

scientific knowledge
20th Century

can't remember Kant?

"hehe"



this instrument protected us from Hume.

absolute space and time? yes.
Euclidean geometry? yes.
Newton's laws? yes.

By 1920

special and general
relativity

special and general
relativity

absolute space and time? not.
Euclidean geometry? not.
Newton's laws? not.

geometries

1900, unified
1905, 1917...figure in Relativity

and they are a
System

maybe all of
mathematics?

can be a system?

meanwhile
late 1800's
extreme
empiricism afoot

even mathematics is empirical

positivism

all knowledge of facts comes from:
the positive data of experience

only

can't observe it?

can't know of it.

alpha male of
positivism in
physics:

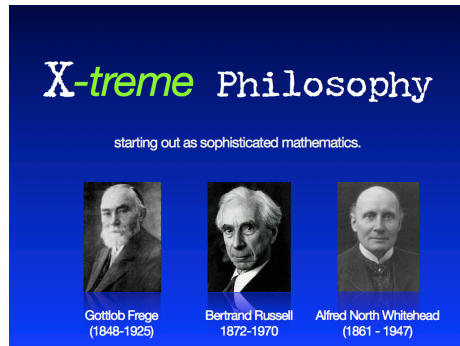
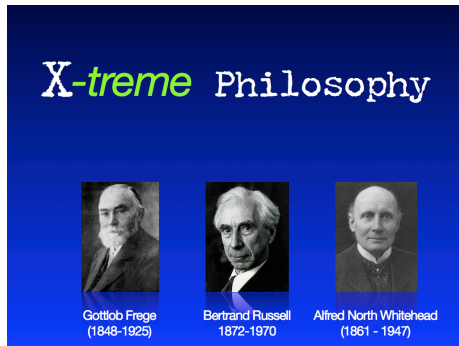
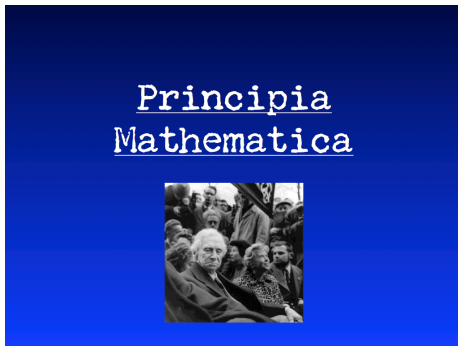
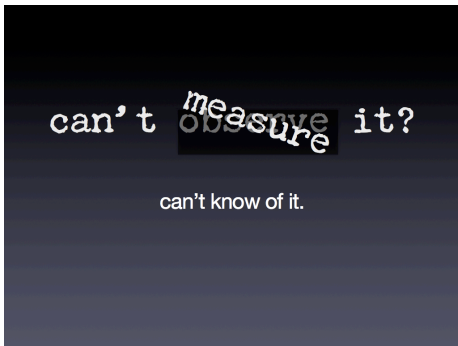


Ernst Mach
1838-1916

scratch a physicist
today
you'll
find
traces of
positivism

can't observe it?

can't know of it.



Russell's Program

His language of logic was precise
 Let F be a predicate standing for, say, a property: "is tall."
 Let x be any individual thing, say, "The tree"

Then the form of the statement, "The tree is tall."
 would be written: Fx
 x = The tree and F -> "is tall"...The form is the same as "The car is black."

There is a functional relationship: (x) -> "all x"
 So, the form of "All trees are tall." would be (x)Fx
 ax stands for "at least one x", so "At least one tree is tall." would be (ax)Fx

With identity: a = b (a & b are not two objects, but one and the same)
 all of the concepts of mathematics can be defined.

How about Socrates?

Russell's Program

His language of logic was precise
 Let F be a predicate standing for, say, a property: "is tall."
 Let x be any individual thing, say, "The tree"

Then the form of the statement, "The tree is tall."
 would be written: Fx
 x = The tree and F -> "is tall"...The form is the same as "The car is black."

There is a functional relationship: (x) -> "all x"
 So, the form of "All trees are tall." would be (x)Fx
 ax stands for "at least one x", so "At least one tree is tall." would be (ax)Fx

With identity: a = b (a & b are not two objects, but one and the same)
 all of the concepts of mathematics can be defined.

How about Socrates?

Russell's Program

His language of logic was precise
 Let F be a predicate standing for, say, a property: "is tall."
 Let x be any individual thing, say, "The tree"

Then the form of the statement, "The tree is tall."
 would be written: Fx
 x = The tree and F -> "is tall"...The form is the same as "The car is black."

There is a functional relationship: (x) -> "all x"
 So, the form of "All trees are tall." would be (x)Fx
 ax stands for "at least one x", so "At least one tree is tall." would be (ax)Fx

With identity: a = b (a & b are not two objects, but one and the same)
 all of the concepts of mathematics can be defined.

