*Leibniz*   *Gottlob Frege*   *Jain Ritual Symbol*

PHIL 50 - Introduction to Logic

Marcello Di Bello, Stanford University, Spring 2014

Week 1 — Wednesday Class

Grading, Exam, Office Hours, etc.
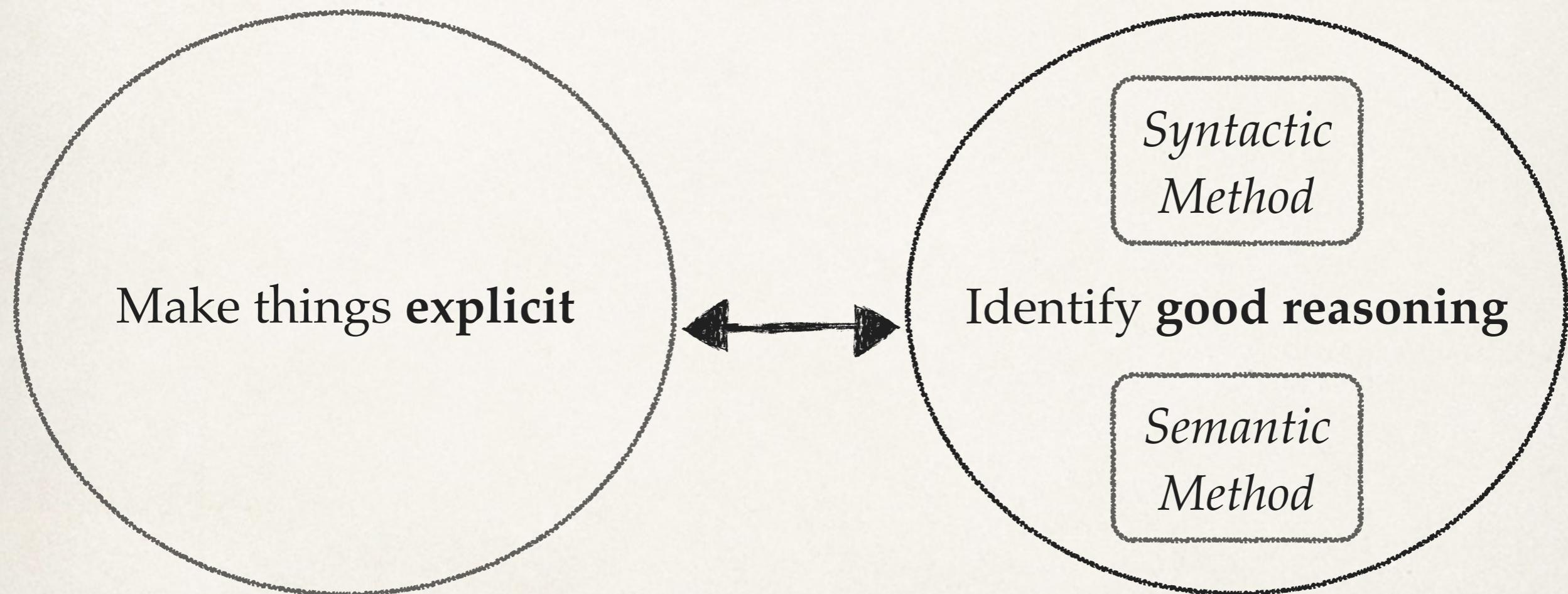
✤ Midterm, final, homework are **graded in percentages**

✤ Weekly homework **due every Monday**

✤ Midterm exam date: Friday **April 25th**

✤ Final exam date: Friday **June 6th**

✤ Office hours: **Wednesday 1:30-3pm**, Room **90-92EE**

✤ Sections: TBD (still!)

Recall —
What's Logic Good For?

Make things **explicit** ⟷ Identify **good reasoning**

Syntactic Method

Semantic Method

Why Making Things Explicit?

