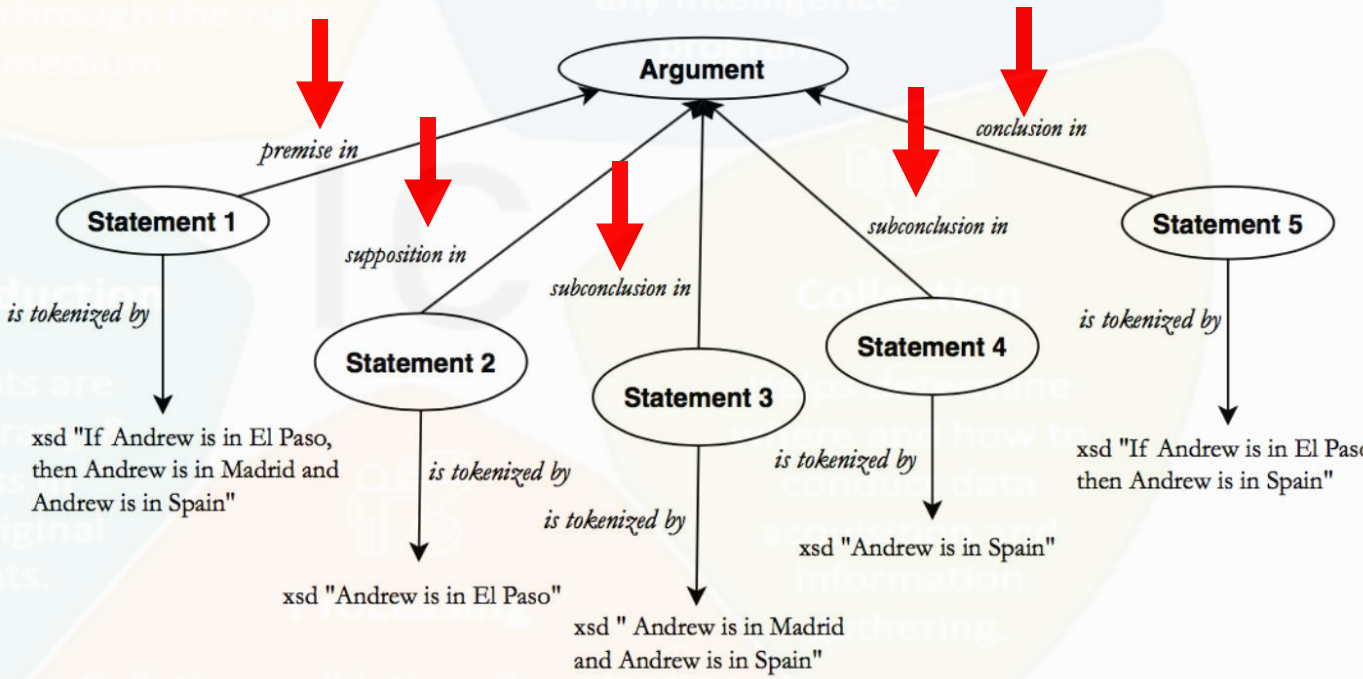

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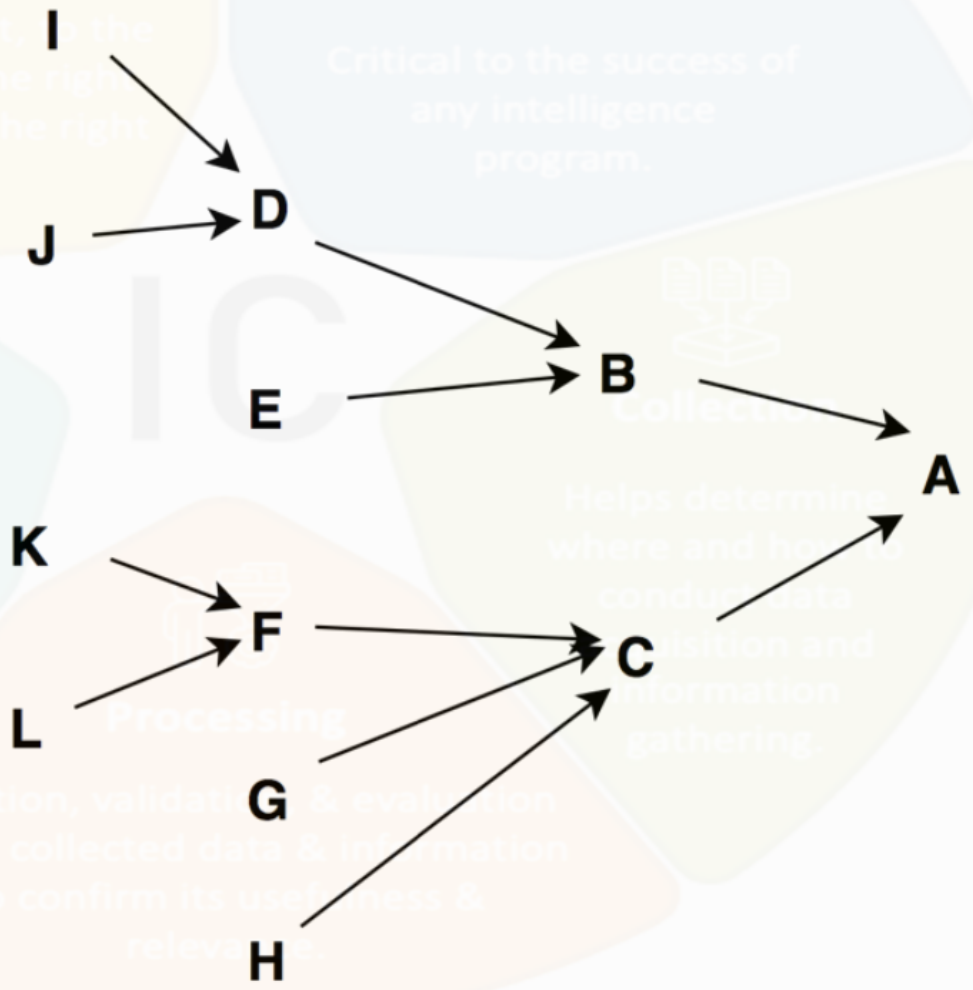