How about Socrates?

numbers

...this is background

numbers

Numbers are defined in terms of classes (or sets):
 2 is the class of all couples; 3 is the class of all triples; etc.

a couple is a class having members x and y where x and y are not identical and where if there is any other member of the class, z, then it must be identical with x or y

with this, the problems of defining 0, 1, and infinity are handled

numbers

Numbers are defined in terms of classes (or sets):
 2 is the class of all couples; 3 is the class of all triples; etc.

a couple is a class having members x and y where x and y are not identical and where if there is any other member of the class, z, then it must be identical with x or y

with this, the problems of defining 0, 1, and infinity are handled

numbers

Numbers are defined in terms of classes (or sets):
 2 is the class of all couples; 3 is the class of all triples; etc.

a couple is a class having members x and y where x and y are not identical and where if there is any other member of the class, z, then it must be identical with x or y

with this, the problems of defining 0, 1, and infinity are handled

that's it.

almost. The next step was to render mathematical proofs logically.

oops: Russell's Paradox

class of those classes which are not members of themselves

oops: Russell's Paradox

What about those things that are classes of themselves?
 class of chairs: not a chair – not a class of itself

what about the class of things that are not chairs
 if it's not a chair, then it is a member of itself

oops: Russell's Paradox

What about those things that are classes of themselves?
 class of chairs: not a chair – not a class of itself

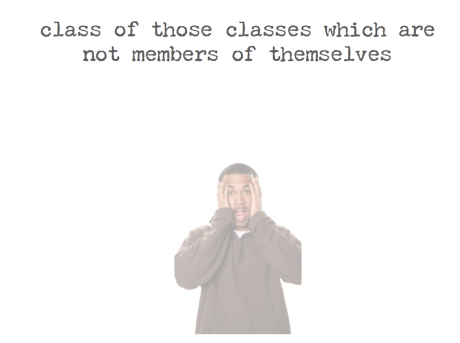
what about the class of things that are not chairs
 if it's not a chair, then it is a member of itself

oops: Russell's Paradox

What about those things that are classes of themselves?
 class of chairs: not a chair – not a class of itself

what about the class of things that are not chairs
 if it's not a chair, then it is a member of itself

What about the class of those classes which are not members of themselves?



class of those classes which are not members of themselves

if it's not a member of itself, then by definition it is a member of itself
and if it is a member of itself...then it is not a member of itself



class of those classes which are not members of themselves

if it's not a member of itself, then by definition it is a member of itself
and if it is a member of itself...then it is not a member of itself

So: it is and is not a member of itself



class of those classes which are not members of themselves

if it's not a member of itself, then by definition it is a member of itself
and if it is a member of itself...then it is not a member of itself

So: it is and is not a member of itself



delayed Principia for years

delayed Principia for years

and destroyed Frege

"A scientist can hardly meet with anything more undesirable than to have the foundation give way just as the work is finished. I was put in this position by a letter from Mr. Bertrand Russell when the work was nearly through the press."

the close to the book which was his life's work on the foundation of mathematics

Logic as the basis of all of mathematics

Before Frege, Russell:



After Frege, Russell:



just a taste



a group of analytic thinkers

disliked metaphysics
was language a possible cause?

ignore the former and fix the latter

mathematics -> language?

assignable truth values for all statements

goal
tackled paradoxical assertions

"The present queen of England is bald."

It's false
or, at least it is a matter of fact and can be checked

"The present queen of France is bald."

"The present queen of France is bald."

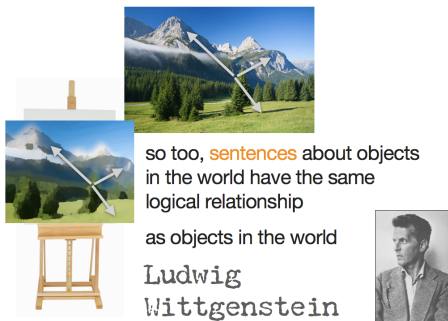
$(\exists x) [Fx \& (y) (Fy \rightarrow y = x) \& Gx]$

1931

Kurt Gödel proved
the consistency of any number theory system cannot be proven using the arguments of that system - logicism proof for mathematics was doomed.

so, sloppy language

was a problem to be solved in philosophy to avoid metaphysics



so too, **sentences** about objects in the world have the same logical relationship

as objects in the world

Ludwig Wittgenstein

Logical Positivists
rid philosophy of metaphysics
using logic and properly constructed language
using Russell's rules

start their repair job with the best example of knowledge that of science

LPs commitments:

LPs commitments:
observation is a neutral act

LPs commitments:
observation is a neutral act
scientific exposition is an inherently logical act

LPs commitments:
observation is a neutral act
scientific exposition is an inherently logical act
which use the rules of the *Principia*

later changed to:
"Logical Empiricism"
(a whimpered out version)

their Goal for Science:
construction of a completely logical account of the world
after the fact

"Verifiability Criterion of Meaning"
A statement is meaningful if and only if it can be proved true or false, at least in principle, by means of experience.

if not:
it is "meaningless noise."

tough guys

“...we appointed one of us to shout “M” (for metaphysics) whenever an illegitimate sentence was uttered in our discussion.

Rudolph Carnap

“...we appointed one of us to shout “M” (for metaphysics) whenever an illegitimate sentence was uttered in our discussion.

He was shouting “M” so much that we got sick of it and got him to shout “not-M” whenever we said something legitimate.

Rudolph Carnap

what’s metaphysics?

anything that does not directly refer to a measurement

things not observable

“theoretical terms”

electron

proton

field

...etc

what physicists say every day?

well, that’s kind of embarrassing.

