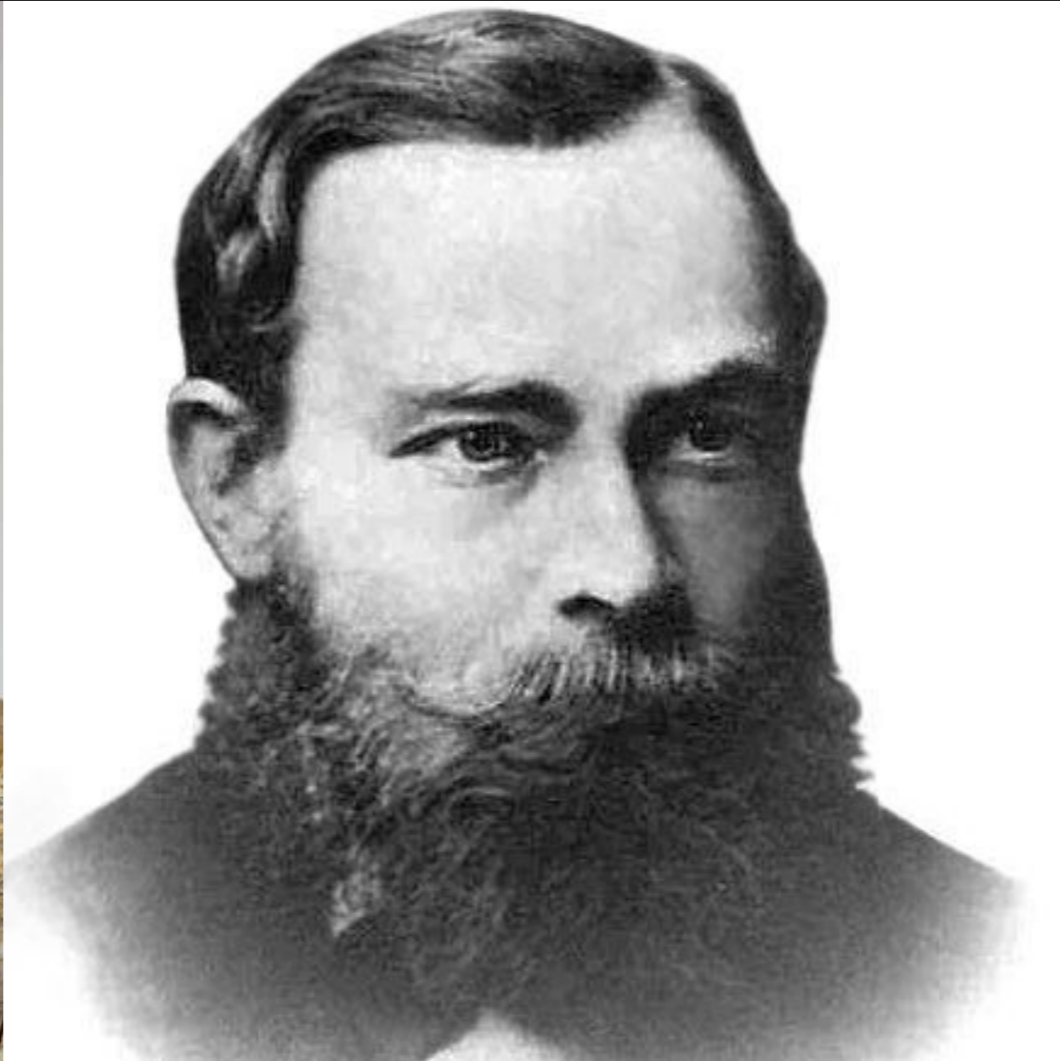




Aristotle



Gottlob Frege



Kurt Goedel

PHIL 50 - Introduction to Logic

Marcello Di Bello, Stanford University, Spring 2014

Week 1 — Monday Class

* SYSTÈME FIGURÉ DES CONNOISSANCES HUMAINES.

ENTENDEMENT.

HISTOIRE

MEMOIRE.

SACRÉE. (HISTOIRE DES PROPHEITIES.
ECCLESIASTIQUE.

CIVILE, } HIST. CIVILE, *proprement dite.* } MEMOIRES.
ANC. } } ANTIQUITÉS.
ET MO- } HISTOIRE LITTERAIRE. } HISTOIRE COMPLETE.
DERNE. }

UNIFORMITÉ DE LA NATURE. } HISTOIRE CELESTE. }
DES METEORES.
DE LA TERRE ET DE LA MER.
DES MINERAUX.
DES VEGETAUX.
DES ANIMAUX.
DES ELEMENS.

