Argumentation: Preliminaries

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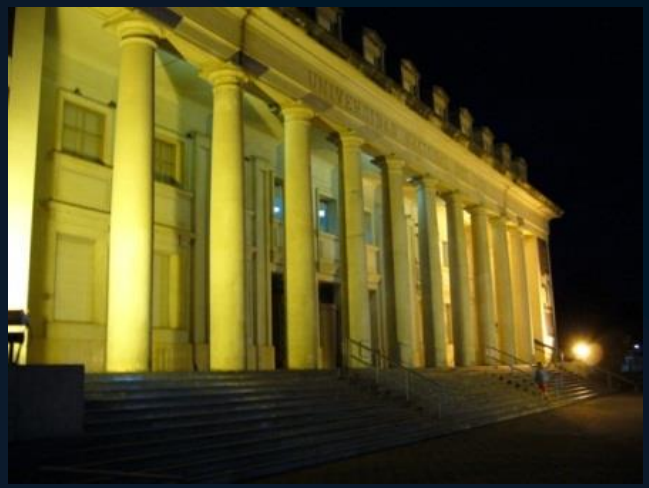
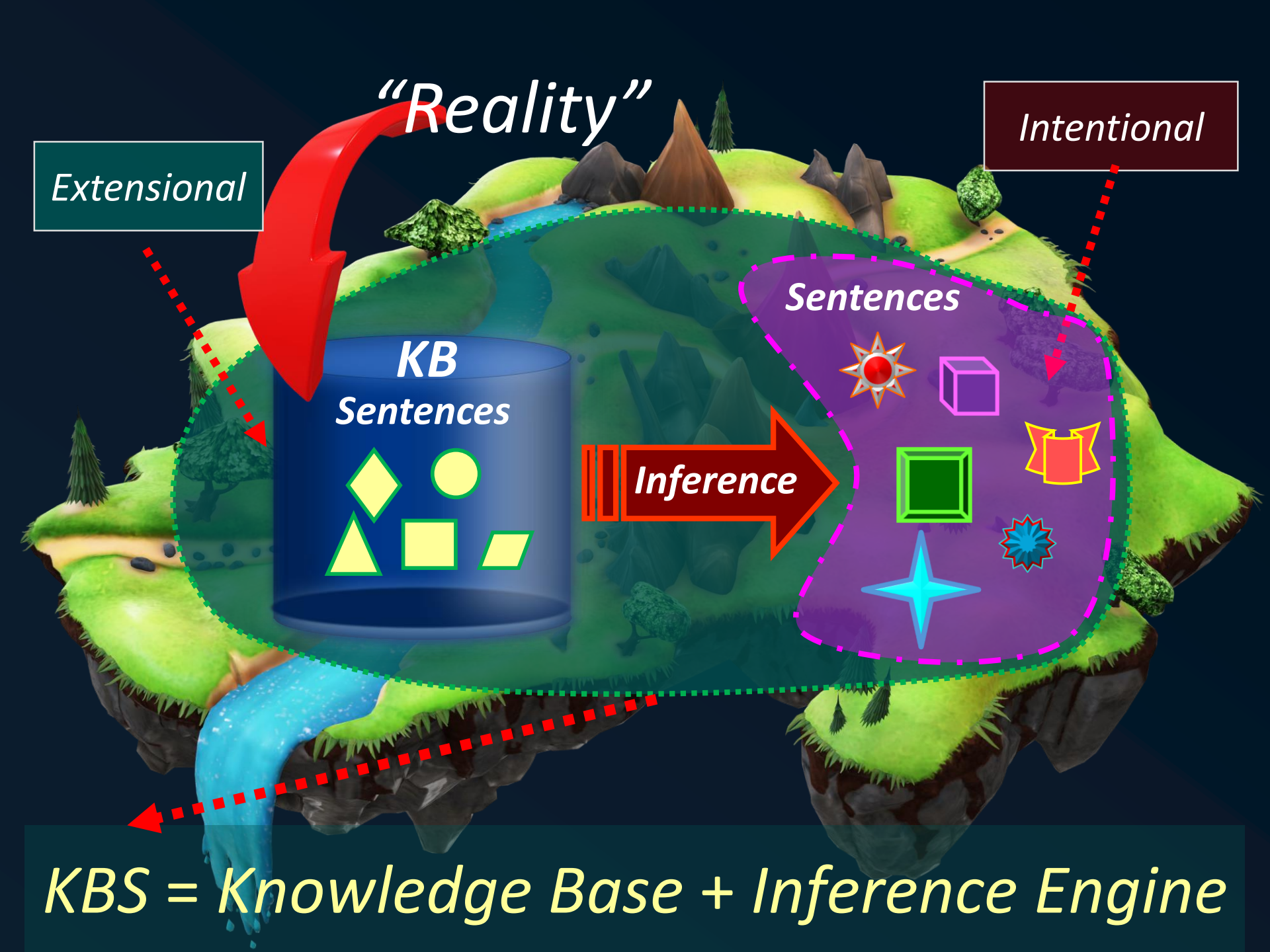
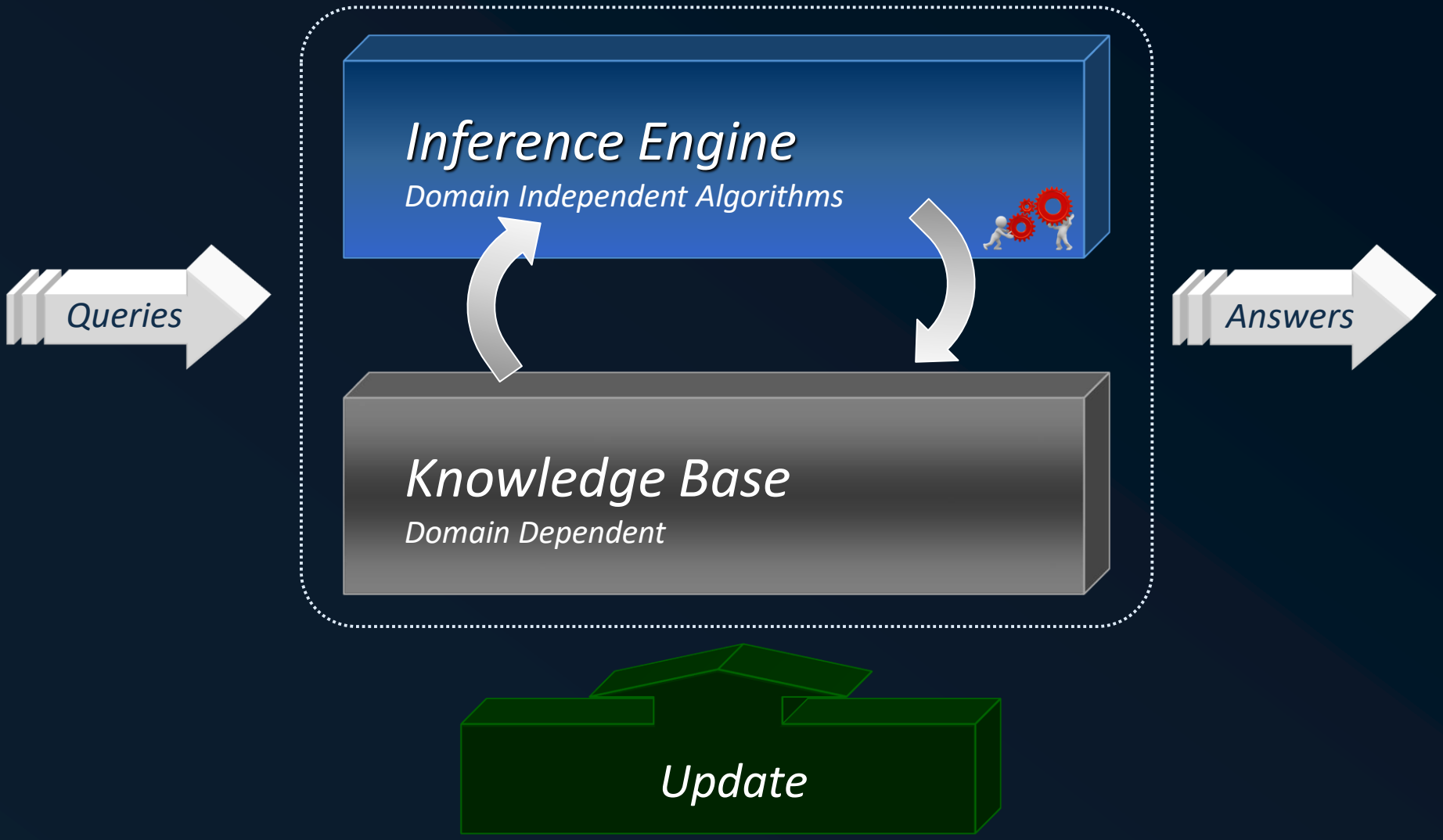