LE’s vocabulary:

“observation statements”

“the sample has a mass of 20 grams”

“the meter reads 10 volts”

“the speck on the film moved from here to there”

...etc

“atomic” terms”

“atomic” terms”

complicated phrases

“atomic” terms”

complicated phrases

parsed into elementary, atomistic statements

“atomic” terms”

complicated phrases

parsed into elementary, atomistic statements

each referring to an observation

theories and theoretical terms were a persistent problem



1. collect facts by performing experiments

1. collect facts by performing experiments

2. synthesize those facts for regularities and similarities & formulate hypotheses

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them
6. and/or explain phenomena on the basis of theories or laws and test them

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them
6. and/or explain phenomena on the basis of theories or laws and test them

close to Newton:

"Hypothetico-Deductive Method"

HD

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them
6. and/or explain phenomena on the basis of theories or laws and test them

2: embarrassment

induction

by this point, **unprotected by Kant**

so, **unjustified**

consistent logic of induction?

failed.

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them
6. and/or explain phenomena on the basis of theories or laws and test them

the "context of discovery"

the "context of justification"

okay, forget 1,2

leave #1 & #2 to psychology
the "Context of Discovery"
work on the good stuff:
the "Context of Justification"

1. collect facts by performing experiments
2. synthesize those facts for regularities and similarities & formulate hypotheses
3. test those hypotheses against further experiments
4. promote some hypotheses to theory or even law-like stature
5. use them to predict new outcomes of untried experiments and perform them
6. and/or explain phenomena on the basis of theories or laws and test them

3: test truth of hypotheses

Confirmation

that's deduction and solid ground, right?

birds...
always birds, or swans

hypothesis: All Ravens are black.

hypothesis: All Ravens are black.
Observation: There goes a black raven.

hypothesis: All Ravens are black.
Observation: There goes a black raven.
...there goes another one

hypothesis: All Ravens are black.
Observation: There goes a black raven.
...there goes another one

each such observation adds "Degrees of Confirmation"

deductive logic is their bible

So, gotta follow the rules.

Houston, we have a problem.

the rules of logic:

the rules of logic:

the rules of logic:

1. All A are B

the rules of logic:

the rules of logic:

the rules of logic:

the rules of logic:

1. All A are B

1. All A are B

1. All A are B

1. All A are B



2. No A is non-B (operation called obversion)

2. No A is non-B (operation called obversion)

2. No A is non-B (operation called obversion)



NON B

the rules of logic:

the rules of logic:

The Rules force:

observation of a brown shoe

(non-B are non-A, non-black, non-raven object)

1. All A are B

1. All A are B

from
All A are B
to
All non-B are non-A



NON B

2. No A is non-B (operation called obversion)

2. No A is non-B (operation called obversion)

3. No non-B is A (operation called conversion)

3. No non-B is A (operation called conversion)

4. All non-B are non-A (obversion again...)

observation of a brown shoe

(non-B are non-A, non-black, non-raven object)

confirms that all ravens are black
(all A are B)

“armchair ornithology”



it gets worse

...this, this is background

- define "grue" to be an attribute of emeralds in which:
 - = green before 2007 and blue after 2007
 - define "green" to be an attribute of emeralds in which:
 - = green for all times and places
- okayokayokay
 H: All emeralds are Green.
 O: Today, we observe: there goes a green emerald ✓:confirmation of H

But...what about a different hypothesis, it deserves a confirmation test:
 H': All emeralds are Grue. ✗ ...it's not easy being Grue... ✗
 O: is also a confirming instance of H'
 O is a confirming instance of an infinite number of H', H'', H''',!
 You're giggling - you want to reject this form of reasoning...why?
 • Because nobody expects emeralds to behave this way
 Why?
 Because of experiences with emeralds
But, but, but... that's Induction!

- define "grue" to be an attribute of emeralds in which:
 - = green before 2007 and blue after 2007
 - define "green" to be an attribute of emeralds in which:
 - = green for all times and places
- okayokayokay
 H: All emeralds are Green.
 O: Today, we observe: there goes a green emerald ✓:confirmation of H

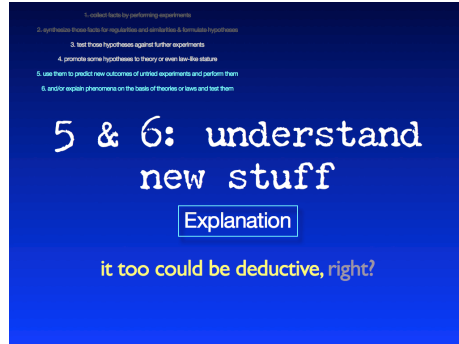
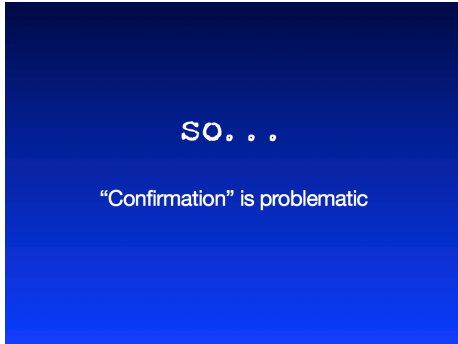
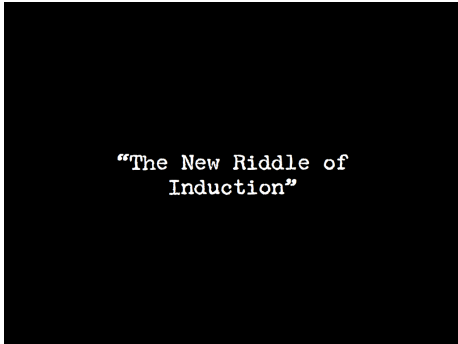
But...what about a different hypothesis, it deserves a confirmation test:
 H': All emeralds are Grue. ✗ ...it's not easy being Grue... ✗
 O: is also a confirming instance of H'
 O is a confirming instance of an infinite number of H', H'', H''',!
 You're giggling - you want to reject this form of reasoning...why?
 • Because nobody expects emeralds to behave this way
 Why?
 Because of experiences with emeralds
But, but, but... that's Induction!
 • Nelson Goodman noted that the only way to get out of this is to refer to the history of emeralds