Artificial Intelligence:

Making things explicit is useful if we want to **instruct a computer**.

Recall the *egg cracking example* from last time.

Peace and Agreement:

Becoming clear about what we mean *might* bring about the **dissolution of disagreements.**

Both are dreams, but still…

Israel ex. Cum Priuil. Reg.

...es Voleurs infames et perdus,   Monstrent bien que le crime (horrible et noire engeance)   Et que cest le Destin des hommes vicieux
...uits malheureux a cet arbre pendus   Est luy mesme instrument de honte et de vengeance.   Desprouuer tost ou tard la iustice des Cie...

Jaques Callot, The Miseries of War, 1632

Europe in the 17th century

The Thirty Year War (1618-1648) caused 8 million causalities

Leibniz's
Calculemus!

*The only way to rectify our reasonings is to make them as tangible as those of the mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: **Let us calculate** [**calculemus**], without further ado, to see who is right. (from The Art of Discovery, 1685)*
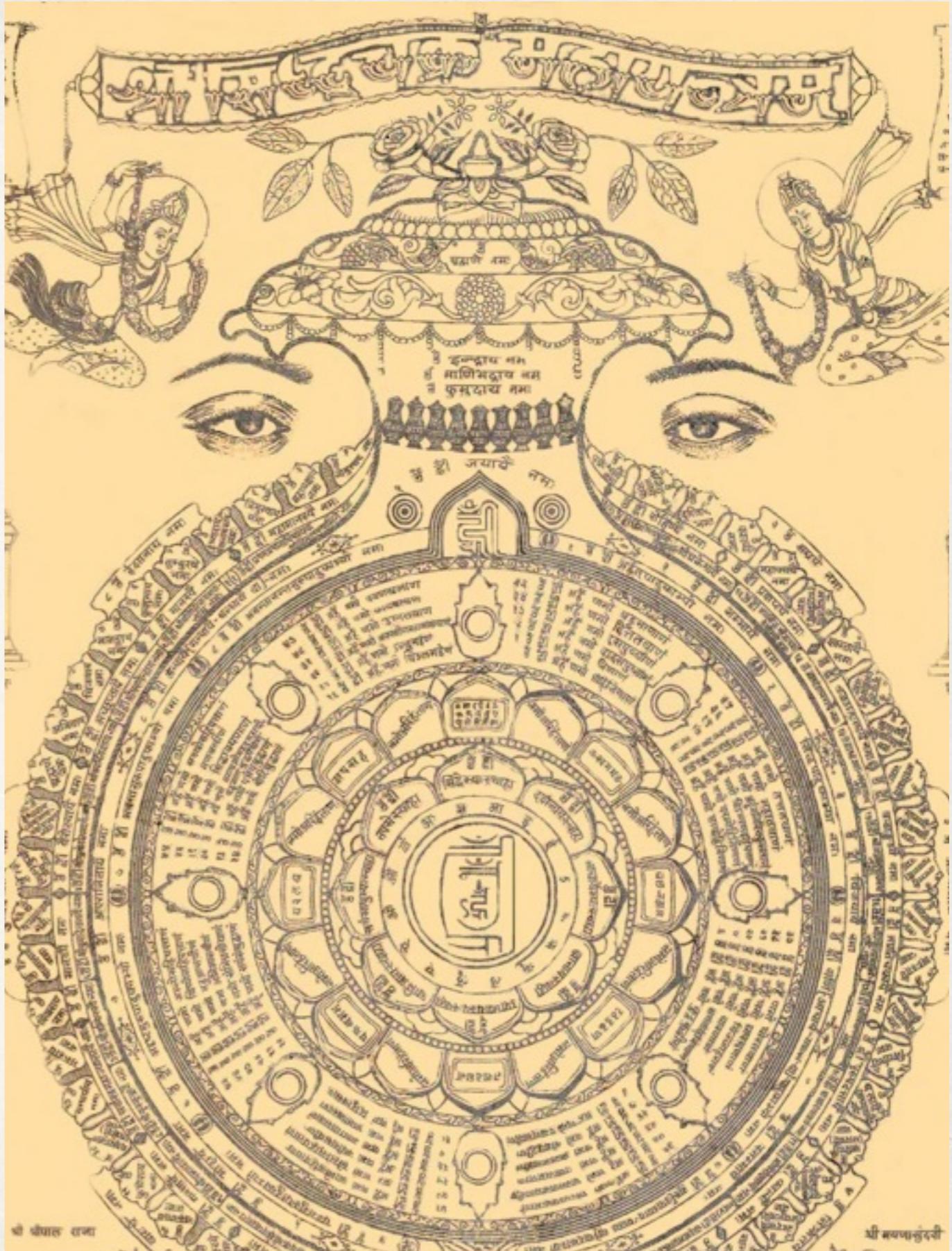
Key idea: *Every statement has a hidden parameter*