Knowledge Representation & Reasoning


"Reality"
Extensional
Intentional
KB
Sentences
Inference
Sentences
KBS = Knowledge Base + Inference Engine

KBS = Knowledge Base + Inference Engine



Reasoning

- *The reasoning allows to obtain information that is explicitly or implicitly in the* KB.
- *The following example shows a knowledge base expressed in the language of propositional logic:*

$$KB = \{\ a,\ a \rightarrow b\ \}$$

- *Assuming the inference mechanisms based in Modus Ponens we have:*

$KB \vdash a$ *(trivial and explicit)*

$KB \vdash a \rightarrow b$ *(trivial and explicit)*

$KB \vdash b$ *(by Modus Ponens)*

Knowledge Bases

- *Representation Language:*

  Expressiveness: What can be expressed in the language and what cannot.

- *Inference Procedure:*

  Soundness: Do the conclusions rationally follow from the knowledge base?

  Completeness: Given a rational conclusion from the KB, it is possible to obtain it?

  Efficiency: What is the computational complexity of the inference process?

Knowledge Representation and Reasoning

In the implementation of KR&R systems the following components are relevant:

1. *A Formal Representation Language.*
2. *A Semantics that links the representation to its meaning.*
3. *A Theory of Reasoning or Proof Theory or Proof Procedure that implements an inferential machine.*

KBS = Knowledge Base + Inference Engine

- *A well-recognized difficulty in building and exploiting Knowledge Bases is to avoid the consequences of inconsistency in Classical Systems of Logic, the well-known*

"Principle of explosion: ex falso quodlibet"

- *Many proposals have been advanced to handle this problem and maintain the usefulness of a potentially inconsistent knowledge base.*

KBS = Knowledge Base + Inference Engine

- *One method that keeps classical logic inference mechanism is to restore consistency before making any inference; this process of change also leads to losing possibly valuable elements.* (*Belief Revision*)

- *A different approach is to avoid obtaining inconsistent conclusions by changing the way the inference engine works, keeping the state of KB.* (*Defeasible Reasoning*)

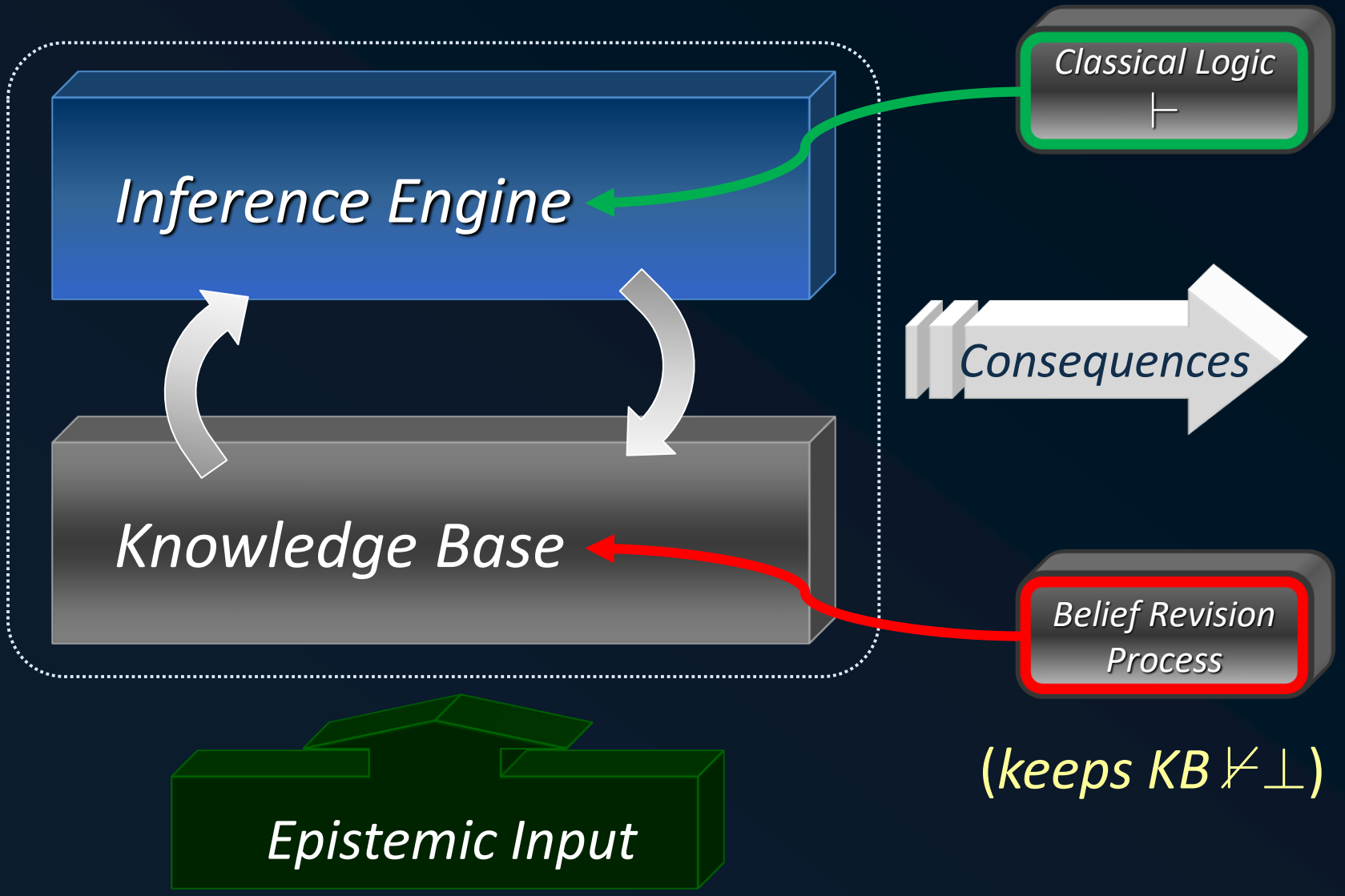
Belief Revision a.k.a. Logic of Theory Change

S.O. Hansson (2001): A Textbook of Belief Dynamics: Theory Change and Database Updating. Kluwer Academic Pub., USA.

P. Peppas (2008): Belief revision. In: van Harmelen, F., Lifschitz, V., Porter, B. (eds.) Handbook of Knowledge Representation, Chap. 8, pp. 317–359. Elsevier.

E. L. Fermé, S. O. Hansson (2018): Belief Change - Introduction and Overview. Springer Briefs in Intelligent Systems, Springer.

