

scientific knowledge

goal

characterize scientific knowledge  
is it special or not?  
Philosophy of Science  
how should we think of it in "2nd half"?

a romp through  
epistemology

a romp through  
epistemology



singular event:

Newton.

singular event:

Newton.



singular event:

Newton.



so successful

method had to be understood

"hypothetico-  
deductive" method

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deductive" method

concoct a theory, T...by observing phenomena

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We see R.

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If a theory, T is true, we expect to see results, R.  
We see R.  
Therefore, theory T is true.

"hypothetico-  
deductive" method

concoct a theory, T...by observing phenomena  
If a theory, T is true, we expect to see results, R.  
We see R.  
Therefore, theory T is true.  
oops.

so, important to

understand the state of "knowledge"  
before Newton  
after Newton

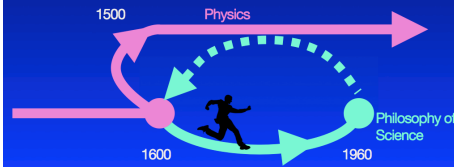
so, a little  
philosophical  
cul-de-sac



so, a little  
philosophical  
cul-de-sac



so, a little  
philosophical  
cul-de-sac



remember:  
middle ages

remember:  
middle ages

solidified: Scholasticism

remember:  
middle ages

solidified: Scholasticism

limiting and authoritarian

what was good knowledge was according to

scripture and Aristotle

scholasticism

a bad idea.

into 18C!

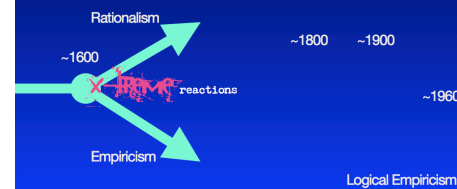
how bad was it?

hating it:

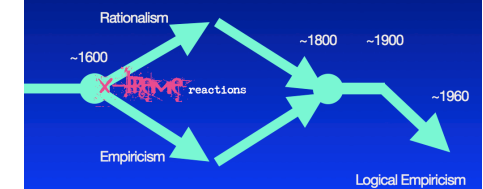
was a good thing

2 x ~~have~~ reactions

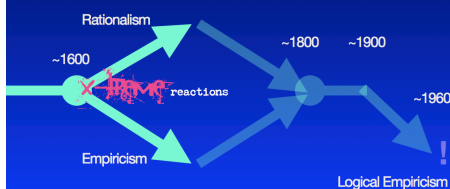
2 strands:



2 strands:



2 strands:



(1) Rationalism

(2) Empiricism



remember, a romp.



bringing home the  
Bacon

Sir Francis  
Bacon

1561-1626



disgraced  
politician



Favorite of  
Good Queen Bess'



Lord Chancellor for  
King James I

new career

a project limited  
to:

"...the total reconstruction of the sciences, arts  
and all human knowledge."

Philosophy:  
disrepute

scholasticism  
theory, rather than experience

syllogisms

no new knowledge

in fact: hated  
scholastics

schoolmen were "degenerate"

his, not so much a  
philosophy

as a method

free your mind

of distractions (idols)

free your mind

of distractions (idols)



free your mind

of distractions (idols)



eliminate all sources of error and prejudice  
Idols of Tribe, Cave, Market-Place, Theater

organize, observe,  
experiment, and  
categorize

according to detailed rules and tables  
100's of lists of similarities and differences for  
phenomena...like Heat.

reach laws

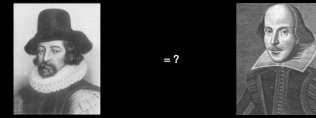
very strict

instruction on the use of  
Induction

# Novum Organon

impossible to  
overestimate impact

in Britain



nah...but some wondered

same...but different

# René Descartes

1596-1650



versatile fellow

suffocated under  
scholastic education



you're not much if  
you're not Dutch

major works:

*Discourse on Method* 1637  
(doubt)

*Principles of Philosophy* 1644  
(analytic geometry, momentum)

certain of?

well: mathematics is  
indubitable

innate

start with

Universals...axioms - not experience.

Deductively move to new knowledge  
which cannot be doubted

But, what about

yourself and your place in the world.  
you know: regular knowledge?  
how to create a mathematical-like certainty for  
human knowledge?

particulars...

good, but not enough for Certainty

wanted the whole enchilada

need Universals

from which good things will follow

doubt as a tool

# The Father of Modern Philosophy



dunno.