Does the World Have an End?

According to substance, the world has no end; according to space, the world has an end; according to time, the world has no end; according to state, the world has no end (Mahavira, Jain philosopher, 6th century B.C.)

Making Legislation Explicit

"Citizen by birth is the child of a father who is an Italian citizen." (Art.1 of the _Old Italian Citizenship Law_)

"Citizen by birth is the child of a father **or a mother** who are Italian citizens." (Art.1 of the _New Italian Citizenship Law)_

Suppose you are born from an Italian mother BEFORE Art.1 of the _New Italian Citizenship Law_ is enacted.

Do you qualify for Italian citizenship according to Art.1 of the _New Italian Citizenship Law?_

No, if the law refers to the **event of birth**.

Yes, if the law refers to the **filial relationship**.

A Tradeoff: Precision v. Versatility
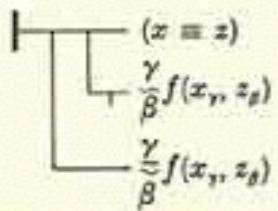
Being fully explicitly about what we mean is good because it allows precision and sharp reasoning.

When is imprecision beneficial?

Always being fully explicit is burdensome. Natural language enjoys versatility and flexibility.

According to the legal theorist Cass Sustein we can agree about Constitutional Law and fundamental rights because these represent "**incompletely theorized agreements**"

(55) ::

$d \mid x$
$c \mid z$

$(x \equiv z)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

(104).

§ 30.

99

$\left[\left[\begin{array}{c} (z \equiv x) \\ \frac{\gamma}{\beta} f(x_\gamma, z_\beta) \end{array} \right] \equiv \frac{\gamma}{\beta} f(x_\gamma, z_\beta) \right]$

(52) :

$f(\Gamma) \mid \Gamma$
c

$(z \equiv x)$
$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$d \mid \frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$(z \equiv x)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

(105).

(37) :

$a \mid \frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$b \mid (z \equiv x)$

$c \mid \frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$

$\frac{\gamma}{\beta} f(x_\gamma, z_\beta)$
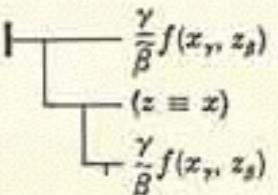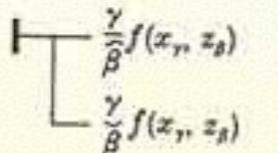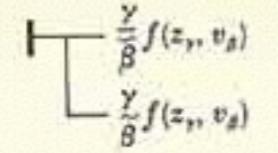
(106).

Whatever follows x in the f-sequence belongs to the f-sequence beginning with x.

106

$x \mid z$
$z \mid v$

$\frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

$\frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

(7) :

$a \mid \frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

$b \mid \frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

$c \mid f(y, v)$

$d \mid \frac{\gamma}{\beta} f(z_\gamma, y_\beta)$

$\frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

$f(y, v)$

$\frac{\gamma}{\beta} f(z_\gamma, y_\beta)$

$\frac{\gamma}{\beta} f(z_\gamma, v_\beta)$

$f(y, v)$

$\frac{\gamma}{\beta} f(z_\gamma, y_\beta)$

(107).