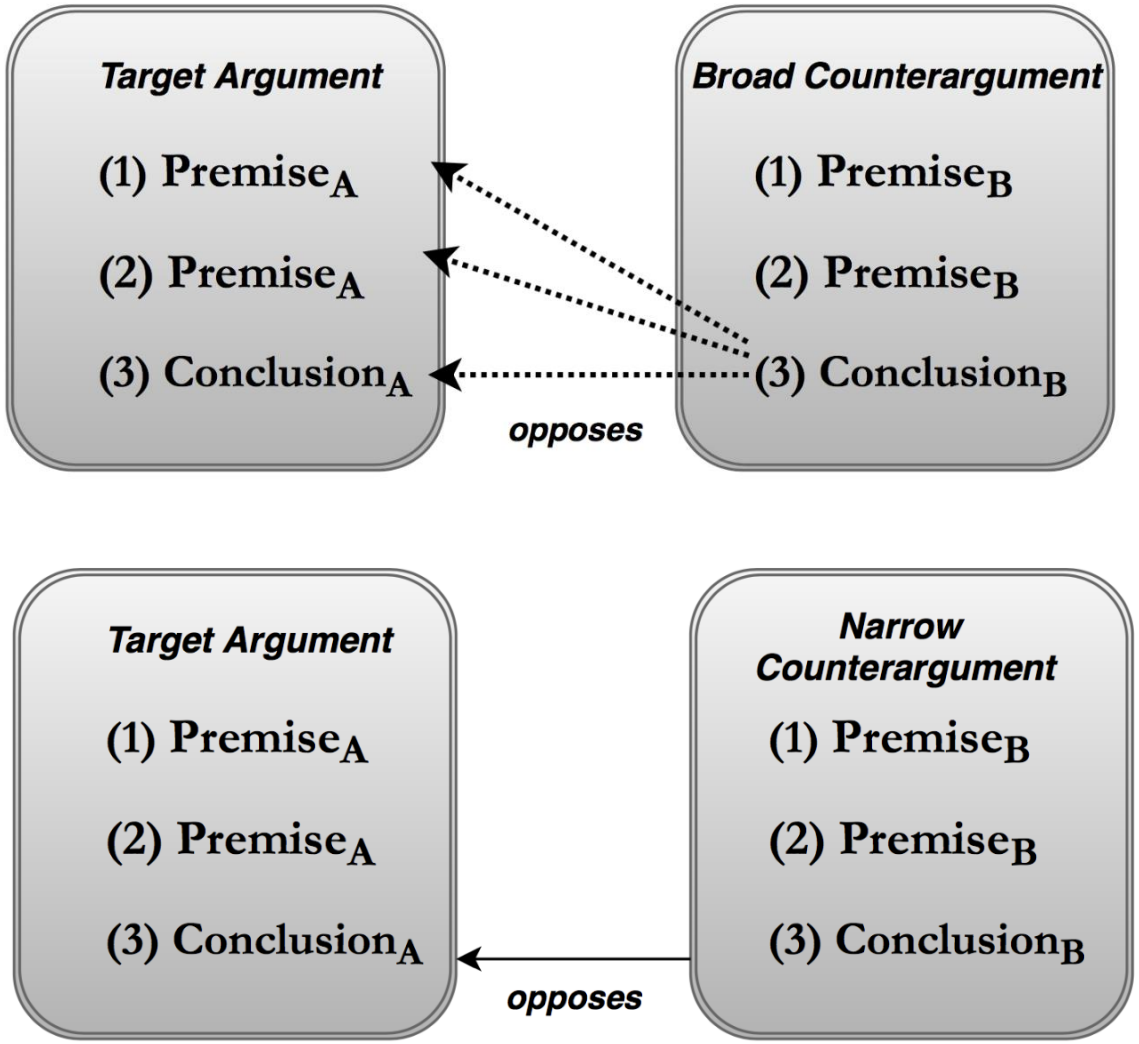
Subconclusions

- A **subconclusion** is part of a **complex argument** that is:
  - Affirmed or accepted input in an **act of inferring**
  - Affirmed or accepted output in an **act of inferring** in an argument distinct from the first
  - Such that both arguments are parts of the **complex argument**

Counterevidence

- Finding **counterevidence** for a conclusion may undermine an argument in different ways

- Classifying these ways informs how ontologies play with intelligence analysis under ACH



Application: Fact-Checking

- Simple strategies involve **tagging** <*claim*, *evidence*> pairs indicating when evidence supports or undermines the claim

- Sophisticated models attempt to **provide missing evidence** or **correct claims**

- Each such strategy attempts to leverage claims and evidence, a relationship often characterized in terms of **arguments**

Blueprints

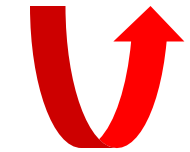
- Suppose statement X in argument A conflicts with statement Y in argument B, resulting in pair options for <*claim*, *evidence*>:

<A, B>
<X, B>
<A, Y>
<X, Y>

- Connected by mereological relationships, opposition relationships, etc.