- define "grue" to be an attribute of emeralds in which:
 - = green before 2007 and blue after 2007
 - define "green" to be an attribute of emeralds in which:
 - = green for all times and places
- okayokayokay
 H: All emeralds are Green.
 O: Today, we observe: there goes a green emerald ✓:confirmation of H

But...what about a different hypothesis, it deserves a confirmation test:
 H': All emeralds are Grue. ✗ ...it's not easy being Grue... ✗
 O: is also a confirming instance of H'
 O is a confirming instance of an infinite number of H', H'', H''',!
 You're giggling - you want to reject this form of reasoning...why?
 • Because nobody expects emeralds to behave this way
 Why?
 Because of experiences with emeralds
But, but, but... that's Induction!
 • Nelson Goodman noted that the only way to get out of this is to refer to the history of emeralds
the more "entrenched" an hypothesis is, the more confidence one can place in projecting it into future use

- define "grue" to be an attribute of emeralds in which:
 - = green before 2007 and blue after 2007
 - define "green" to be an attribute of emeralds in which:
 - = green for all times and places
- okayokayokay
 H: All emeralds are Green.
 O: Today, we observe: there goes a green emerald ✓:confirmation of H

But...what about a different hypothesis, it deserves a confirmation test:
 H': All emeralds are Grue. ✗ ...it's not easy being Grue... ✗
 O: is also a confirming instance of H'
 O is a confirming instance of an infinite number of H', H'', H''',!
 You're giggling - you want to reject this form of reasoning...why?
 • Because nobody expects emeralds to behave this way
 Why?
 Because of experiences with emeralds
But, but, but... that's Induction!
 • Nelson Goodman noted that the only way to get out of this is to refer to the history of emeralds
the more "entrenched" an hypothesis is, the more confidence one can place in projecting it into future use
 • An explicit reliance on History as a way out.



Explanation...should be simple enough concept

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion
 • Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion
 • Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
 We take first law of thermodynamics

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion
 • Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
 We take first law of thermodynamics
 We take the laws of the properties of materials

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion
 • Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
 We take first law of thermodynamics
 We take the laws of the properties of materials
 specific heat of water: 4.18kJ/kg-K

Explanation...should be simple enough concept
 take a law, take a circumstance, and Deductively explain a conclusion
 • Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
 We take first law of thermodynamics
 We take the laws of the properties of materials
 specific heat of water: 4.18kJ/kg-K
 specific heat of aluminum: 0.908 kJ/kg-K

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

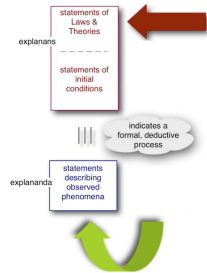
...mlbx, this is background

Explanation...should be simple enough concept

take a law, take a circumstance, and **Deductively** explain a conclusion

- Drop a heated piece of Aluminum into a beaker of water and measure the equilibrium temperature:
- We take *first law of thermodynamics*
- We take *the laws of the properties of materials*
- specific heat of water: $4.18\text{kJ/kg}\cdot\text{K}$
- specific heat of aluminum: $0.908\text{kJ/kg}\cdot\text{K}$
- We take the *initial conditions of:*

...mlbx, this is background



...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...mlbx, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

...mlbx, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

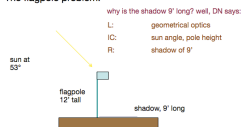
...mlbx, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

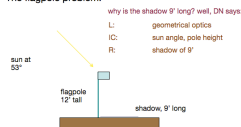
...mlbx, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

The flagpole problem:

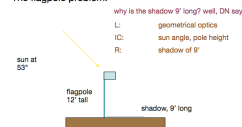


The flagpole problem:



Also ask: why is the flagpole 12' high?

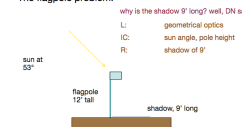
The flagpole problem:



Also ask: why is the flagpole 12' high?

well, DN says: 'cause of optics and the shadow

The flagpole problem:



Also ask: why is the flagpole 12' high?

well, DN says: 'cause of optics and the shadow

OR: why is the sun at 53°?

Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...indeed, this is background

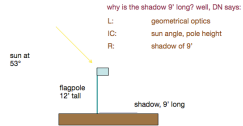
Law: law of conservation of angular momentum
 Initial conditions:
 1. kid riding on a rotating playground merry-go-round
 2. it is well-lubricated and not affected by any external force
 3. kid moves to center
 result: merry-go-round rotates faster

...indeed, this is background

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

Law: no man who takes birth control pills will get pregnant
 Initial conditions:
 1. Bill is a man
 2. Bill takes birth control pills
 result: Bill has not become pregnant

The flagpole problem:



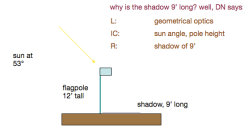
Also ask: why is the flagpole 12' high?

well, DN says:
 L: geometrical optics
 IC: 'cause of optics and the shadow

OR: why is the sun at 53°?

well, DN says:
 uh, 'cause of height and the shadow

The flagpole problem:



Also ask: why is the flagpole 12' high?

well, DN says:
 L: geometrical optics
 IC: 'cause of optics and the shadow

OR: why is the sun at 53°?

well, DN says:
 uh, 'cause of height and the shadow

Well, duh, scientific explanation isn't like this! DN is blind to that.

SO...
 Explanation is problematic

statistical arguments?
 no help.

so.
 induction, no justification
 &
 even the use of deduction is shockingly difficult to justify

outta logic?

another kind
 Abduction
 "Inference to the Best Explanation"
 Charles Pierce, ca 1870

Deduction
 rule: All the beans from this bag are white.
 case: These beans are from this bag.
 result: These beans are white.

Deduction
 rule: All the beans from this bag are white.
 case: These beans are from this bag.
 result: These beans are white.

Induction
 These beans are from this bag.
 These beans are white.
 Therefore, all of the beans in this bag are white.

Deduction
 rule: All the beans from this bag are white.
 case: These beans are from this bag.
 result: These beans are white.

Induction
 These beans are from this bag.
 These beans are white.
 Therefore, all of the beans in this bag are white.

Abduction
 All the beans from this bag are white.
 These beans are white.
 Therefore, these beans are from this bag.

this rings true

plumbers, doctors,
 detectives,
 physicists...

abduction vs.
 induction?
 good rules of thumb:
 induction: lots of trials /abduction: probably 1 circumstance
 induction: usually generalizes things that can be observed /
 abduction: probably some unobservable involved

Lots of AI research
 in abductive
 perception...

1. We have some data
 2. If correct, H would explain those data
 3. Nothing else explains those data as well as H
 4. Therefore, H is probably correct.

1. We have some data
 2. If correct, H would explain those data
 3. Nothing else explains those data as well as H
 4. Therefore, H is probably correct.

1. I arrive home and find that my key does not work.
 2. Among the possible explanations are the following hypotheses:
 my wife has finally kicked me out
 my key transmogrified in my pocket into a different shape
 my lock suddenly transmogrified into a different shape
 I am in the bright-light zone
 there's another neighborhood exactly like mine and I've stumbled to it
 I'm using the wrong key because I wore my son's coat this morning
 3. Nothing explains the locked door better than the wrong key hypothesis
 4. Therefore, I probably am using my son's apartment key by mistake.

1. We have some data
2. If correct, H would explain those data
3. Nothing else explains those data as well as H

4. Therefore, H is probably correct.

1. I arrive home and find that my key does not work.
2. Among the possible explanations are the following hypotheses:
 my wife has finally kicked me out
 my key transmogrified in my pocket into a different shape
 my lock suddenly transmogrified into a different shape
 I am in the twilight zone
 there is another neighborhood exactly like mine and I've stumbled to it
 I'm using the wrong key because I wore my son's coat this morning
3. Nothing explains the locked door better than the wrong key hypothesis
4. Therefore, I probably am using my son's apartment key by mistake.

it uses history

it uses experience

it makes sense

it comes with no guarantees—truth not insured

Logical Empiricism

hoist by its own petard

Logical Empiricism

hoist by its own petard



an antidote? a way out for Deduction?

Sir Karl Popper



1902–1994

hated
“pseudoscience”

a distinguishing
feature:

pseudoscientists will protect their own theories
 realscientists will constantly attack their own theories

that must say
something

HD is CH

Conjectures and Refutations

1963

not
confirmation...but
DISconfirmation

is the purpose of science

figuring out what
makes an hypothesis
fail

is a strictly Deductive process

when in doubt, throw
it out

serious problems
with this

serious problems
with this

tests theories not in isolation

serious problems
with this

tests theories not in isolation

Popper had this vision of scientists furiously
picking arbitrary theories just to disconfirm
them

serious problems
with this

tests theories not in isolation

Popper had this vision of scientists furiously
picking arbitrary theories just to disconfirm
them

an example of the naïveté that PS had become

also

we keep theories which have had bad experiences all the time

but

Popper's a useful benchmark to distinguish science from non-science

scientific statements

must be in-principle falsifiable
(must be in-principle testable)

please:

in spite of what school boards in Kansas, Pennsylvania, Georgia have said:

Scientific Theories
must be in-principle falsifiable
(must be in-principle testable)

by 1970 or so

Logical Empiricism is kaput
a steaming heap on the philosophical floor

program of airtight justification

for scientific knowledge

Can't confirm things...that breaks the rules
Can't live without Induction, can't live with it
Theories became rigid things having nothing to do with actual science
Theoretical terms—I mean, what's an "electron" to these people?—doesn't fit.