(102) ::
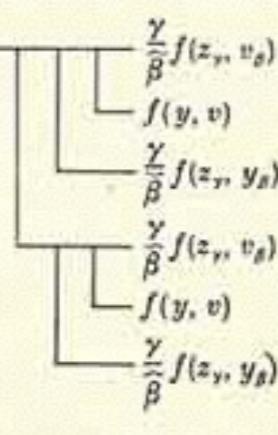
*I believe that I can best make the relation between my **ideography** to **ordinary language** clear if I compare it to that which the **microscope** has to the **eye**. Because the range of its possible uses and the versatility with which it can adapt to the most diverse circumstances, **the eye is far superior to the microscope**. Considered as an optical instrument, to be sure, it exhibits many imperfections, which ordinarily remain unnoticed only on account of its intimate connection with our mental life. But, **as soon as scientific goals demand great sharpness of resolution, the eye proves to be insufficient**. The microscope, on the other hand, is perfectly suited to precisely such goals, but that is just why it is useless for all others.*

Frege, *Ideography* (1879)

01

On Identifying Good Reasoning
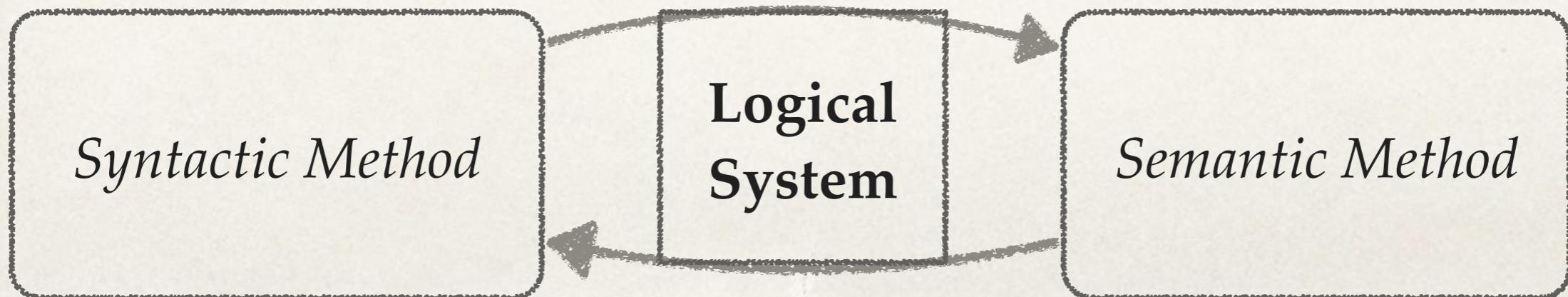
Recall —
# Two Ways to Identify Good Reasoning

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

The Syntactic Method Works Best Here

Conclusion to be established:

Every natural number has a successor

Reasoning:

Let **n** be a natural number. Now, **n**'s successor is **n+1**. Therefore, every natural number has a successor