<X, Y>

<X, Y>

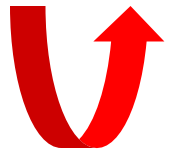


opposes

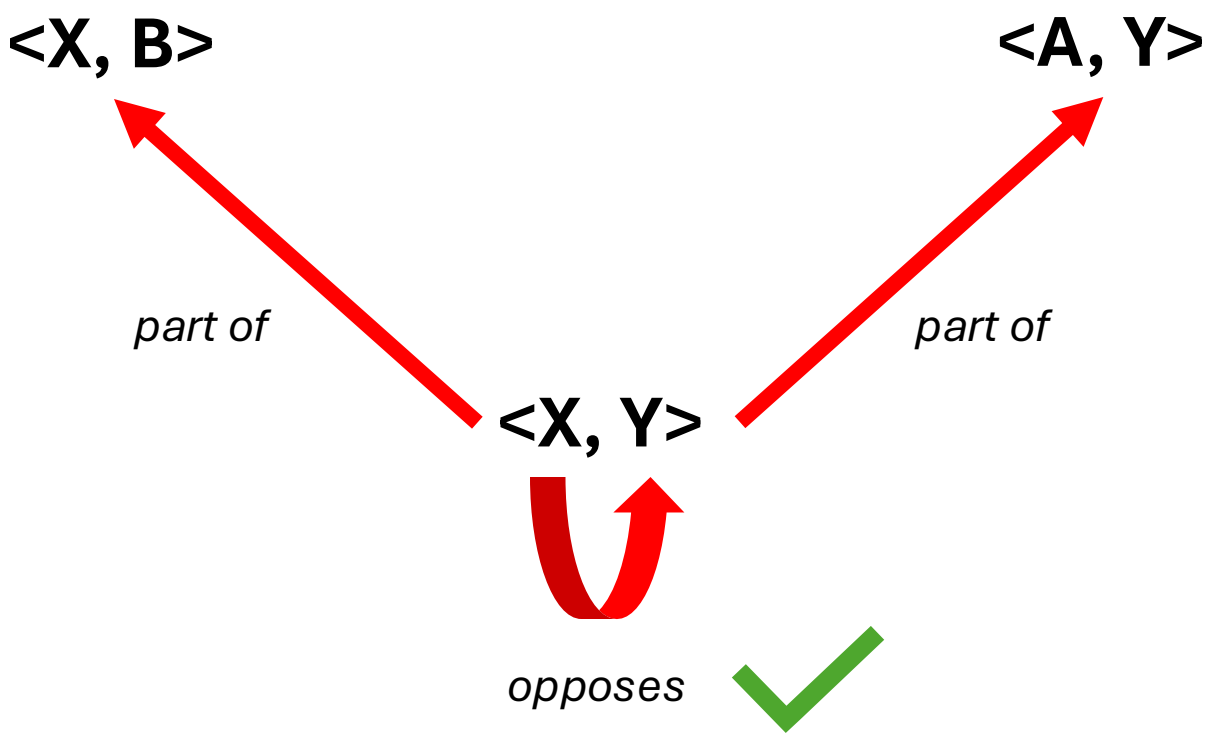
<X, B>

<A, Y>

<X, Y>



opposes


<X, B>
<A, Y>
part of
part of