biggest 2 disasters



(1)

inability to really isolate hypotheses
"Quine-Duhem Thesis"

if a voltmeter reading

reports 10V
when the hypothesis suggested 5V...

is the hypothesis wrong?

the meter-reading

presumes a whole string of theoretical commitments
electrical conduction, magnetic attraction, calibration of the dial...*on and on*
how do you just blame only the hypothesis?

no way out of this

Logical Empiricists
— especially Popper —
could really not recover

(2)

the presumed neutrality of observation

who are the best observers?

painters

• Landscapes were not a visible subject for artists until the early 1600s when the Dutch started to deal with just nature.

• With Poussin, the most influential post-renaissance landscape artist — dominating the field for 200 years — was Claude Lorraine, a contemporary of late Descartes and early Newton.

• He was French, but spent much time in Italy and doing work for Christina of Sweden (the lady who worked Descartes to death).



Claude Lorraine, Landscape with Shepherds, 1648

John Constable was a British painter from the early 1800s.

A thoughtful person, of modest upbringing (reminds me of Faraday, whom we'll meet in a while).

He was celebrated for landscapes, but not until after having to bring the genre to acceptability (with Turner).

"Painting is a science and should be pursued as an inquiry into the laws of nature... a branch of natural philosophy of which pictures are but experiments"



John Constable, Wivenhoe Park, Essex, 1816



Constable saw things differently.
He made a discovery in Representation.

“What a painter inquires into is not the nature of the physical world but the nature of our reactions to it.

[the familiar] will always remain the likely starting point for the rendering of the unfamiliar: an existing representation will always exert its spell over the artist even while he strives to record the truth

Sir E.H.Gombrich
Art and Illusion (1960)

for Gombrich

a painter does not start with impressions

but with ideas or concepts.

an active process

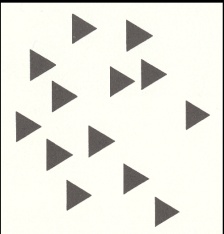
stimulus and the brain

not: look, then process

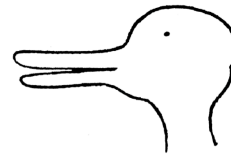
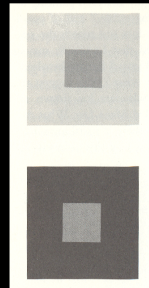
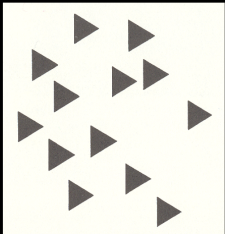
but: look/process as a real time action

THE CAT

THE CAT



THE CAT



Pope Urban VIII, Gianlorenzo Bernini 1623

“Seeing is already a creative operation, one that demands an effort.

Matisse

that's in art

what about science?

“There is more to seeing than meets the eyeball.

Norwood Russell Hanson

it happens all the time in science:

two people look at the same phenomena
but
they see different things.

if both are unbiased

how can this happen?

further:

how can the presumption of neutral observation hold?

1960's

evolved the belief that no observation is unbiased.

Hanson & Gombrich

wrote about the same time, saying very similar things

about science and art

"theory-ladenness"

observations

come with baggage of

previous theories

conceptual frameworks

physiological and psychological necessities

"theory-ladenness"

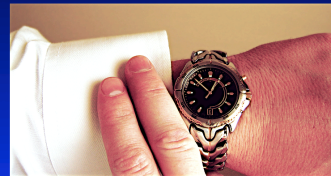
"seeing as" vs
"seeing that"

seeing an object
"as"

is a significant perceptual event

seeing "that" an
object is thus and
so

is a significant scientific event



Aristotle &
Copernicus

look at a sunrise

A: sees the sun come
up and revolve to
the west

C: sees the earth rotate to the east

same retinal stimulation

see different things

C and A even agree that the yellow globe

is the sun

A sees that the sun rises
C sees that the earth rotates

both are making scientific observations

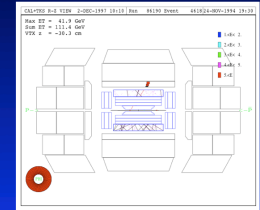
their disagreement?

their disagreement?

On the theories that they hold.

this suggests that observation

is a very complicated activity



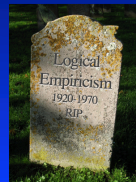
what do you see?

so, no recovery for LE from this either

Observation just does not happen
with neutrality
and without bias

add in the logical flaws?

the project of accounting for science as a justifiably logical process was dead.



fatal methodological flaw?

the LE's almost never examined real science
almost always Ravens and Swans-like arguments

so, how does science actually work?

became a research issue in the Philosophy of Science
cooperating with the History of Science

“historicist approaches”



paradigm n:

1. a typical example of something
2. an example that serves as a pattern or model for something, especially one that forms the basis of a methodology or theory
3. a set of word forms giving all of the possible inflections of a word
4. in the philosophy of science, a generally accepted model of how ideas relate to one another, forming a conceptual framework within which scientific research is carried out.[†]