Reasoning Pattern:
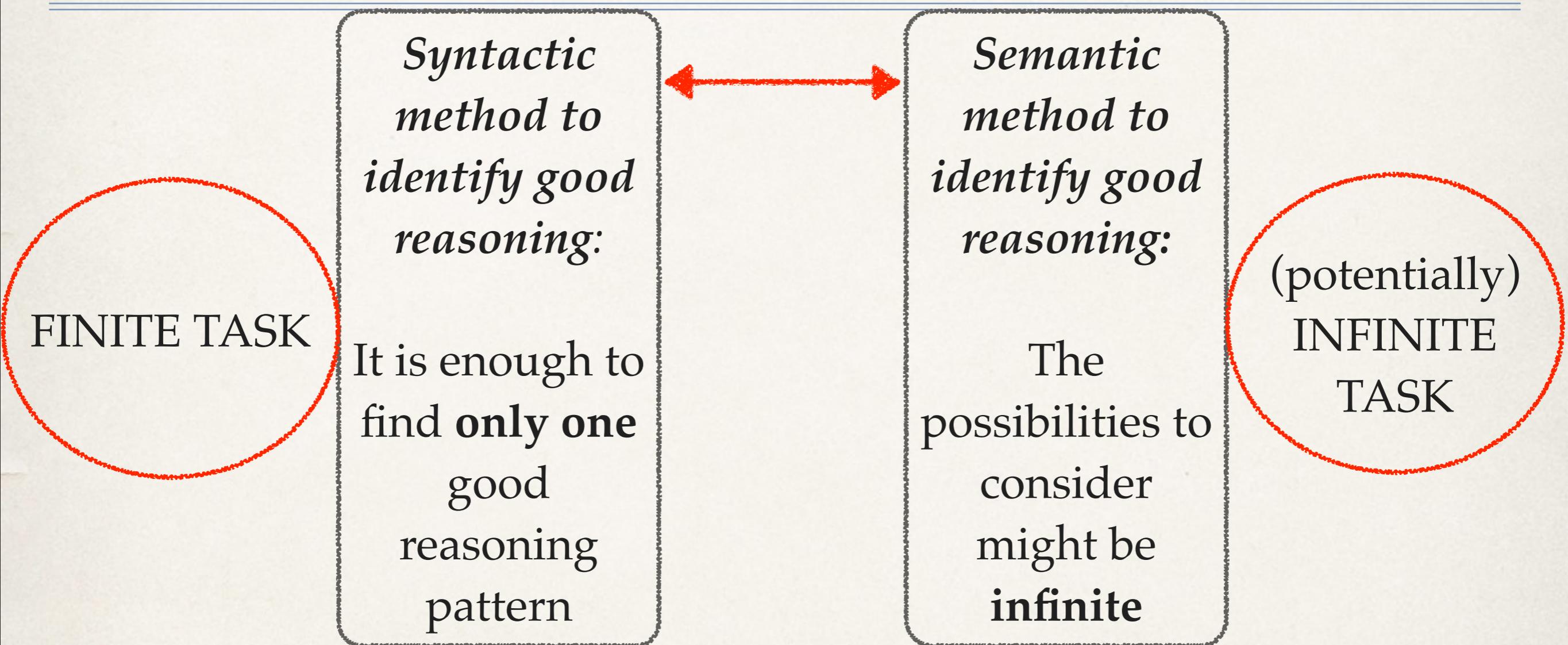
If **n** is a natural number, **n** has a successor

_____

For all **n** (if **n** is a natural number, **n** has a successor)

It is impossible to check every number since numbers are infinite!

Another Definition of Logic

Syntactic method to identify good reasoning:

It is enough to find **only one** good reasoning pattern

Semantic method to identify good reasoning:

The possibilities to consider might be **infinite**

FINITE TASK

(potentially) INFINITE TASK

Since a logical system establishes the equivalence of the two methods, logic can be seen as the attempt to <u>render the infinite finite</u>.

Some Useful Terminology

Syntax:

The study of **strings of symbols** and their **manipulations**
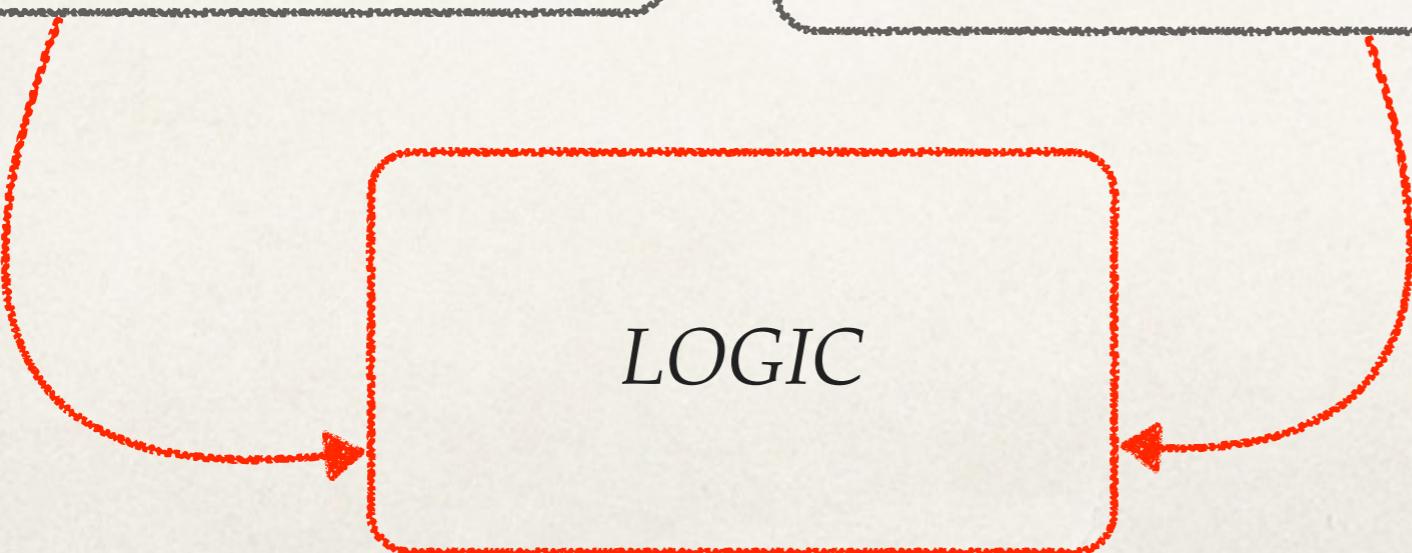
Semantics:

The study of the **meaning and truth values** of string of symbols

Pragmatics:

The study of the meaning of string of symbols insofar as they are **used to communicate with an audience**