ECARTS DE LA NATURE. } PRODIGES CELESTES.
METEORES PRODIGIEUX.
PRODIGES SUR LA TERRE ET LA MER.
MINERAUX MONSTRUEUX.
VEGETAUX MONSTRUEUX.
ANIMAUX MONSTRUEUX.
PRODIGES DES ELEMENS.

NATURELLE.

TRAVAIL ET USAGES DE L'OR ET DE L'ARGENT. } MONNOYEUR.
BATEUR D'OR.
FILEUR D'OR.
TIREUR D'OR.
ORFÈVRE.
PLANEUR.
METTEUR EN ŒUVRE, &c.

TRAVAIL ET USAGES DES PIERRES FINES ET PRÉCIEUSES. } LAPIDAIRE.
DIAMENTAIRE.
JOAILLIER, &c.

TRAVAIL ET USAGES DU FER. } SERRURERIE.
TAILLANDERIE.
ARMURERIE.
ARQUEBUSERIE, &c.

VERRERIES.

RAISON.

MÉTAPHYSIQUE GÉNÉRALE, ou ONTOLOGIE, ou SCIENCE DE L'ÊTRE EN GÉNÉRAL, DE LA POSSIBILITÉ, DE L'EXISTENCE, DE LA DURÉE, &c.

SCIENCE DE DIEU. } THÉOLOGIE NATURELLE. } RELIGION,
D'ou par abus,
THÉOLOGIE RÉVÉLÉE. } SUPERSTITIONS.
SCIENCE DES ESPRITS } DIVINATION.
BIEN ET MAL FAISANS. } MAGIE NOIRE.

PNEUMATOLOGIE ou SCIENCE DE L'ÂME } RAISONNABLE.
SENSITIVE.

SCIENCE DE L'HOMME. } LOGIQUE. }
ART DE PENSER. } APPREHENSION. } SCIENCE DES IDÉES.
JUGEMENT. } SCIENCE DES PROPOSITIONS.
RAISONNEMENT. } INDUCTION.
ET MÉTHODE. } DÉMONSTRATION. } ANALYSE.
SYNTHÈSE.
ART DE RETENIR. } MÉMOIRE. } NATURELLE } ARTIFICIELLE. } PRÉNOTION.
EMBLEME.
SUPPLÉMENT DE LA MÉMOIRE. } ÉCRITURE. } ALPHABETH.
IMPRIMERIE } CHIFFRES. } ARTS D'ÉCRIRE,
D'IMPRIMER, DE LIRE, DE DÉCHIFFRER. } ORTHOGRAPHE.
ART DE COMMUNIQUER. } SCIENCE DE L'INSTRUMENT DU DISCOURS. } GRAMMAIRE } PROSODIE.
CONSTRUCTION.
SYNTAXE.
PHILOGOLOGIE.
CRITIQUE. } PEDAGOGIQUE. } CHOIX DES ÉTUDES.
MANIÈRE D'ENSEIGNER.
SCIENCE DES QUALITÉS DU DISCOURS. } RHÉTORIQUE.
MÉCANIQUE DE LA POÉSIE ou VERSIFICATION.

MORALE } GÉNÉRALE } SCIENCE DU BIEN ET DU MAL EN GÉNÉRAL. DES DEVOIRS EN GÉNÉRAL.
DE LA VERTU. DE LA NÉCESSITÉ D'ÊTRE VERTUEUX, &c.

MORALE } PARTICULIÈRE. } SCIENCE DES LOIX, ou JURISPRUDENCE } NATURELLE.
ÉCONOMIQUE. } COMMERCE INTÉRIEUR, EXTERIEUR,
POLITIQUE. } DE TERRE, DE MER.

MÉTAPHYSIQUE DES CORPS, ou PHYSIQUE GÉNÉRALE. DE L'ÉTENDUE, DE L'IMPÉNÉTRABILITÉ, DU MOUVEMENT, DU VUIDE, &c.