23,500,000 hits on Google

† the Bill Gates dictionary in Office applications

“paradigm”

*The Structure of Scientific Revolutions**



*384,000 hits on Google

Thomas Kuhn 1922-1996

impossible to overestimate

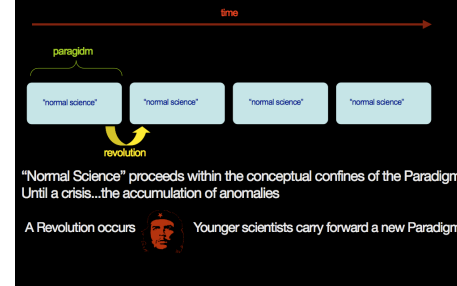
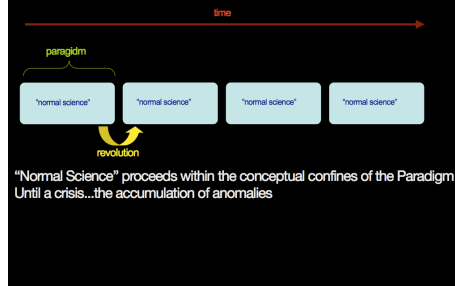
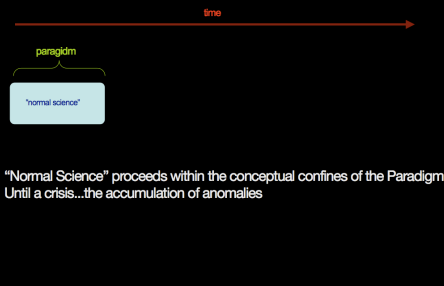
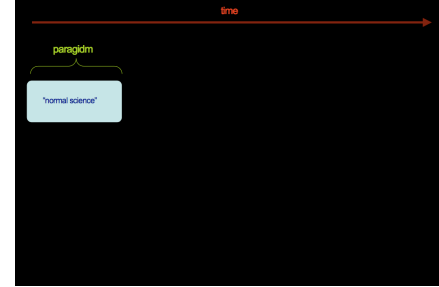
the impact of this book.

Popper's problem, but:

decided that **real science** mostly solved problems ("Normal Science") but "puzzles" become anomalies
Then, a revolution.

paradigm:

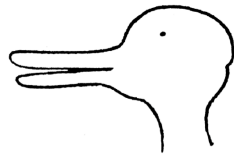
Normal Science works within a Paradigm
Many different interpretations...
essentially a shared body of beliefs, values, techniques, commitments by the community working within the paradigm.



“...something like a paradigm is prerequisite to perception itself. What a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see

Thomas Kuhn

“paradigm” is problematic:



“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible

“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible
SO: science ceases to be steadily progressive and cumulative

“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible
SO: science ceases to be steadily progressive and cumulative
the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs
• it determines what should be questioned and what should not be

“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible
SO: science ceases to be steadily progressive and cumulative
the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs
• it determines what should be questioned and what should not be
relativism was the inevitable outcome, much to Kuhn's dismay
• sociology community now claims that science is their purview
• science has no more claim to Truth than any other form of knowledge.

“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible
SO: science ceases to be steadily progressive and cumulative
the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs
• it determines what should be questioned and what should not be
relativism was the inevitable outcome, much to Kuhn's dismay
• sociology community now claims that science is their purview
• science has no more claim to Truth than any other form of knowledge.
falsification: evidence against at theory is not often used as immediate rejection

“paradigm” is problematic:

language
• across-paradigms, 1) scientific terms don't mean the same things (incommensurability?)
Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible
SO: science ceases to be steadily progressive and cumulative
the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs
• it determines what should be questioned and what should not be
relativism was the inevitable outcome, much to Kuhn's dismay
• sociology community now claims that science is their purview
• science has no more claim to Truth than any other form of knowledge.
falsification: evidence against at theory is not often used as immediate rejection
Very difficult to figure out whether a Paradigm is a big, big thing? or one of a thousand individual commitments that scientists make
• Quantum Theory Paradigm?
• or a particular hypothesis about...say...diatomic molecular spectrum of NaCl

"paradigm" is problematic:

language

- across-paradigms, 1) scientific terms don't mean the same things ("incommensurability?") Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible

SO: science ceases to be steadily progressive and cumulative

(✓) the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs

- it determines what should be questioned and what should not be

relativism was the inevitable outcome, much to Kuhn's dismay

- sociology community now claims that science is their purview
- science has no more claim to Truth than any other form of knowledge.