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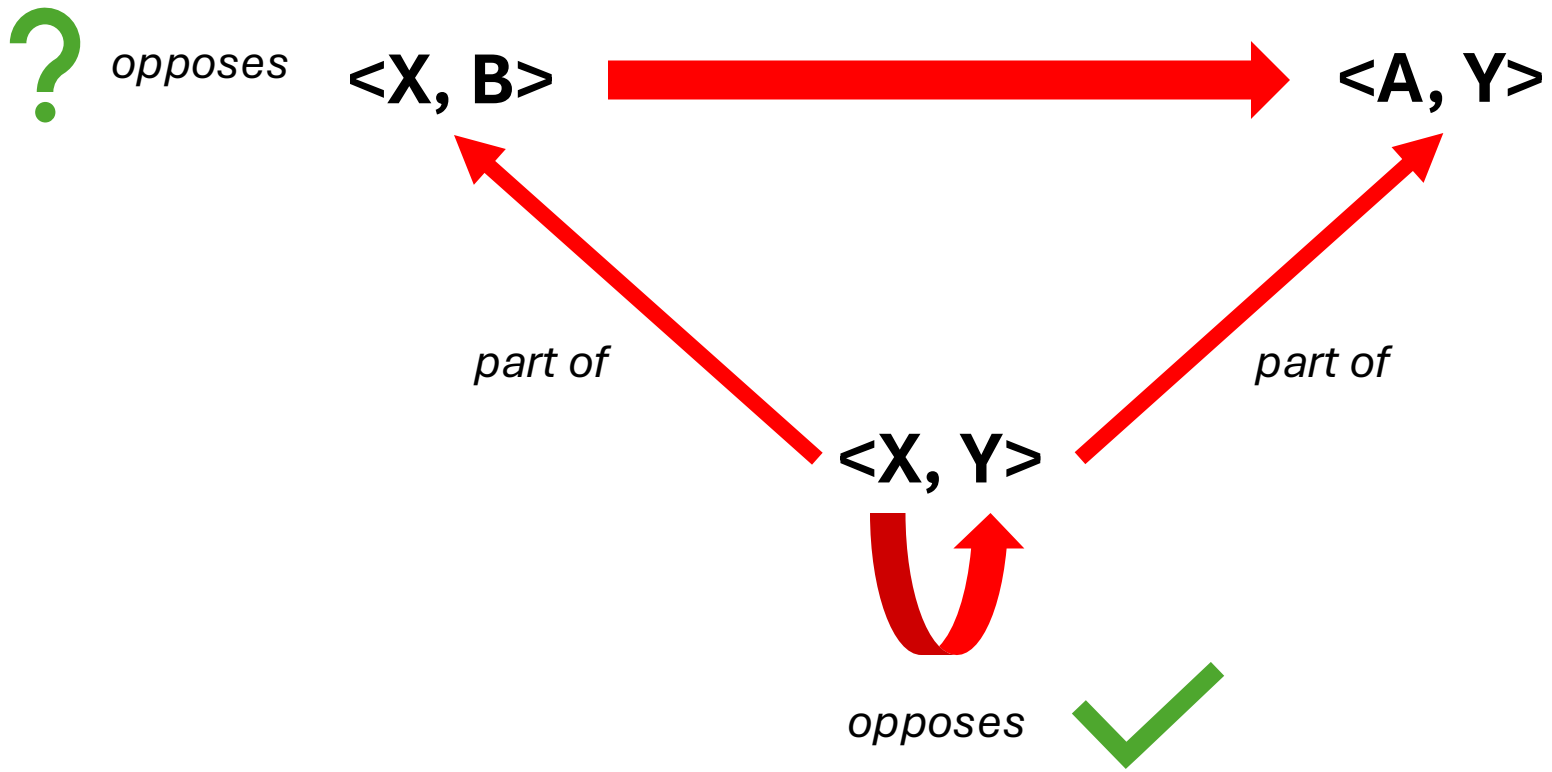
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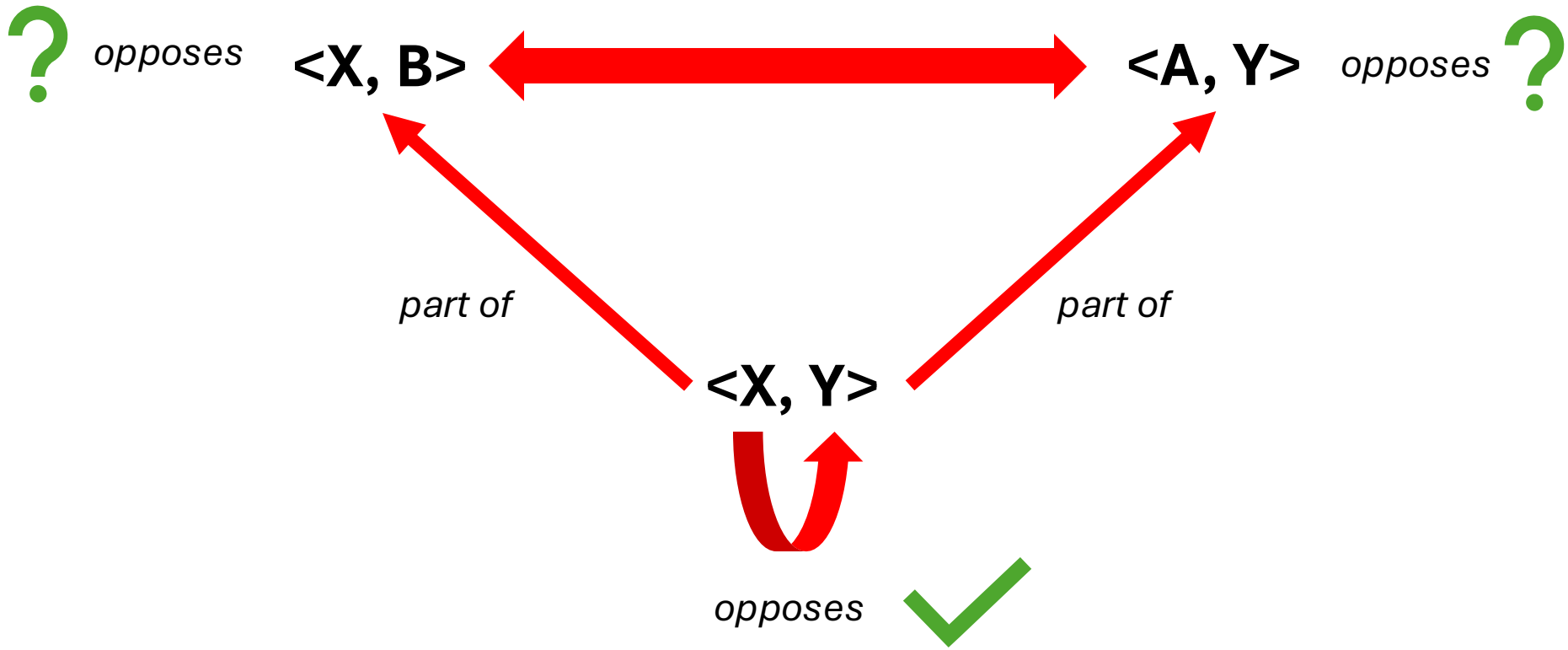