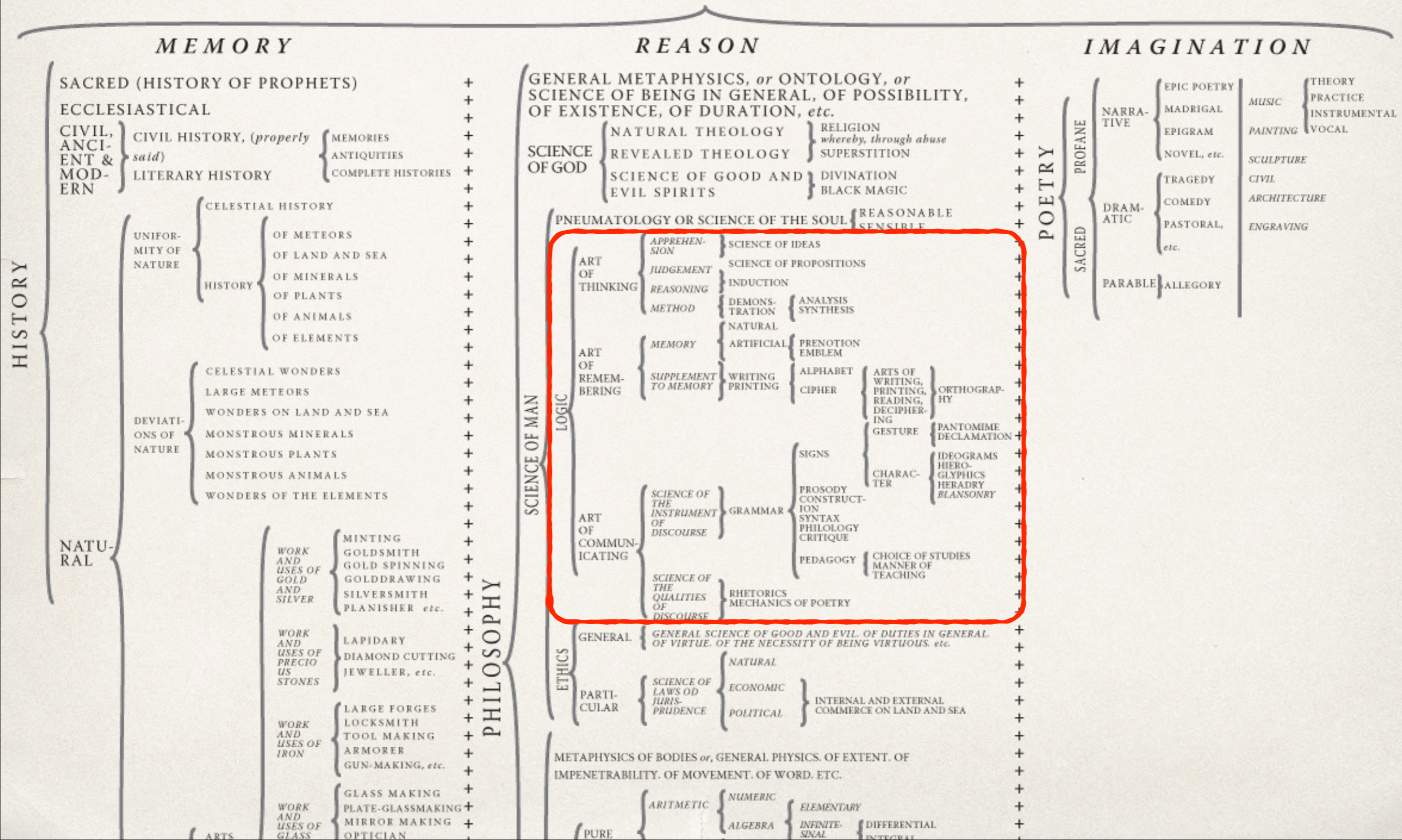
NUMÉRIQUE

IMAGINATION.

POÉSIE } SACRÉE. } NARRATIVE. } POÈME EPIQUE.
MADRIGAL.
EPIGRAMME
ROMAN, &c. } MUSIQUE. } THEORIQUE.
INSTRUMENTALE.
VOCALLE.
PEINTURE.
SCULPTURE.
ARCHITECTURE CIVILE.
GRAVURE.
SACRÉE. } DRAMATIQUE. } TRAGÉDIE.
COMÉDIE.
OPERA.
PASTORALES, &c.
PARABOLIQUE. } ALLEGORIES.

MAP of the SYSTEM of HUMAN KNOWLEDGE

UNDERSTANDING



REASON

GENERAL METAPHYSICS, or ONTOLOGY, or SCIENCE OF BEING IN GENERAL, OF POSSIBILITY, OF EXISTENCE, OF DURATION, etc.