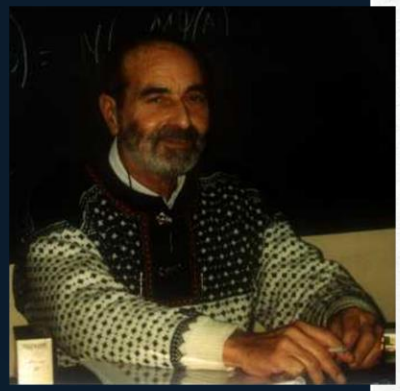
KBS = Knowledge Base + Inference Engine

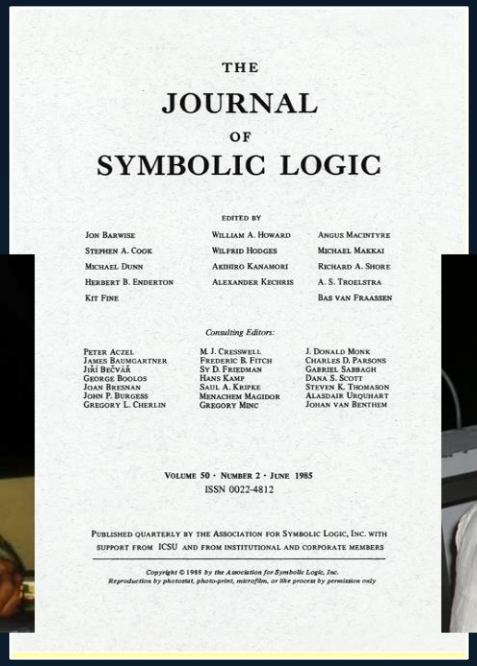


Logic of Theory Change

The foundational publication of the area is referred to as AGM for the initials of the authors' family names:

C. E. Alchourrón, P. Gärdenfors, and D. Makinson (1985): *On the logic of theory change: Partial meet contraction and revision functions. The Journal of Symbolic Logic* 50, 510-530.

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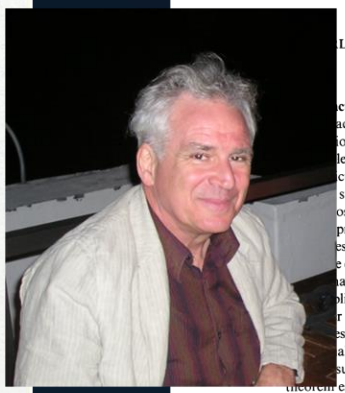

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ON THE LOGIC OF THEORY CHANGE:
PARTIAL MEET CONTRACTION AND REVISION FUNCTIONS

LOS E. ALCHOURRÓN, PETER GÄRDENFORS AND DAVID MAKI

ct. This paper extends earlier work by its authors on formal aspects of th
acting a theory to eliminate a proposition and revising a theory to
on. In the course of the earlier work, Gärdenfors developed general pos
less equational nature for such processes, whilst Alchourrón and Makin
cular case of contraction functions that are maximal, in the sense o
subset of the theory (or alternatively, of one of its axiomatic bases), that f
osition being eliminated.
present paper, the authors study a broader class, including contraction fu
ess than maximal. Specifically, they investigate "partial meet contraction
e defined to yield the intersection of some nonempty family of maximal su
at fail to imply the proposition being eliminated. Basic properties of the
blished: it is shown in particular that they satisfy the Gärdenfors pos
r that they are sufficiently general to provide a representation theore
es. Some special classes of partial meet contraction functions, notably th
al" and "transitively relational", are studied in detail, and their conne
supplementary postulates" of Gärdenfors investigated, with a further re
theorem established.

Argumentation

C. Chesñevar, A. Maguitman, R. Loui. Logical Models of Argument. ACM Computing Surveys, 32(4):337-383, (2000).

H. Prakken, G. Vreeswijk. Logical Systems for Defeasible Argumentation, in D. Gabbay (Ed.), Handbook of Philosophical Logic, 2nd Edition, (2002).

Bench-Capon, T.J.M., Dunne, P.E.: Special Issue on Argumentation in Artificial Argumentation in Artificial Intelligence. Artificial Intelligence 171(10-15), 619–641 (2007)

Besnard, P., Hunter, A.: Elements of Argumentation. MIT Press (2008)

Rahwan, I., Simari, G.R.: Argumentation in Artificial Intelligence. Springer (2009)

K. Atkinson, P. Baroni, M. Giacomin, A. Hunter, H. Prakken, C. Reed, G. R. Simari, M. Thimm, S. Villata: Towards Artificial Argumentation. AI Magazine 38(3): 25-36 (2017)

P. Baroni. D. Gabbay, L. van der Torre: Handbook of Formal Argumentation (HOFA), Volume 1 (of 5). College Publications, 2018

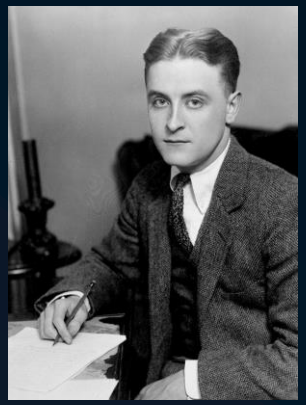
D. Gabbay, M. Giacomin, G.R.Simari, M. Thimm: Handbook of Formal Argumentation (HOFA), Volume 2 (of 5). College Publications, 2021 (forthcoming).

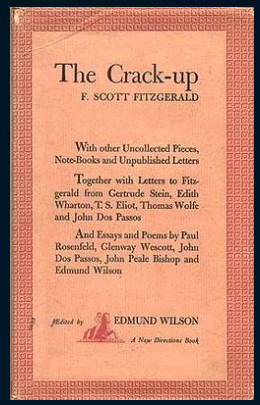
What Argumentation brings to the table?

The test of a first-rate intelligence is the ability to hold two opposed ideas in the mind at the same time, and still retain the ability to function.

- F. Scott Fitzgerald,

"The Crack-Up" (1936)





Paraphrasing:

The test of a useful knowledge base is the ability to store two contradictory sentences and still retain the ability to provide valuable inferences.

Argumentation as a decision process

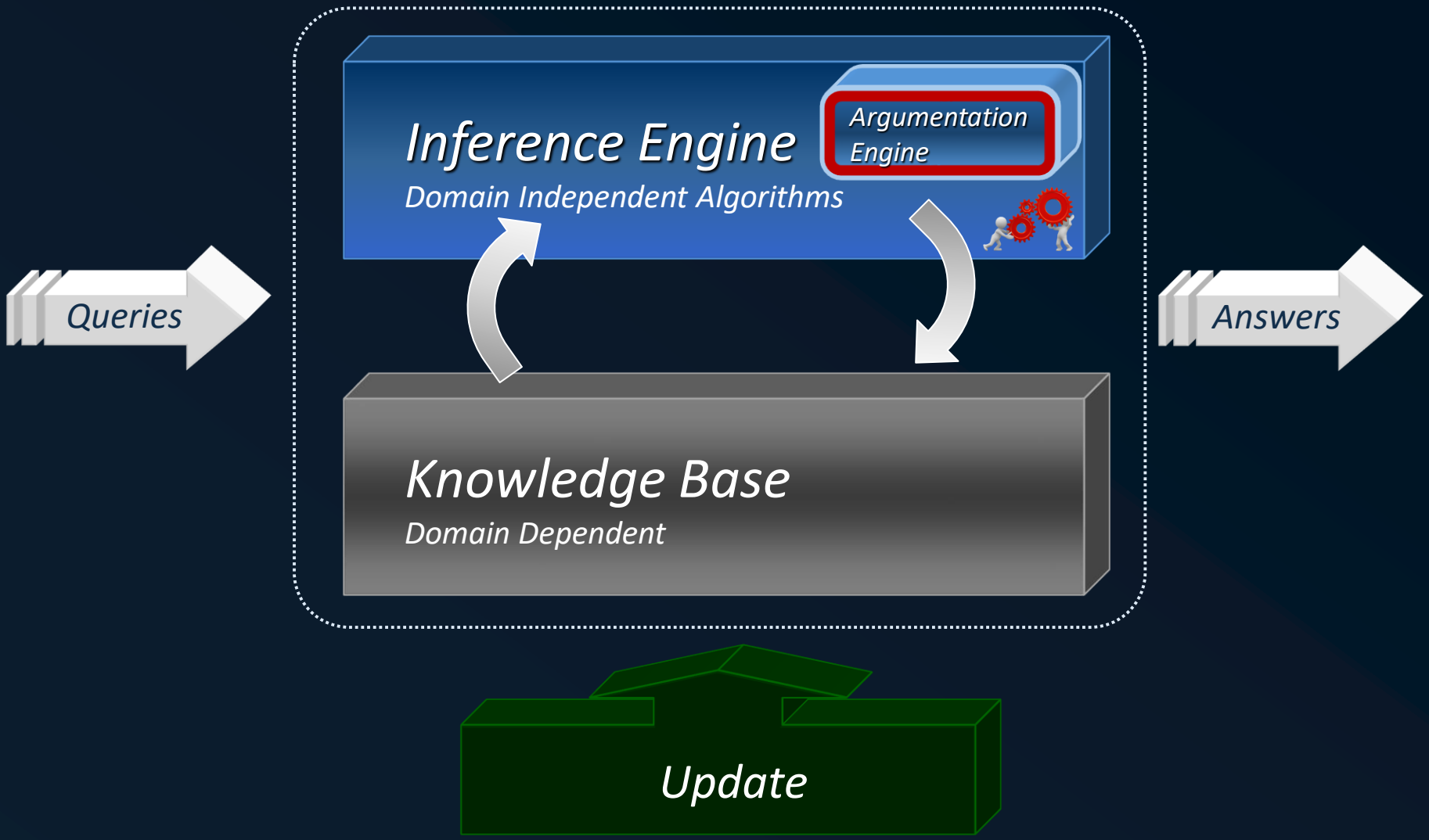
Argumentation is the "human", natural way of rationally handling conflicting information to establish beliefs:

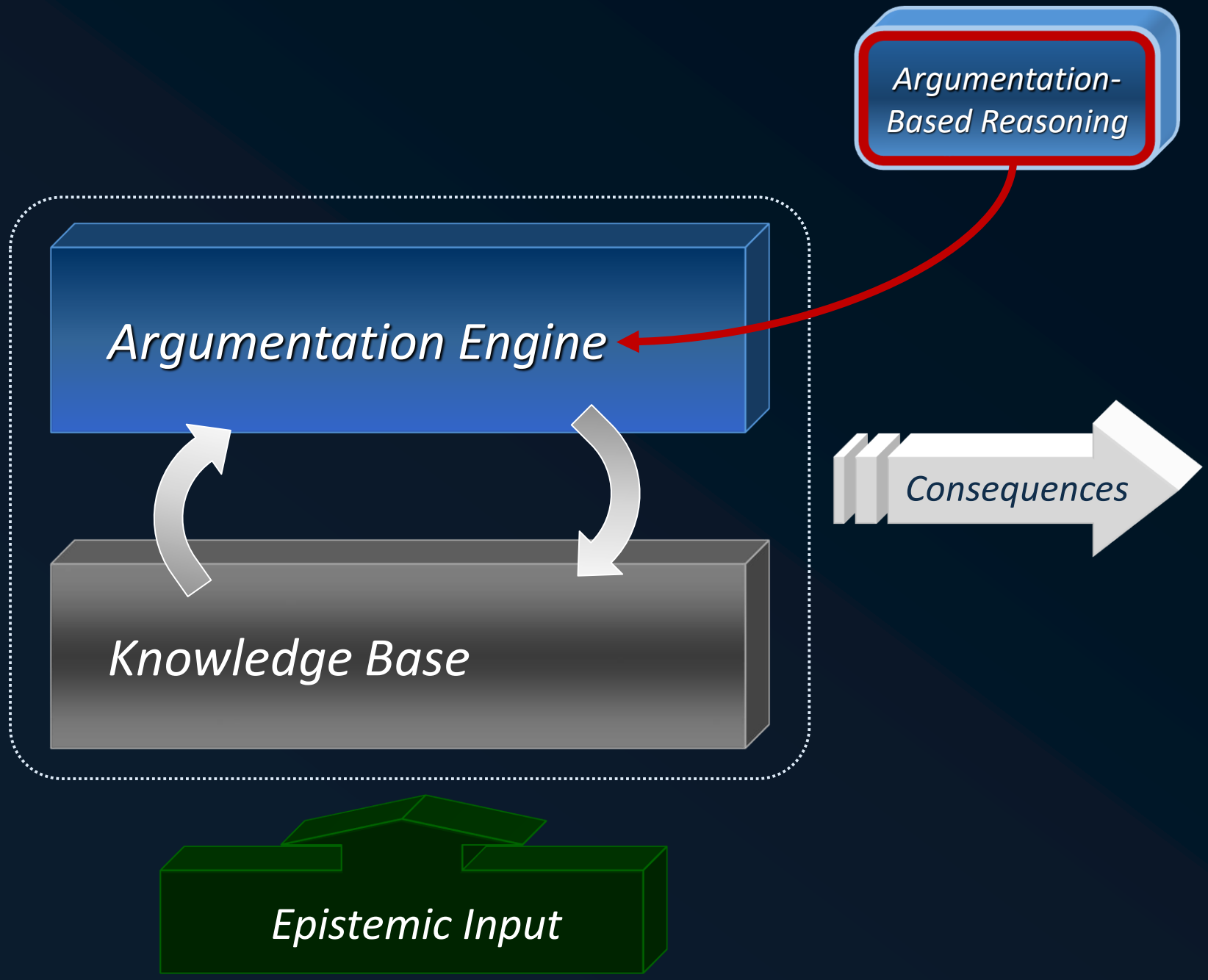
- *When arguing, we seek arguments in favor (or pro) and arguments against (or con) the point of conflict.*
- *Pro arguments aim at promoting the issue, while Con arguments suggest points against it.*

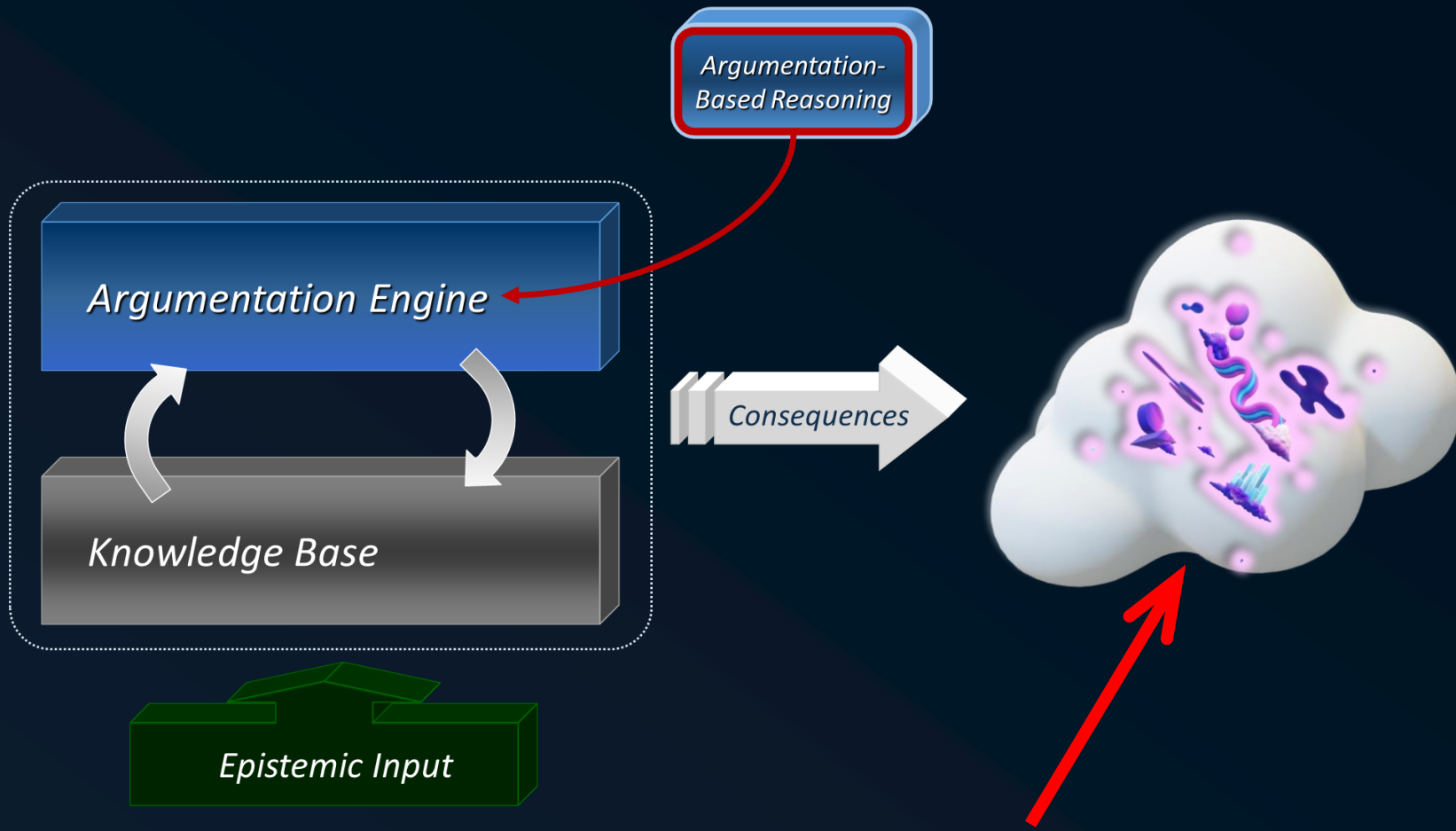
Argumentation as a decision process

- *After considering the argument and finding the pros and cons related to it, is necessary to compare them to answer the question: which one is better?*
- *The decision might depend on who is considering the pros and cons: sometimes the analysis is internal to the reasoner, sometimes it involves an external audience.*