LOGIC
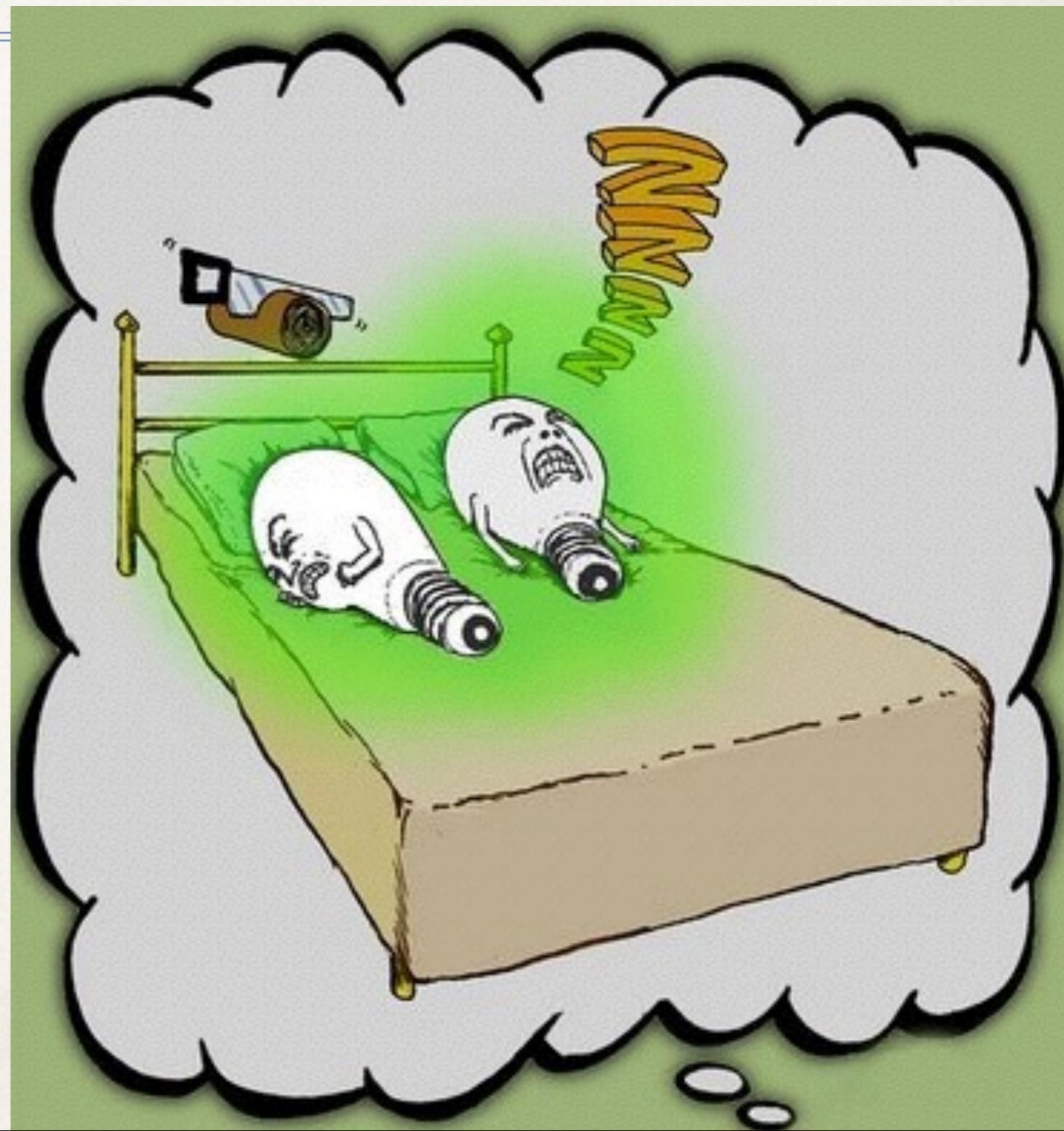
Good Syntax But No Meaning

*Colorless green ideas
sleep furiously*

Naom Chomsky

Looking Ahead…

Recall —
What to Expect from this Course

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

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

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

Learn about **logical puzzles** and **paradoxes**

Propositional v. Predicate Logic

Statements of Propositional Logic

Simple statements:

A, B, C, etc.

More complex statements:

A **and** B
if A, **then** B
A **or** B
not-A

Even more complex statements:

(A **and** B) **and** C
if(**if** A, **then** B), **then** B
if(**if** (**not**-A), **then** B), **then** C
not((**if** A, **then** B), **then** C)

Statements of Predicate Logic

Simple statements:

"Francis is a pope"
"Blue is a color"

More complex statements:

"Francis is **the** pope"
"Blue is **the** warmest color"
"**Not all** popes are corrupt"
"**Some colors** are warm"

What makes *Predicate Logic* **more expressive** than *Propositional Logic* is that the use of **predicates, names, and quantifiers**

Modal Logic

Statements of Modal Logic

Statements in Propositional and Predicate Logic are typically **about the world as it is**

Statements in Modal Logic are **about the world as it could be** (e.g. the world in our imagination, the world in our beliefs, the world in the future or in the past)

Statements in Modal Logic:

"Possibly (A)"
"In the future (A)"
"In the past (A)"
"She believes-that (A)"
"She wants-that (A)"

Deductive v. Inductive Validity

Deductively Valid Arguments

An *argument* is said to be
deductively valid

if and only if

whenever **the premises** are **true**,
the **conclusion** is **always true**.

if and only if

whenever it conforms to a valid
argument pattern.