SCIENCE OF GOD

- NATURAL THEOLOGY
 - RELIGION
 - whereby, through abuse
- REVEALED THEOLOGY
 - SUPERSTITION
- SCIENCE OF GOOD AND EVIL SPIRITS
 - DIVINATION
 - BLACK MAGIC

PNEUMATOLOGY OR SCIENCE OF THE SOUL

- REASONABLE
- SENSIBLE

SCIENCE OF MAN

- LOGIC
 - ART OF THINKING
 - APPREHENSION
 - JUDGEMENT
 - REASONING
 - METHOD
 - ART OF REMEMBERING
 - MEMORY
 - SUPPLEMENT TO MEMORY
 - ART OF COMMUNICATING
 - SCIENCE OF THE INSTRUMENT OF DISCOURSE
 - GRAMMAR
 - PROSODY
 - CONSTRUCTION
 - SYNTAX
 - PHILOLOGY
 - CRITIQUE
 - PEDAGOGY
 - CHOICE OF STUDIES
 - MANNER OF TEACHING
 - SCIENCE OF THE QUALITIES OF DISCOURSE
 - RHETORICS
 - MECHANICS OF POETRY

ETHICS

- GENERAL
 - GENERAL SCIENCE OF GOOD AND EVIL. OF DUTIES IN GENERAL. OF VIRTUE. OF THE NECESSITY OF BEING VIRTUOUS, etc.
- PARTICULAR
 - SCIENCE OF LAWS OR JURISPRUDENCE
 - NATURAL
 - ECONOMIC
 - POLITICAL

INTERNAL AND EXTERNAL COMMERCE ON LAND AND SEA

METAPHYSICS OF BODIES or, GENERAL PHYSICS. OF EXTENT. OF IMPENETRABILITY. OF MOVEMENT. OF WORD. ETC.

PURE

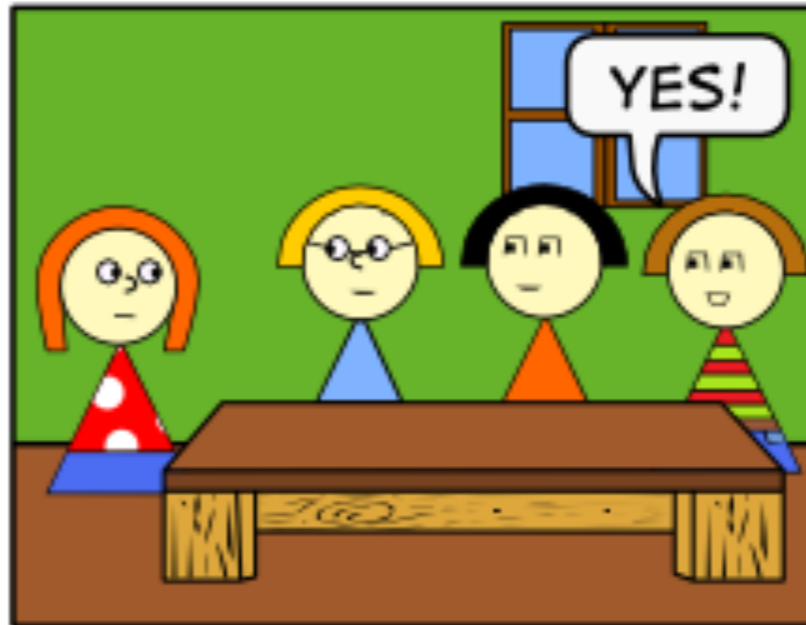
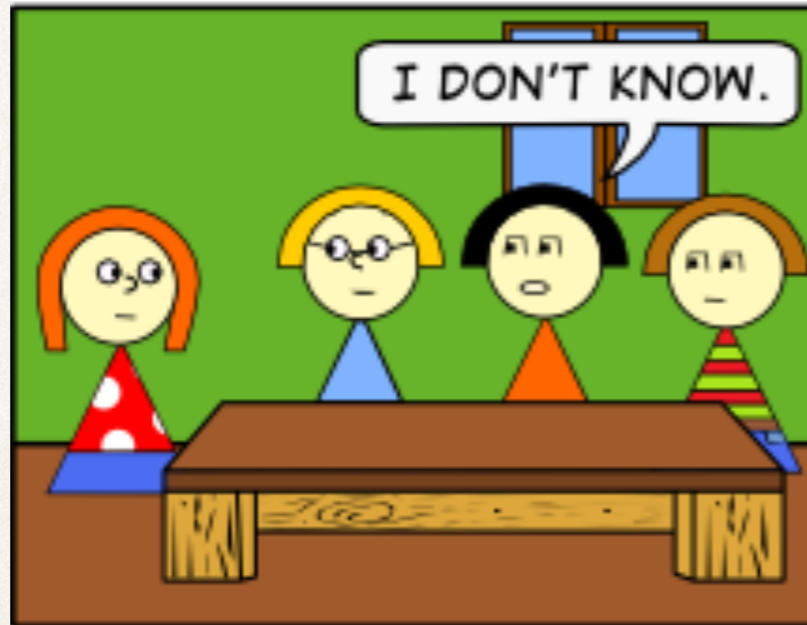
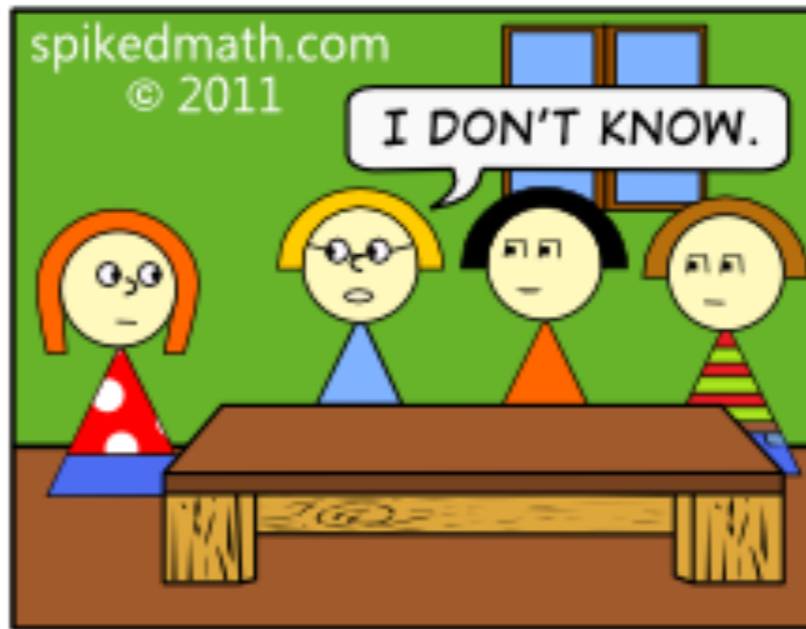
- ARITHMETIC
 - NUMERIC
 - ALGEBRA
 - ELEMENTARY
 - INFINITE-SERIAL
 - DIFFERENTIAL
 - INTEGRAL