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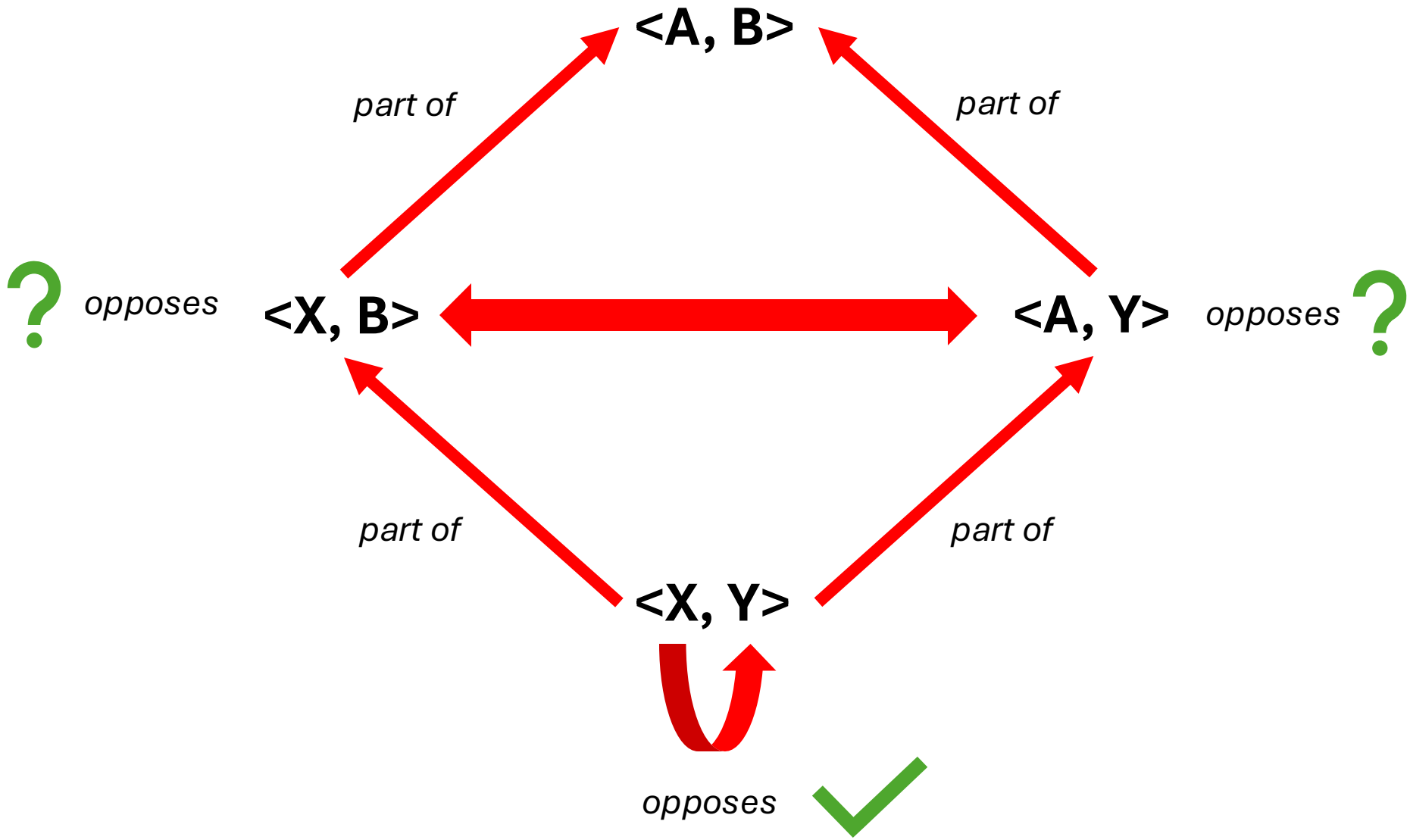
<A, B>
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