KBS = Knowledge Base + Inference Engine




Argumentation-Based Reasoning
Argumentation Engine
Knowledge Base
Consequences
Epistemic Input



<u>Common assumptions</u>:
If the Knowledge Base contains a classical subset, that part should be consistent and the inference engine should be <u>superclassical</u>.

The set of conclusions must be classically consistent, i.e. soundness is required, *and any sentence considered as a fact must be inferred. Also, completeness is desirable.*

Argumentation

- *Argumentation is reason-giving, that is, when people speak to one another, or with an audience in mind, claims are made in the form of statements they believe, and they would like for their listeners to accept as well.*
- *Therefore, a claim is a statement that we assert as our belief, and we want our interlocutor to share that belief.*
- *These claims are about matters that are uncertain, that cannot be established absolutely or definitely.*

Argumentation

- *Given a particular claim, justifications are reasons supporting this claim; they are not absolute proofs for they are inherently uncertain.*
- *Thus, claims depend on external judgment; from that point of view, argumentation can be considered as the practice of justifying claims.*
- *A substantial part of human rationality is based on the ability to engage in connecting the claims we make to their justifications.*

Argumentation

- *An essential aspect of argumentation is that it is a form of effective reasoning.*
- *This effectiveness is measured in relation to an audience because the success of an argument depends upon the assent the audience gives.*
- *Therefore, adherence to the claim is obtained based on the reasons given for it and the connection made between those reasons and the claim.*

Argumentation as a Process

In brief:

Argumentation is the practice of giving reasons to justify claims seeking the adherence of an audience.

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These action words point to the fact that argumentation is a process.

Argumentation as Debate

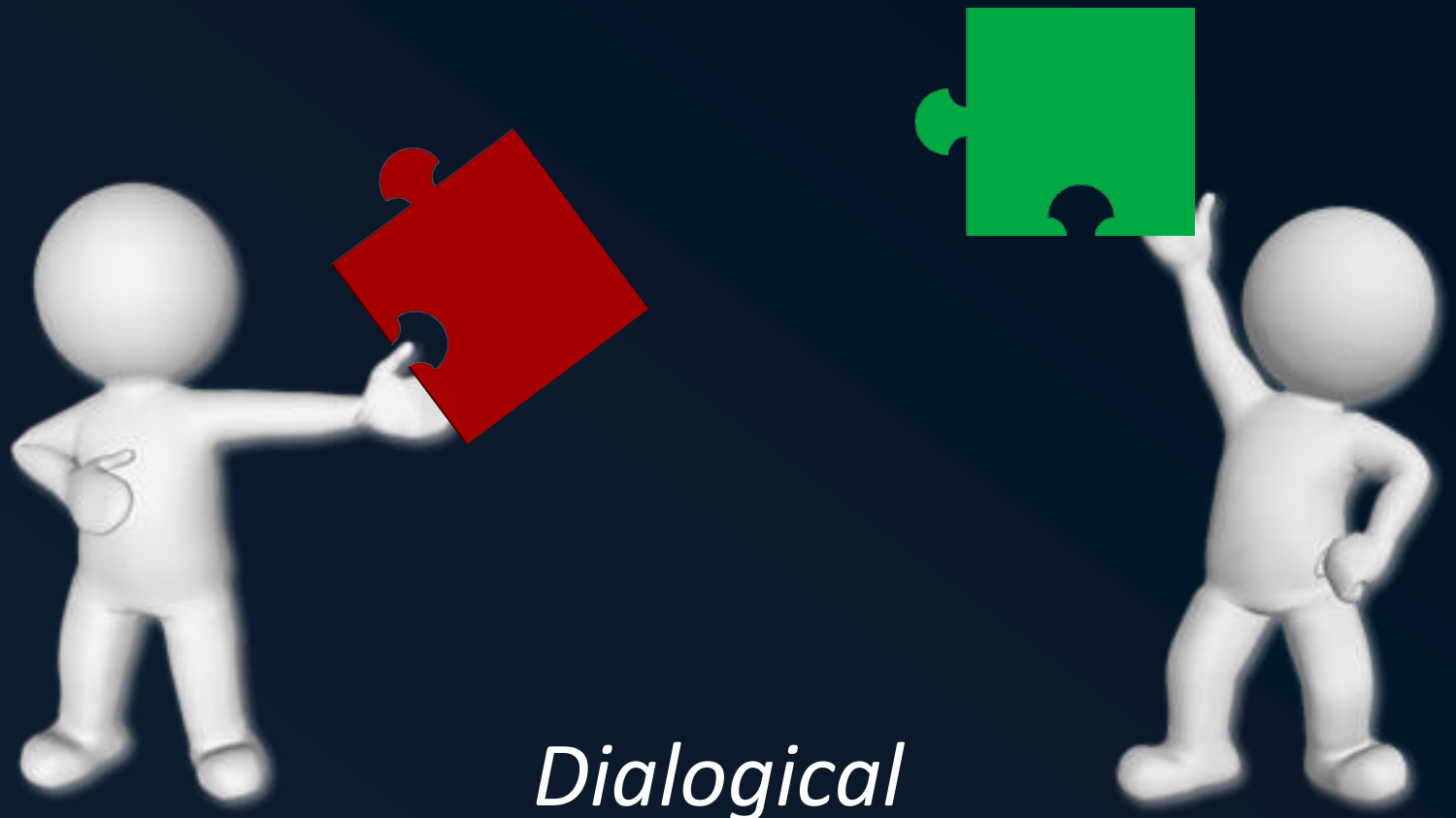
- *Another aspect that is worthwhile to remark is that the persuasion sought after when introducing a claim and the reasons that support it, is reached through a controversial process.*

- *Argumentation is Debate, therefore it is a form of reasoning that closely follows the model of a formal disputation that seeks to find the best reason to support a possible conclusion.*

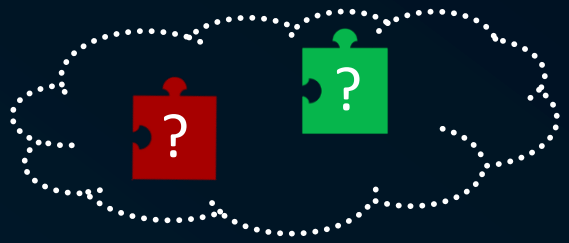
Arguments

- *Informally, an argument is a coherent set of statements leading from a premise to a conclusion.*
- *More precisely, an argument is a set of statements in which a claim is made and support is offered for that claim attempting to influence someone in a context of disagreement.*
- *Usually, the parts of an argument are called Claim, Evidence, and Reasoning.*

Dispute(s)



Dialogical Dispute



Judge, Audience, Arbiter (determiner)

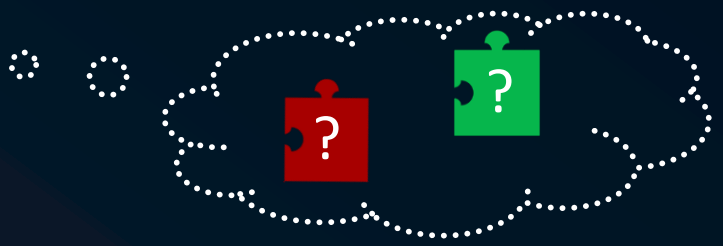
Presides the dispute as the one capable of deciding and controls the evolution of the dispute