## strategy for Truth?

- a. Never accept as true, that which he did not clearly know as such.
- b. Divide every difficulty into as many parts as possible.
- c. Conduct one's thoughts in an orderly manner proceeding from the simple to the complex

## criterion for Truth

clear and distinct

which senses are not

D's a Platonist in many ways

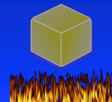
consider this

this

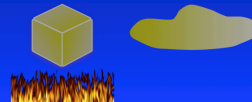
waxy buildup



waxy buildup

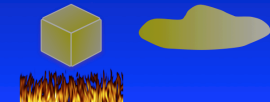


waxy buildup



waxy buildup

For example, know it's wax through your reasoning,  
not your senses



knowledge of the external world?



in your mind

a method for clarity

if in doubt,  
throw it out.

build from the  
indubitable

1 thing

cogito ergo sum

so.  
can obtain  
indubitable  
knowledge from



mental  
activities  
↓  
reliable  
knowledge

Rationalism

amazing

if you...um...think  
about it

established  
knowledge from pure  
thought

now what.

gotta rebuild all of  
<regular> knowledge

God is referee.

God is referee.

God is referee.

God is referee.

Because God is perfect...

Because God is perfect...

Because God is perfect...

He can be trusted...

He can be trusted...

so, whatever is clear and distinct

God is referee.

Because God is perfect...  
He can be trusted...  
so, whatever is clear and distinct  
is true

a little muddy here.

a mathematization

of thinking  
he comes by this naturally

but, wait, there's  
more

“  
This 'I' - that is, the soul, by which I am what  
I am, is entirely distinct from  
the body, and would not fail to be what it  
is even if the body did not exist.

Descartes

minds <--> bodies

2 substances.  
active, incorporeal                      passive, material,  
require cause to move

minds think  
bodies occupy space

conceivable:  
mind could exist without a body

Cartesian dualism.

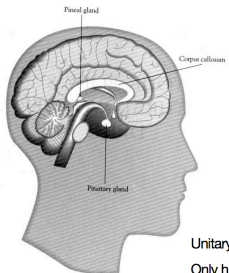


Figure 1. The Pineal Gland Lies at the Exact Center of the Brain.

Unitary  
Only humans have one

he'll be back, but  
one more thing...

Descartes banished  
Aristotle's  
Qualities

A:  
Qualities were *in* the thing

D:

Qualities: only extension, motion, place...in a thing  
matters of space & time: objects of mathematics

with Descartes

with Descartes

the Project of modern western philosophy was  
On.

Cartesianism

Certainly, **Certainty**.  
what we know *a priori* is certain  
anti-scepticism

we'll come back...

SO

- by ~1665 in Britain
- Descartes was being read secretly at university
- Bacon had been adopted as the mascot of the Royal Society
- long civil war was over



SO

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and John Locke reads Descartes

and is not impressed

John Locke

1632-1704



Glorious Revolution

June 1688



Essay Concerning Human Understanding

"necessary to examine our own abilities, and see what objects our understandings were, or were not, fitted to deal with..."

limitations

examine knowing...

without innate ideas

cannot argue for truth on that basis  
certainly not universal assent

all efforts to learn about real things

face the skeptical argument

the thing in itself



all efforts to learn about real things

face the skeptical argument

the thing in itself



Locke suggests



Locke suggests

the thing in itself



Locke suggests

"sense data"...appearances  
-> the experience of an apple

the thing in itself



Locke suggests

the thing in itself




tabula rasa





simple ideas:  
a passive activity


sensations:  
touch, sight, hearing



simple ideas:  
a passive activity

reflection

sensations:  
touch, sight, hearing




simple ideas:  
a passive activity

reflection

Complex ideas:  
an active activity

sensations:  
touch, sight, hearing




simple ideas:  
a passive activity

reflection

Complex ideas:  
an active activity

sensations:  
touch, sight, hearing

complex ideas



primary qualities

in the thing  
independent of observer

length, breadth, height, weight, position, speed,  
etc

secondary qualities

produce extra ideas in the mind

taste, color, smell, etc

Between Descartes  
and Locke

A's Qualities are now gone.

All we can know  
comes from our senses impressions.

Empiricism

Political philosophy

no innate hierarchy

hugely informed the US Founding Fathers


But.

how do the primary qualities **really** differ from the secondary qualities?

well?

Bishop George Berkeley

1685-1753





Locke, but  
consistent

“primary” does not  
mean unambiguously  
separate



“...it is not in my power to frame an idea of a body extended and moving, but I must **without give it** some colour or other sensible quality, which is acknowledged to exist only in the mind.