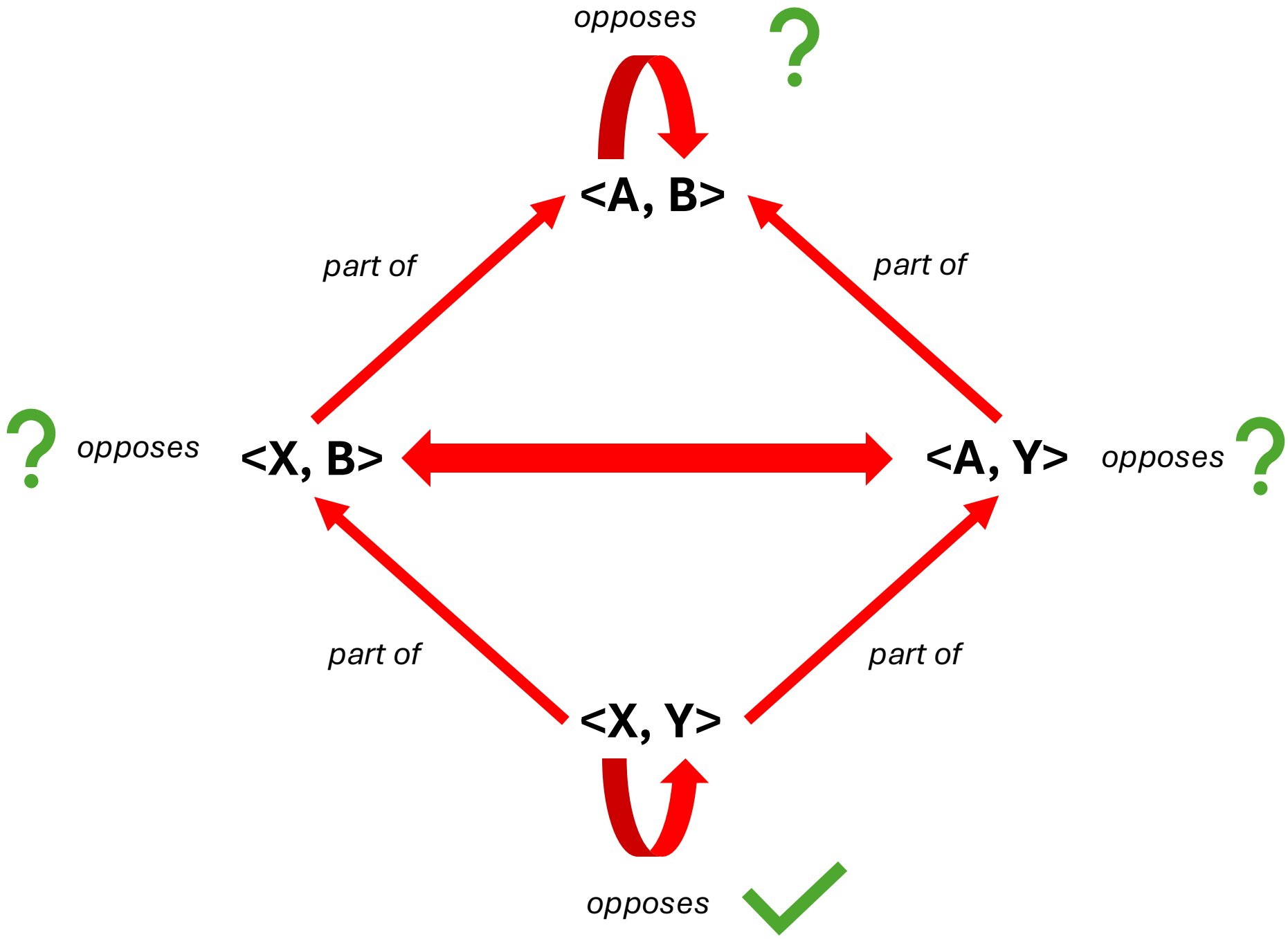
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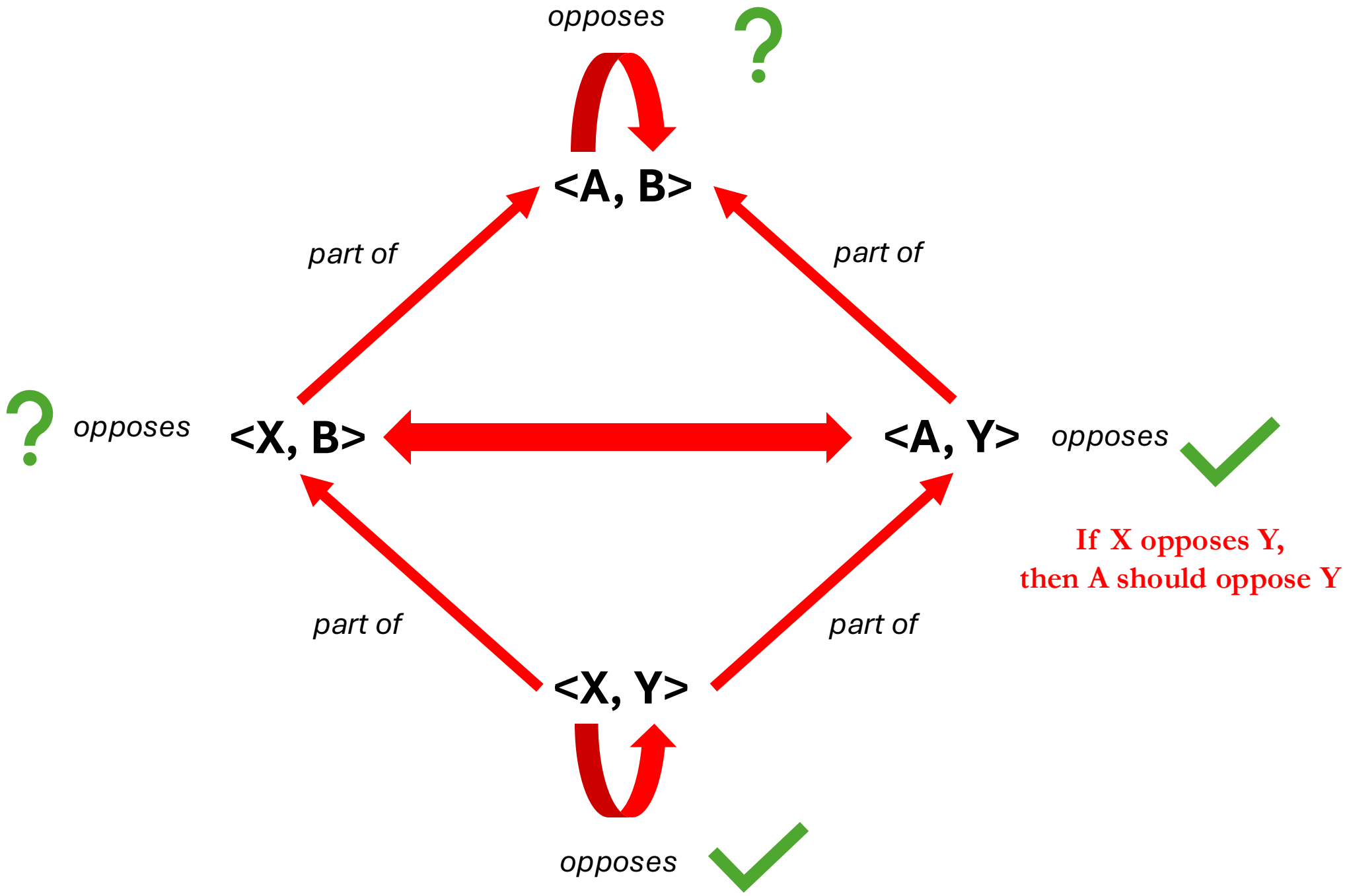
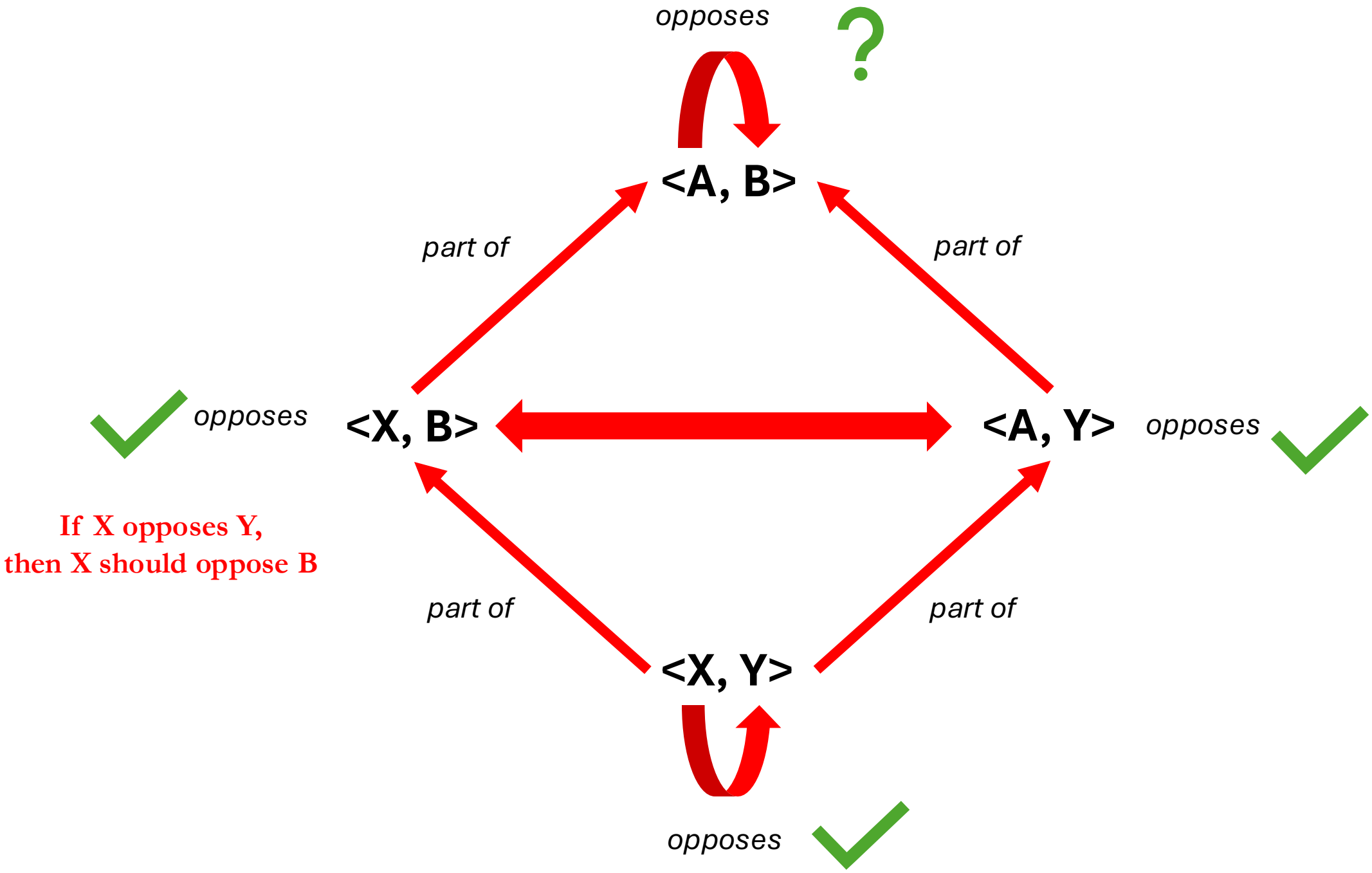