IMAGINATION

POETRY

- PROFANE
 - NARRATIVE
 - EPIC POETRY
 - MADRIGAL
 - EPIGRAM
 - NOVEL, etc.
 - DRAMATIC
 - TRAGEDY
 - COMEDY
 - PASTORAL, etc.
 - PARABLE
 - ALLEGORY
- SACRED
 - MUSIC
 - THEORY
 - PRACTICE
 - INSTRUMENTAL
 - VOCAL
 - PAINTING
 - SCULPTURE
 - CIVIL
 - ARCHITECTURE
 - ENGRAVING

THREE LOGICIANS WALK INTO A BAR...



What Should the Waiter Conclude?

The Waiter's Reasoning

- ❖ The question was “Does everyone want beer?”
- ❖ If the first guest did not want beer, he would have answered “No”.
- ❖ If the second guest did not want beer, he would have answered “No.”
- ❖ The third guest answered “Yes”, **so everybody must want beer.**

What to Expect from this Course

Learn about
**propositional,
predicate, modal,
and inductive logic**

Learn how to write
formal proofs, both
semantic and
syntactic proofs

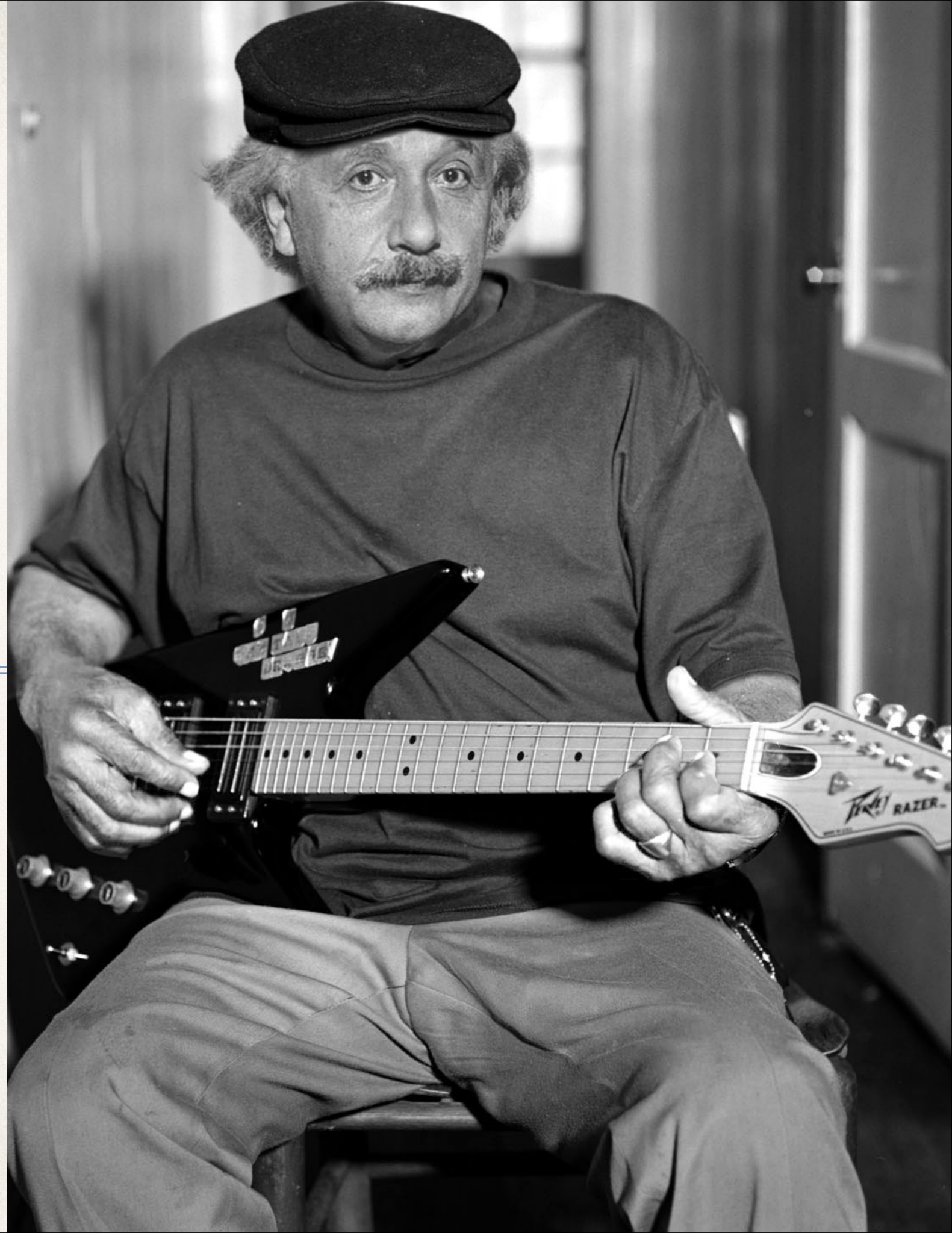
Learn some **history**
and **philosophy of**
logic along the way

Learn about
logical puzzles and
paradoxes

What's Logic Good for?

“Logic will bring
you from A to B.
Imagination will
bring you
everywhere.”

Albert Einstein



So... What's Logic Good For?

Make things explicit

Identify good reasoning

Making Things Explicit

How Difficult Can it Be to Crack an Egg?