Introduces the initial thesis

Dialogical Dispute

Opponent

Proponent



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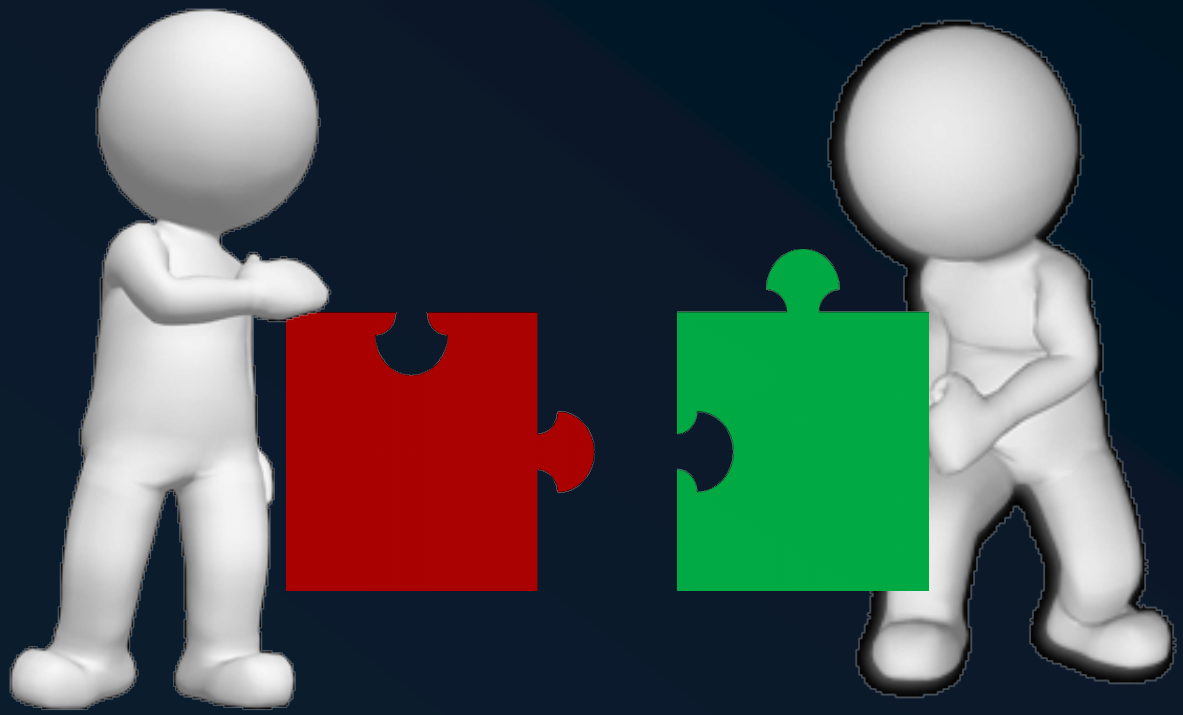
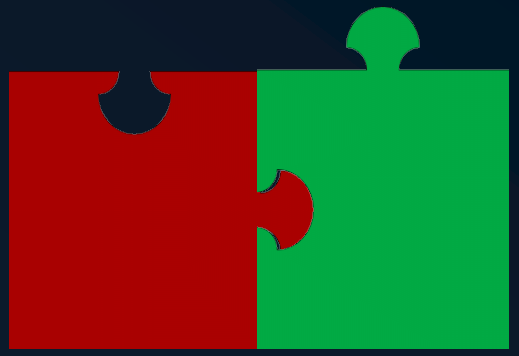
Dispute Resolution



Dispute Resolution



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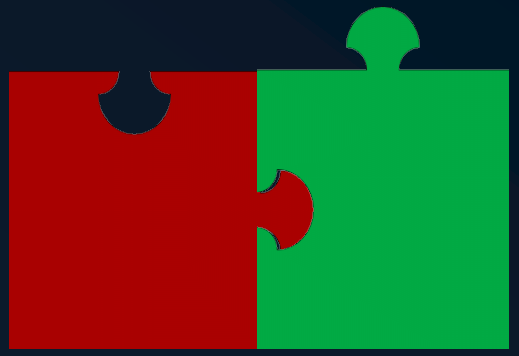
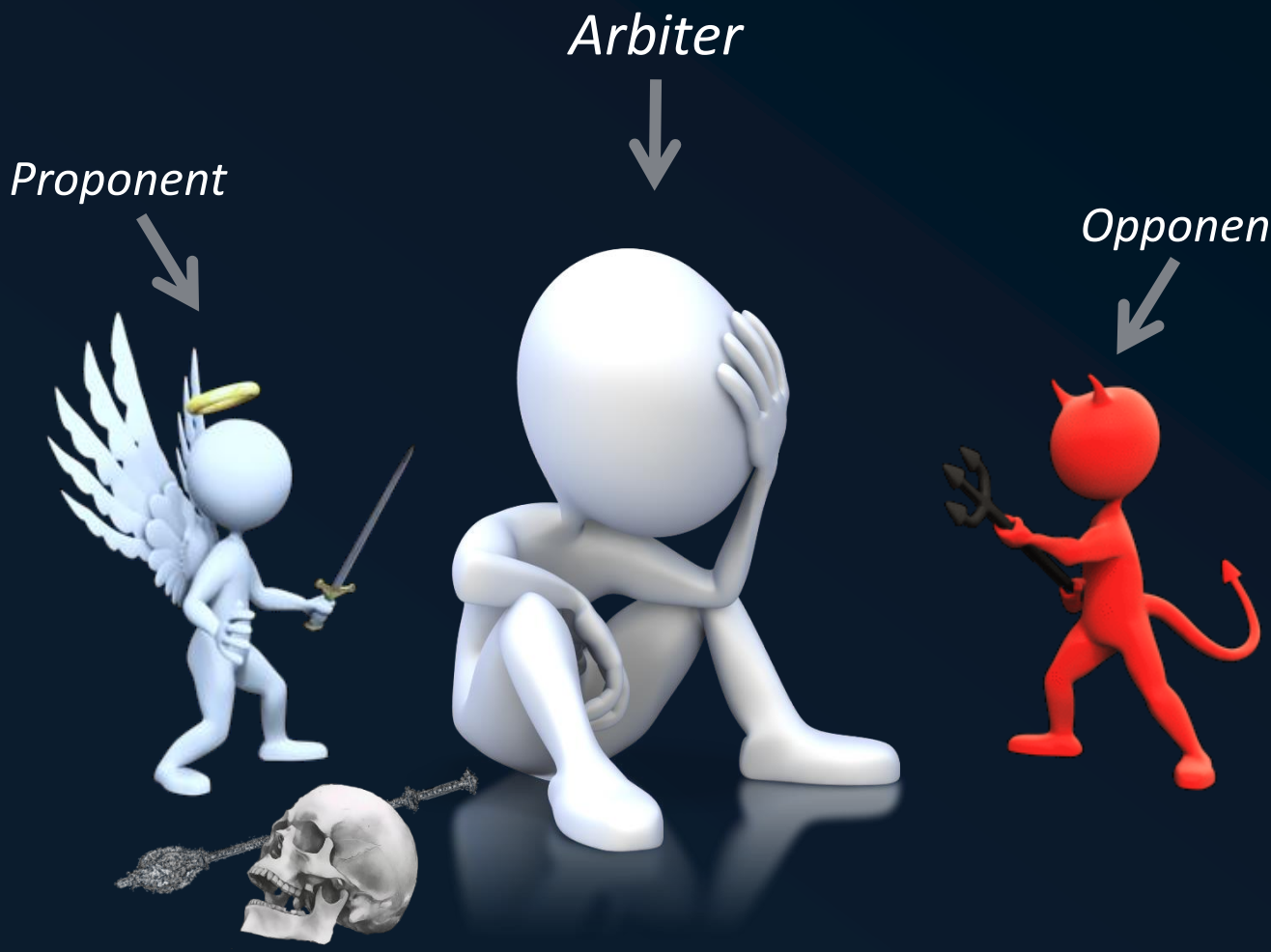