opposes
?
<A, B>
part of
part of
?
opposes
<X, B>
<A, Y>
opposes
If X opposes Y,
then A should oppose Y
part of
part of
<X, Y>
opposes


opposes
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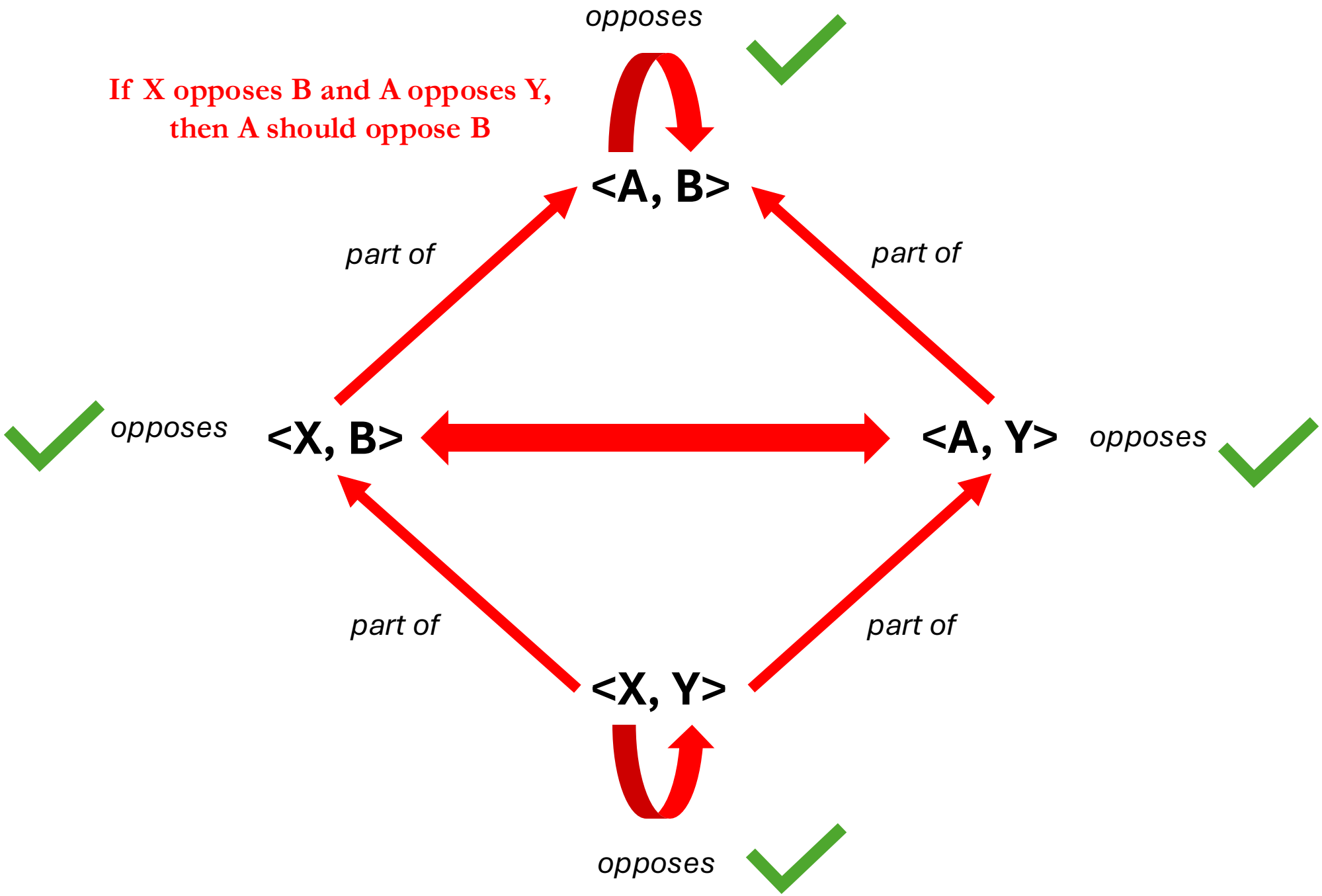

If X opposes B and A opposes Y, then A should oppose B
opposes
<A, B>
part of
part of
opposes
<X, B>
<A, Y>
opposes
part of
part of
<X, Y>
opposes

Example

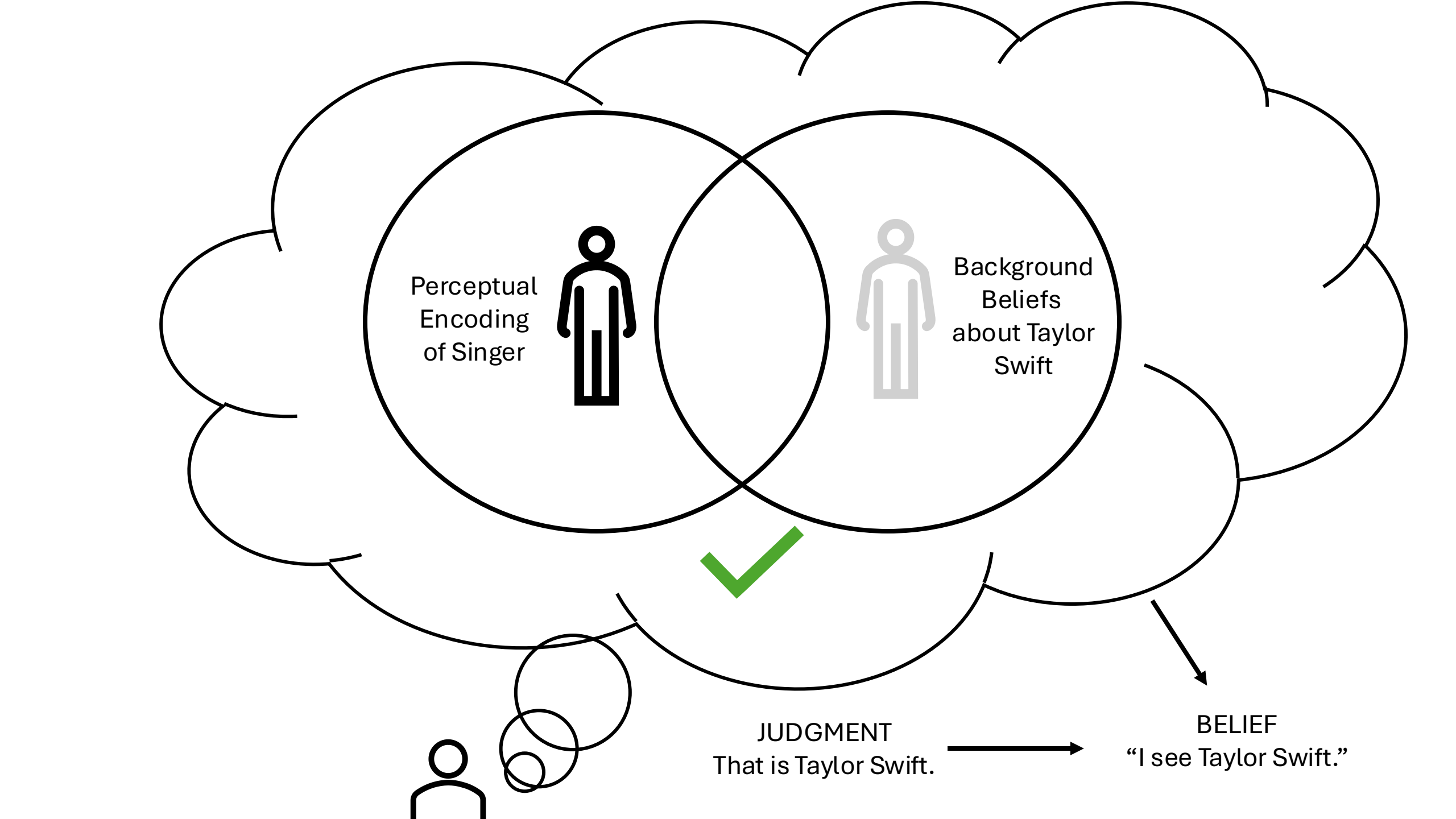
- Indeed, if A does not oppose Y, then at a minimum A does **not support X opposing Y**