Modus Ponens:

If A, then B
A
_____

B

Modus Tollens:

If A, then B
not-B
_____

not-A

Terminological Clarifications

Instead of "**reasoning**", I am now using "**argument**"

Instead of "**good**" (reasoning), I am now using "**valid**" (argument)

An **argument** is a **list of statements** such that

(a) some statements in the list are the **premises**; and

(b) one statement in the list is the **conclusion**

A **statement** is a string of symbols which is **capable of being true or false**

What About Inductive Validity?

A challenge for Sherlock Holmes (1)

" … I have here a watch which has recently come into my possession. Would you have the kindness to let me have an opinion upon the character or habits of the late owner?"

I handed him over the watch with some slight feeling of amusement in my heart, for the test was, as I thought, an impossible one, and I intended it as a lesson against the somewhat dogmatic tone which he occasionally assumed. He balanced the watch in his hand, gazed hard at the dial, opened the back, and examined the works, first with his naked eyes and then with a powerful convex lens…

"There are hardly any data," he remarked. "The watch has been recently cleaned, which robs me of my most suggestive facts."

Here Sherlock Holmes means that he **cannot make any deduction,** but…

"Though unsatisfactory, my research has not been entirely barren," he observed, staring up at the ceiling with dreamy, lack-lustre eyes. "…**I should judge that the watch belonged to your elder brother, who inherited it from your father**."

"That you gather, no doubt, from the H. W. upon the back?"

"Quite so. The W. suggests your own name. The date of the watch is nearly fifty years back, and the initials are as old as the watch: so it was made for the last generation. Jewelry usually descends to the eldest son, and he is most likely to have the same name as the father. Your father has, if I remember right, been dead many years. It has, therefore, been in the hands of your eldest brother."

"Right, so far," said I. "Anything else?"

"He was a man of untidy habits,—very untidy and careless. He was left with good prospects, but he threw away his chances, lived for some time in poverty with occasional short intervals of prosperity, and finally, taking to drink, he died. That is all I can gather."

I sprang from my chair and limped impatiently about the room with considerable bitterness in my heart…

A challenge for Sherlock Holmes (3)

" … how in the name of all that is wonderful did you get these facts? They are absolutely correct in every particular."

"Ah, that is good luck. I could only say what was the **balance of probability**. I did not at all expect to be so accurate."

"But it was not mere guess-work?"

"No, no: I never guess. … I began by stating that your brother was **careless**. When you observe the lower part of that watch-case you notice that it is not only dinted in two places, but it is cut and marked all over from the habit of keeping other hard objects, such as coins or keys, in the same pocket. **Surely it is no great feat to assume that a man who treats a fifty-guinea watch so cavalierly must be a careless man**. **Neither is it a very far-fetched inference that a man who inherits one article of such value is pretty well provided for in other respects.**"

I nodded, to show that I followed his reasoning.

A challenge for Sherlock Holmes (4)

"It is very customary for pawnbrokers in England, when they take a watch, to scratch the number of the ticket with a pin-point upon the inside of the case. It is more handy than a label, as there is no risk of the number being lost or transposed. There are no less than four such numbers visible to my lens on the inside of this case. **Inference**,—that your brother was often at low water.

Secondary inference,—that he had occasional bursts of prosperity, or he could not have redeemed the pledge.

Finally, I ask you to look at the inner plate, which contains the key-hole. Look at the thousands of scratches all round the hole,—marks where the key has slipped. What sober man's key could have scored those grooves? But you will never see a drunkard's watch without them. He winds it at night, and he leaves these traces of his unsteady hand.

Where is the mystery in all this?"

Sherlock Holmes could arrive at these conclusions **as a matter of probability**. *Reasoning based on probability is called inductive.*

Inductively Valid Arguments

An argument is said to be
inductively valid

if and only if

whenever **the premises** are **true**,
the **conclusion** is **MOST
PROBABLY true**.

Monetarist Economics

*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 **most probably** not come down.*

Is this an inductively valid argument?