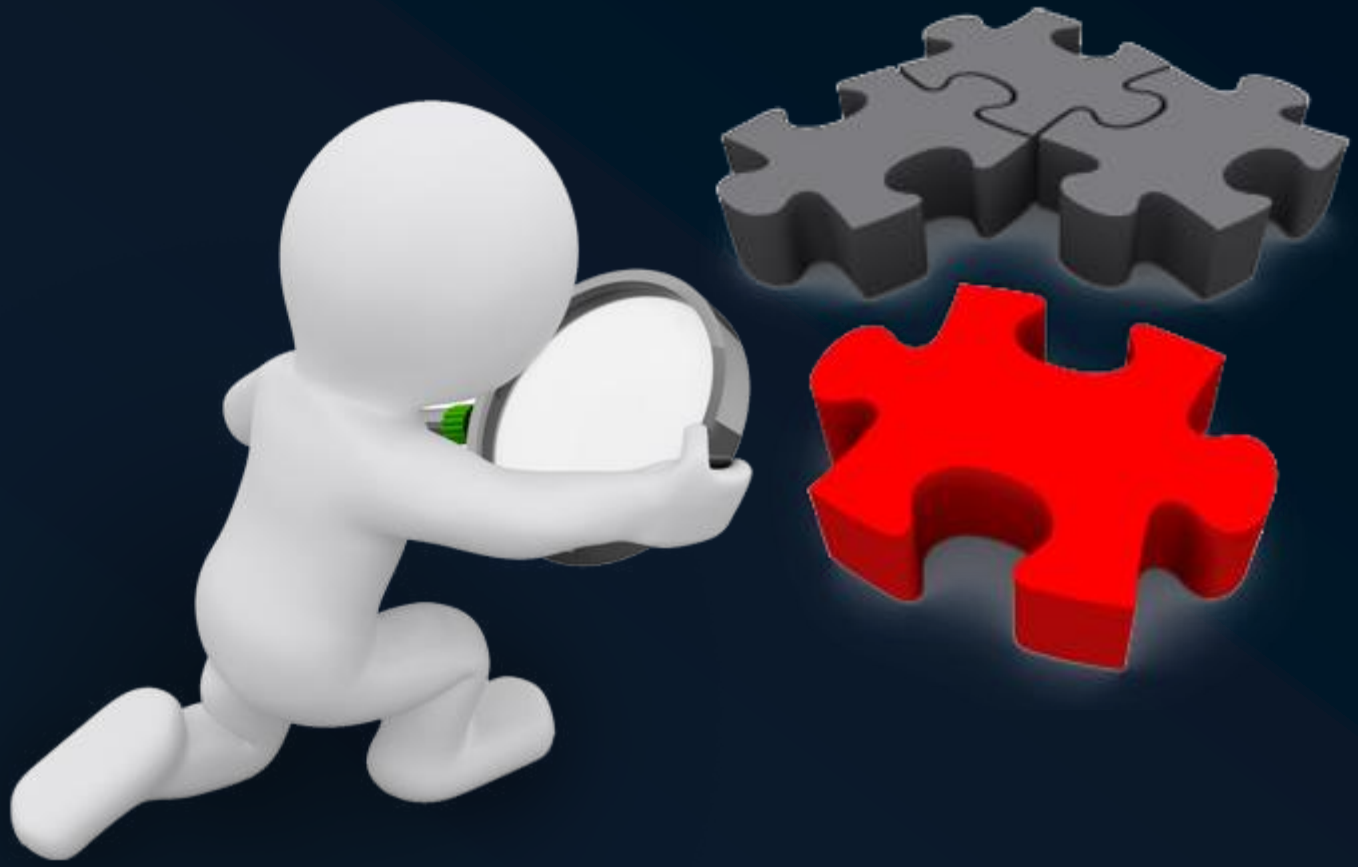
Monological Dispute

The agent itself introduces the initial thesis, plays the opponent's role, and is also the judge.



Dispute Resolution

Dispute Resolution



Dispute Resolution

Dispute Resolution

Example

From "A Practical Study of Argument", Trudy Govier, 6th Edition, Wadsworth, 2005.

"Marijuana should not be legalized. That's because sustained use of marijuana worsens a person's memory, and nothing that adversely affects one's mental abilities should be legalized."

Example

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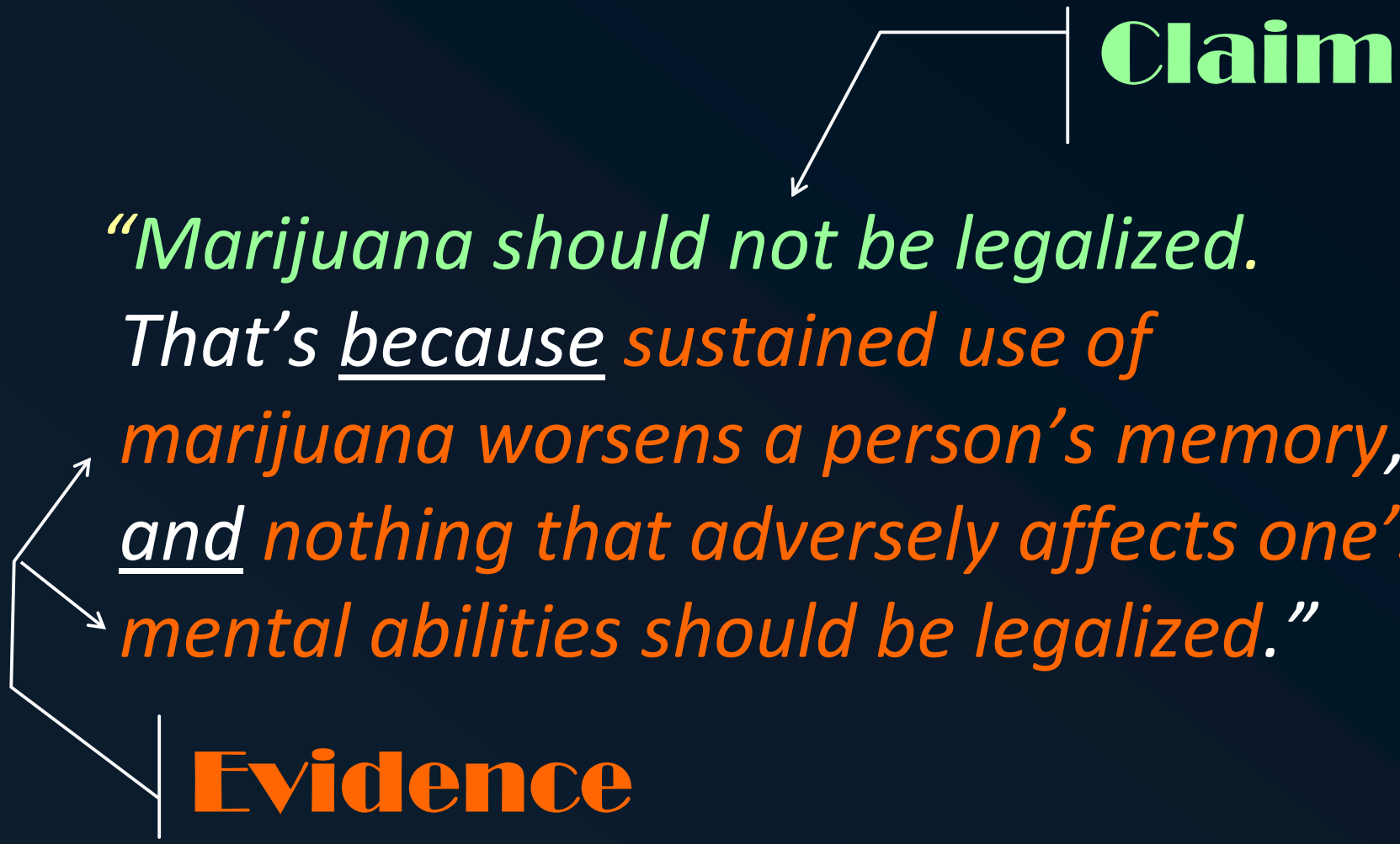
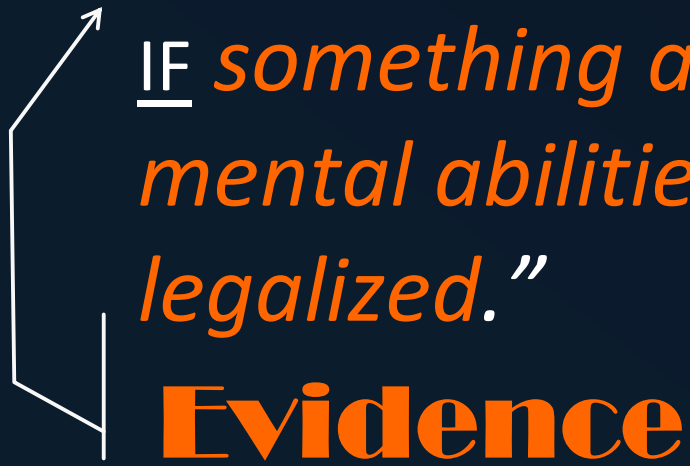