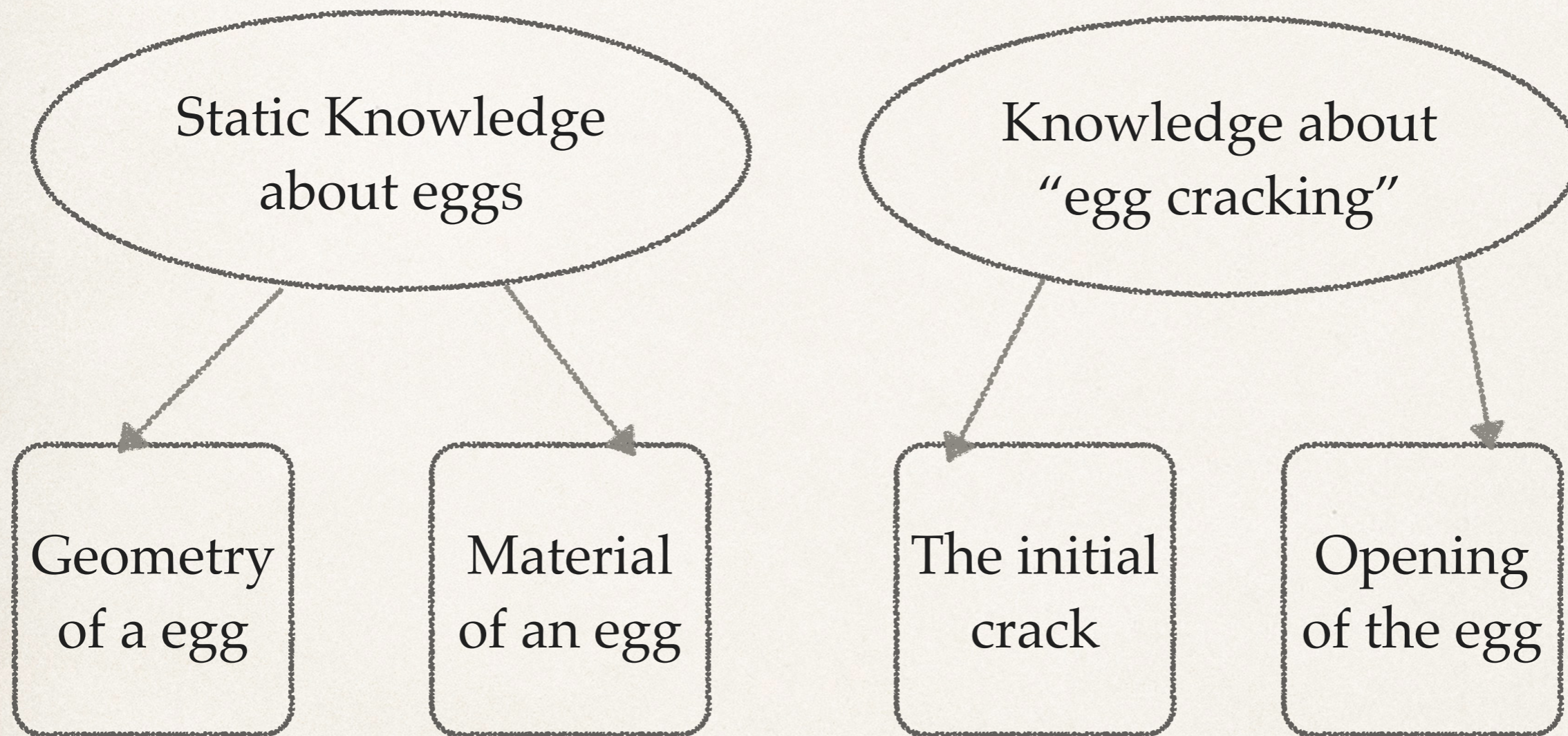


A Standard Problem in Artificial Intelligence

“A cook is cracking a raw egg against a glass bowl. Properly performed, the impact of the egg against the edge of the bowl will crack the eggshell in half. Holding the egg over the bowl, the cook will then separate the two halves of the shell with his fingers, enlarging the crack, and the contents of the egg will fall gently into the bowl. The end result is that the entire contents of the egg will be in the bowl, with the yolk unbroken, and that the two halves of the shell are held in the cook’s fingers.”

Source: <http://www-formal.stanford.edu/leora/commonsense/>

Cracking an Egg Isn't That Easy!



By making this knowledge explicit, we can instruct a computer

Identifying Good Reasoning

Good Reasoning (1)

Premise 1: If you take the medication, then you will get better

Premise 2: You are taking the medication

Conclusion: You will get better

Modus Ponens:

If A, then B

A

B

Good Reasoning (2)

Premise 1: If you take the medication, then you will get better

Premise 2: You are NOT getting better

Conclusion: You are NOT taking the medication

Modus Tollens:

If A, then B

not-B

not-A

**Good reasoning is
reasoning that conforms to a good
reasoning pattern**

Monetarist Politics

Let's assume, given our knowledge of the US economy, that if the money supply were to increase at less than 5%, the rate of inflation would come down. Now, since the money supply is increasing at a rate well above 10%, we must conclude that inflation will not come down.

Is this a good piece of reasoning?

Good Reasoning?

Premise 1: If the money supply increases by less than 5%, inflation will decrease

Premise 2: The money supply does NOT increase by less than 5%

Conclusion: Inflation will NOT decrease

If A, then B

not-A

not-B

This reasoning does **not**
seem to conform to a **good**
reasoning pattern

Which Patterns Are Good? (1)

If A, then B

A

B

If A, then B

not-B

not-A

If A, then B

not-A

not-B

If A, then B

B

A

Good

(Typically
considered)

Bad

Which Patterns Are Good? (2)

If A, then B
If B, then C
If C, then D

A

D

If A, then B
If C, then D
A and C

B and D

If A, then B
If C, then D
not-B and not-D

not-A and not-C

There is an infinite number of good reasoning patterns.