(✓) falsification: evidence against at theory is not often used as immediate rejection

Very difficult to figure out whether a Paradigm is a big, big thing? or one of a thousand individual commitments that scientists make

- Quantum Theory Paradigm?
- or a particular hypothesis about...say...diatomic molecular spectrum of NaCl

these ring true to me about science ✓

"paradigm" is problematic:

language ✗

- across-paradigms, 1) scientific terms don't mean the same things ("incommensurability?") Newtonian "mass" ≠ Einsteinian "mass" - no universal belief in the meaning of things - and 2) that communication is impossible

SO: science ceases to be steadily progressive and cumulative ✗

(✓) the role of the Community becomes paramount as the Authority on what is acceptable meaning, technique, beliefs

- it determines what should be questioned and what should not be

relativism was the inevitable outcome, much to Kuhn's dismay ✗

- sociology community now claims that science is their purview ✗
- science has no more claim to Truth than any other form of knowledge. ✗

(✓) falsification: evidence against at theory is not often used as immediate rejection

Very difficult to figure out whether a Paradigm is a big, big thing? or one of a thousand individual commitments that scientists make ✗

- Quantum Theory Paradigm?
- or a particular hypothesis about...say...diatomic molecular spectrum of NaCl

these do not ✗

perceived threat to reality

IF:

- scientists form their own criteria for Truth
- paradigm switches are based on other than scientific grounds
- the switch is Gestalt-like...religious conversion-like
- even language meanings depend on your allegiance

then rationality is threatened

scientific progress is non-existent

I think this is not accurate

but it is vogue to define science as a form of Relativism

now rampant within some sociology of science communities

non-realist theories of science

some.

pragmatic empiricists, usually

an alternative:

around 1968, Imre Lakatos had a more subtle methodology:

research program: rules which tell researchers which paths to follow (positive heuristics) & which paths to avoid (negative heuristics).

time →

research program

"hard core": propositions accepted by convention, surrounded by hypotheses which can be questioned

an alternative:

around 1968, Imre Lakatos had a more subtle methodology:

research program: rules which tell researchers which paths to follow (positive heuristics) & which paths to avoid (negative heuristics).

time →

research program

"hard core": propositions accepted by convention, surrounded by hypotheses which can be questioned

positive heuristic

an alternative:

around 1968, Imre Lakatos had a more subtle methodology:

research program: rules which tell researchers which paths to follow (positive heuristics) & which paths to avoid (negative heuristics).

time →

research program

"hard core": propositions accepted by convention, surrounded by hypotheses which can be questioned

positive heuristic

"protective belt of auxiliary hypotheses gets bigger: the target of experimental tests within the research program"

an alternative:

around 1968, Imre Lakatos had a more subtle methodology:

research program: rules which tell researchers which paths to follow (positive heuristics) & which paths to avoid (negative heuristics).

time →

research program

"hard core": propositions accepted by convention, surrounded by hypotheses which can be questioned

positive heuristic

"protective belt of auxiliary hypotheses gets bigger: the target of experimental tests within the research program"

"problemshifts": motivations to further research (predictions, if theoretical; anomalies if experimental)...if successful, then "progressive"; if unsuccessful, then "degenerative".

Too many degenerative problemshifts, or if, say, theoretical problemshifts are not balanced by experimental problemshifts, then the research program is no longer useful.

Scientific Realism

Scientific Realism

the belief in:

Scientific Realism

the belief in:

Entity Realism: things exist (electrons, galaxies,...)

Scientific Realism

the belief in:

Entity Realism: things exist (electrons, galaxies,...)

Theory Realism: descriptions, relationships happen as hypothesized

what do scientists think?

dunno

we tend not to talk about it.

all would be
Scientific Realists:

all would be
Scientific Realists:

all would be
Scientific Realists:

it works

if success is not saying something about reality,
it's a bloody miracle

it works

if success is not saying something about reality,
it's a bloody miracle


there is an ultimate reality "out there"
and we get closer with each success

me:

the whole enchilada




OPINION ALERT



OPINION ALERT


I don't believe in Miracles, so the "it works" argument is persuasive.



OPINION ALERT

I don't believe in Miracles, so the "it works" argument is persuasive.

I believe that entities exist.




OPINION ALERT

I don't believe in Miracles, so the "it works" argument is persuasive.

I believe that entities exist.

I believe that accurate theories describe at least "a part of the truth."




OPINION ALERT

I don't believe in Miracles, so the "it works" argument is persuasive.

I believe that entities exist.

I believe that accurate theories describe at least "a part of the truth."

I hold an artichoke metaphor—every success is digging deeper to the core.



OPINION ALERT

I don't believe in Miracles, so the "it works" argument is persuasive.

I believe that entities exist.

I believe that accurate theories describe at least "a part of the truth."

I hold an artichoke metaphor—every success is digging deeper to the core.

Each layer, if prediction and experiment agree to an expected precision, is as close to **Truth** as human beings can get.

LE has infected
everyday notions of
science:

LE has infected
everyday notions of
science:

LE has infected
everyday notions of
science:

LE has infected
everyday notions of
science:

I'm on a roll, baby.

- scientific knowledge is beyond doubt?
we deal in **doubt & contingency**

- scientific knowledge is beyond doubt?
we deal in **doubt & contingency**
- scientific method is formally grounded?
like a recipe

OPINION ALERT

I'm on a roll, baby.

OPINION ALERT

I'm on a roll, baby.

Repeat. It's all a theory:
some are better tested than others.

OPINION ALERT

I'm on a roll, baby.

Repeat. It's all a theory:
some are better tested than others.

All are vulnerable and to degrees, uncertain...
Hume was right.

OPINION ALERT

I'm on a roll, baby.

Repeat. It's all a theory:
some are better tested than others.

All are vulnerable and to degrees, uncertain...
Hume was right.

All are refutable in principle...
Hume and Popper were right.

whew

...I'm okay now. Thanks.

OPINION ALERT

anyhow.

that's my story, and I'm sticking to it.