Example

From "A practical Study of Argument", Trudy Govier, 6th Edition, Wadsworth, 2005.

"Marijuana should not be legalized. That's because sustained use of marijuana worsens a person's memory, AND IF *something adversely affects one's mental abilities* THEN *it shouldn't be legalized."*



Example

From "A practical Study of Argument", Trudy Govier, 6th Edition, Wadsworth, 2005.

Claim

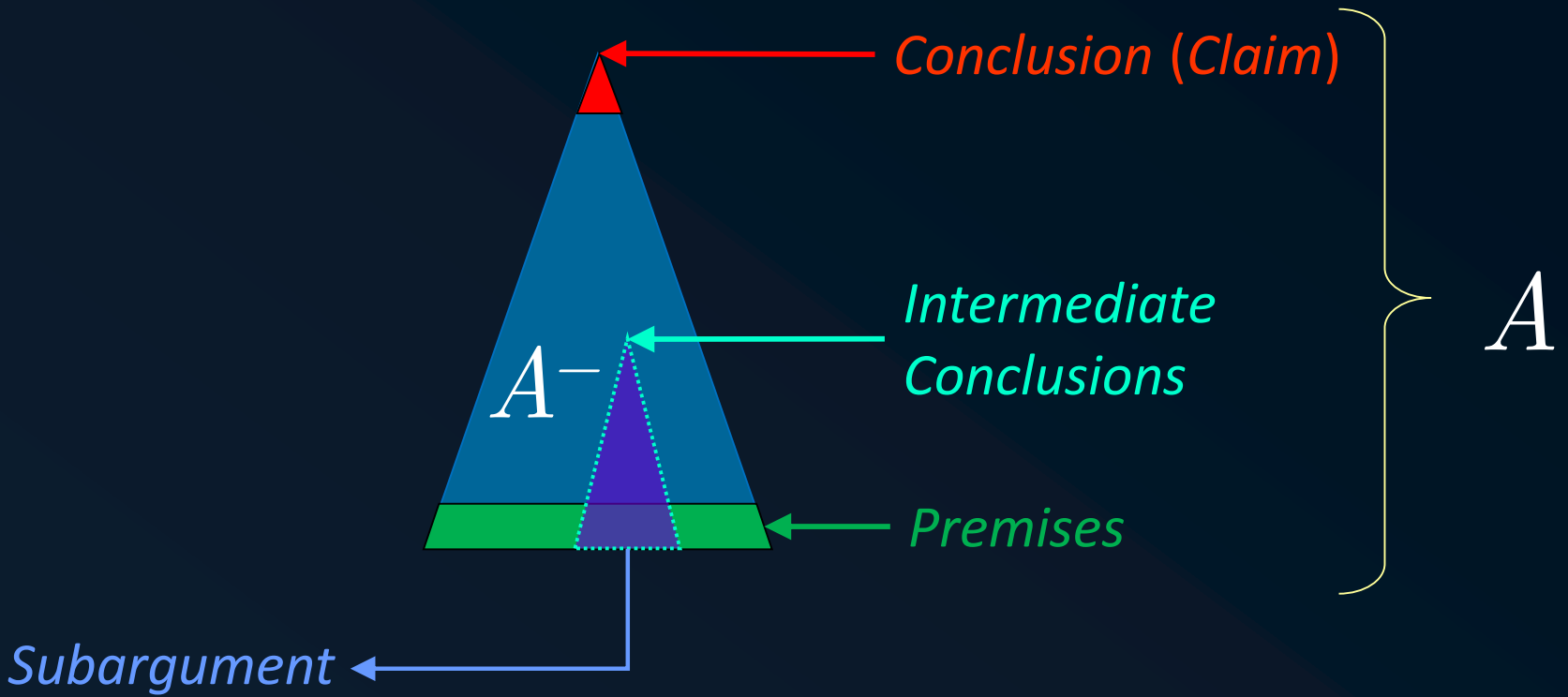
"*Marijuana should not be legalized.*
That's because sustained use of marijuana worsens a person's memory, AND
IF *something adversely affects one's mental abilities* THEN *it shouldn't be legalized.*"

Evidence

Reasoning:

Defeasible Detachment

Argument Structure



Given an argument A, an argument that is part of A is called a subargument, sometimes denoted A^-, and an argument such that A is a subargument of it may be denoted A^+ (Clearly, $(A^-)^+ = A$)

Example

"Marijuana should not be legally available.
IF *a controlled substance is not legalized*
THEN *it should not be legally available.*

Marijuana should not be legalized.
That's because sustained use of marijuana worsens a person's memory, AND
IF *something adversely affects one's mental abilities* THEN *it shouldn't be legalized."*

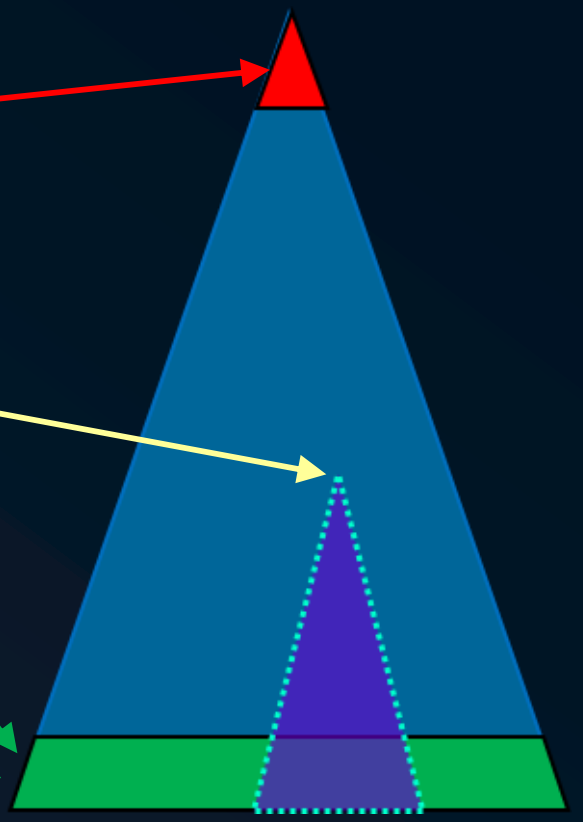
Example

A

"Marijuana should not be legally available
IF *a controlled substance is not legalized*
THEN *it should not be legally available.*

Marijuana should not be legalized.
That's because sustained use of marijuana worsens a person's memory, AND
IF *something adversely affects one's mental abilities* THEN *it shouldn't be legalized."*

A^-



The Process of Argumentation

As examples of argumentation we will look at two types of systems.

- *First, we will describe abstract argumentation where arguments are handled without analyzing how they are built.*
- *Second, we will consider two systems that actually build arguments and decide if there exists a prevailing argument for a given claim.*

Before starting with the formal development we will look at a simple, but rich, model.

Thank you!

Questions?