We cannot list them all!

Another Way to Identify Good Reasoning

A Murder Case



- A1 At least one of them is guilty.
- A2 Not all of them are guilty.
- A3 If Mrs White is guilty, then Colonel Mustard helped her (he is guilty too).
- A4 If Miss Scarlet is innocent then so is Colonel Mustard.

Listing All the Possibilities



innocent	innocent	innocent
innocent	innocent	guilty
innocent	guilty	innocent
innocent	guilty	guilty
guilty	innocent	innocent
guilty	innocent	guilty
guilty	guilty	innocent
guilty	guilty	guilty

Ruling Out Possibilities



- A1 At least one of them is guilty.
- A2 Not all of them are guilty.
- A3 If Mrs White is guilty, then Colonel Mustard helped her (he is guilty too).
- A4 If Miss Scarlet is innocent then so is Colonel Mustard.

innocent	innocent	innocent
innocent	innocent	guilty
innocent	guilty	innocent
innocent	guilty	guilty
guilty	innocent	innocent
guilty	innocent	guilty
guilty	guilty	innocent
guilty	guilty	guilty

Good Reasoning

✓ $\frac{A_1, A_2, A_3, A_4}{\text{Miss Scarlet is guilty}}$

In **every** situation in which A_1, A_2, A_3 and A_4 are all true, “**Miss Scarlet is guilty**” is true.

✓ $\frac{A_1, A_2, A_3, A_4}{\text{Mrs White is innocent}}$

In **every** situation in which A_1, A_2, A_3 and A_4 are all true, “**Mrs White is innocent**” is true.

Not So Good

X $\frac{A_1, A_2, A_3, A_4}{\text{Colonel Mustard is guilty}}$

There is a situation in which A_1, A_2, A_3 and A_4 are all true, but “Colonel Mustard is guilty” is false (there is a **counter-example**).

X $\frac{A_1, A_2, A_3, A_4}{\text{Colonel Mustard is innocent}}$

There is a situation in which A_1, A_2, A_3 and A_4 are all true, but “Colonel Mustard is innocent” is false (there is a **counter-example**).

Two Ways to Identify Good Reasoning

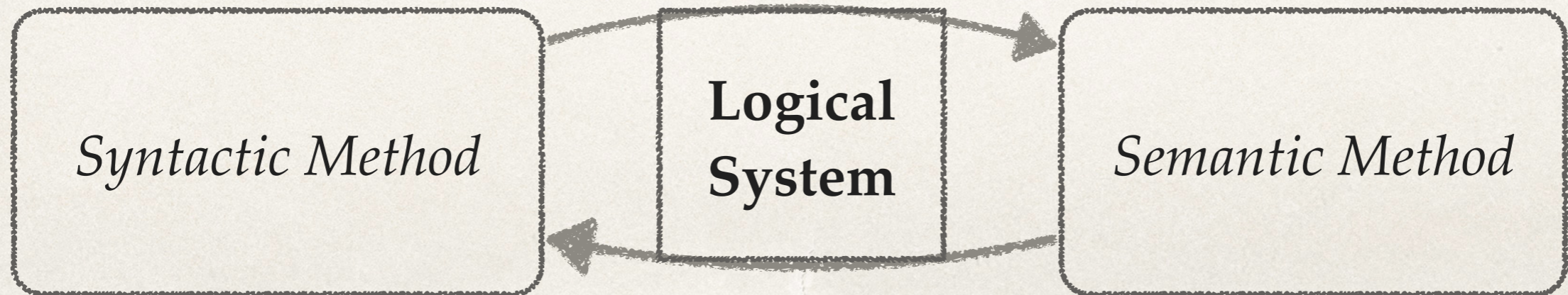
Check whether the proposed reasoning **conforms to a good reasoning pattern.**

List all the possibilities, rule out the possibilities that are excluded by the premises, and check whether **the putative conclusion is true in all the possibilities that are left.**

Syntactic Method

Logical System

Semantic Method



From Lewis Carroll

There is no box of mine here that I dare open. My writing desk is made of rosewood. All my boxes are painted, except those that are here. There is no box of mine I dare not open, unless it is full of live scorpions. All my rosewood boxes are unpainted. Therefore...

Therefore...my desk is full of live scorpions!