Example

- For example, suppose "Tom is at the grocery store" (**Y**) is opposed by "Tom is at home" (**X**). Suppose the latter is part of the argument (**A**):

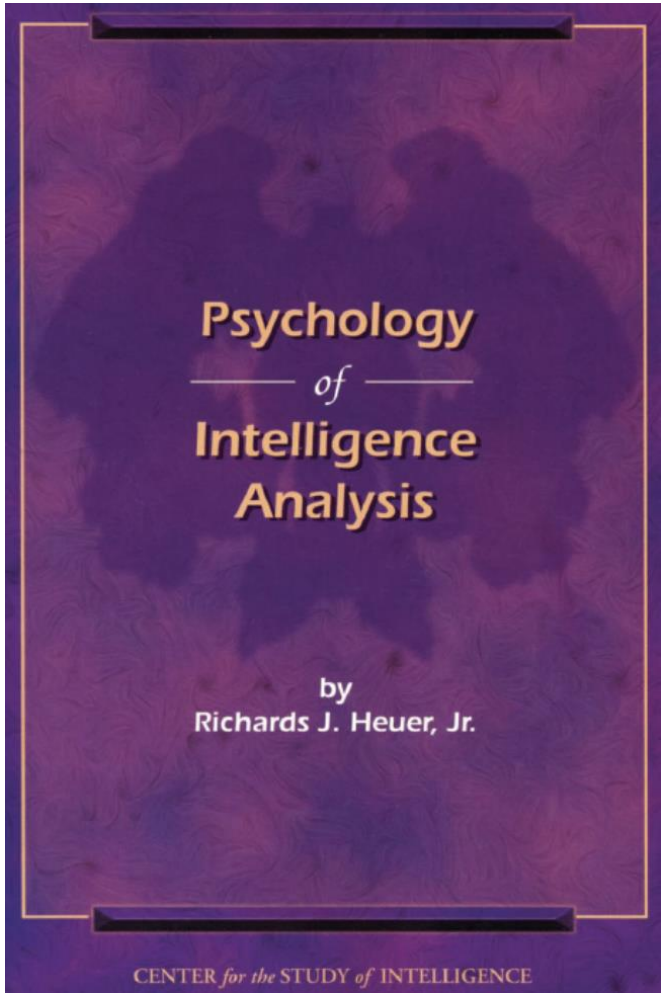
1. If Tom lives in the grocery store then he is at home.
2. Tom lives in the grocery store.
3. Hence, Tom is at home.

- This does not oppose "Tom is at the grocery store" (**Y**) because line 2 of the argument (**A**) does not support "Tom is at home" (**X**) opposing "Tom is at the grocery store" (**Y**)


Perceptual Encoding of Singer
Background Beliefs about Taylor Swift
JUDGMENT
That is Taylor Swift.
BELIEF
“I see Taylor Swift.”

Analysis of Competing Hypotheses (ACH)

1. Identify Possible Hypotheses
2. Compile Evidence in Favor or Against
3. Prepare Hypothesis vs Evidence Matrix
4. Refine Matrix
5. Extract Conclusions & Counterexamples
6. Evaluate Sensitivity to Critical Evidence
7. Report Conclusions
8. Identify Milestones for Future



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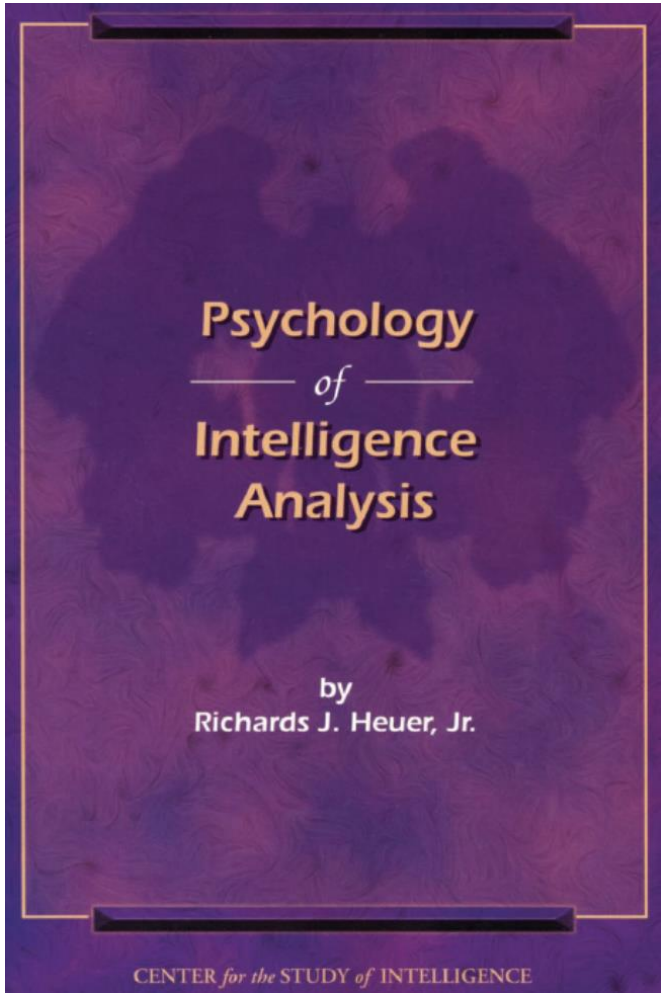

Readings

- Whitesmith, Part 1
- Understanding Bias in Twitter-Based Intelligence Analysis
- Ontology and Cognitive Outcomes