George Berkeley

all are sensations

don't ever know anything about  
the thing.

Locke postulates  
matter

but he cannot justify anything beyond  
Impressions

Esse est Percipi

Esse est Percipi

Mind is all that exists.  
No grounds for believing anything else.  
if you follow the Empiricist rules.

God is busy

philosophical  
idealism

David Hume

1711-1776



philosophical  
skepticism

Really applies the Empiricist rules.

agreed with  
criticism of Locke

but, Self? not.

but, Self? not.

can't even presume that our Self exists

but, Self? not.

can't even presume that our Self exists  
introspection finds  
just a bunch of sensations

but, God? not.

He exists. Or, He doesn't.  
Only observations can determine  
no credible observation report of God.  
Possible...but not certain.

all we have

deceitful sensations

ideas and impressions  
that's it.

ideas

simple and complex  
simple ones -> simple impression  
complex ones? notso much.

So:

we cannot be certain of anything

but wait, there's  
more

just like Self, just  
like God

Cause and Effect cannot be directly observed  
merely habit

fooled into thinking that repetitive sequences  
are necessary



billiards



billiards



billiards

does the red ball cause the yellow ball to  
move?



billiards

does the red ball cause the yellow ball to  
move?



billiards

does the red ball cause the yellow ball to  
move?



There is no impression that you can have of that  
connection

billiards

does the red ball cause the yellow ball to  
move?

cause and effect

cause and effect

not.

cause and effect

not.  
merely habit.

a philosophical  
crisis

Hume showed that

Inductive  
conclusions cannot be necessarily true

in fact, **no way**

to justify that sort of knowledge

“But, but but...”  
you sputter...

induction

works so well!

oops.

that uses induction  
to justify induction.

All of the objects of human reason or enquiry may naturally be divided into TWO kinds, to wit, **Relations of Ideas**, and **Matters of fact**. Of the first kind are the sciences of Geometry, Algebra, and Arithmetic...[which are] discoverable by the mere operation of thought...Matters of fact, which are the second object of human reason, are not ascertained in the same manner; **NOT** is our evidence of their truth, however great, of a like nature with the foregoing.

David Hume



Hume's Fork

a problem

Deduction: guaranteed, but nothing new  
Induction: unjustified, but useful

Newton's success

surely  
demonstrated that induction was justified

nope.

implies:



implies:



implies:

Science?  
not certain.

Newton used a method

for which justification is impossible

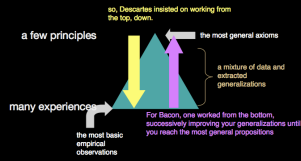
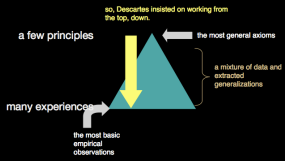
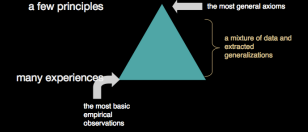
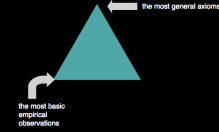


“ If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion.

Hume

metaphysics: no.

Religion. no.



an important distinction

Certainty  
Uncertainty

professional physics

theoretical  
experimental

Hume:

a philosophical crisis



Immanuel Kant

1724-1804



Induction: acquisition of knowledge that goes beyond the act: **synthetic**  
that comes about as a part of a process: **a posteriori**  
Empiricism

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that comes about as a part of a process: **a posteriori**  
Empiricism

Deduction: acquisition of knowledge that is required by the act: **analytic**  
that is built-in to the process: **a priori**  
Rationalism

Induction: acquisition of knowledge that goes beyond the act: **synthetic**  
that comes about as a part of a process: **a posteriori**  
Empiricism

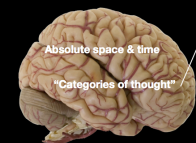
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Rationalism

Kant says that the mind comes equipped with **synthetic, a priori** knowledge.

Factory Equipment: mind is active.



including...  
categories of relation:  
causality  
dependence  
categories of quality:  
reality  
negation  
limitation  
categories of quantity  
categories of modality

There are pieces of experience that cannot be justified or experienced in a direct way...because they are a part of experience itself.

## embedded inside Kant's ideas

synthetic, a priori:

1. Euclidean geometry
2. Newton's mechanics



## a big but:

a century after Kant  
Hume comes screaming back  
because of Einstein's theory of relativity.

## yet another

Philosophical Crisis