

Module 3

Induction and Confirmation

Theory and Reality - Chapter 3



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Overview

- The problem of confirmation
- Deduction, induction, abduction
- Hume's problem of induction
- How to understand confirmation:
 - Hypothetico-deductivism (problems from logic)
 - Instance confirmation (the problem of ravens)
- The new riddle of induction

The problem of confirmation

Observation-----**H**ypothesis

How can **O** confirm **H**?

How does **O** support **H**?

What makes **O** evidence for **H**?

The problem of confirmation

Logical empiricism... Again
(no “state of the art” approaches)

Logical analysis of science

The problem of confirmation

“Logical analysis of science”

P1: **O**bservation 1

P2: **O**bservation 2

Pn: **O**bservation n

Therefore

C: **H**ypothesis (Theory)

The problem of confirmation

Can such inferences from O to H be always deductive?

NO: O \rightarrow Particular cases
H \rightarrow Generalization

There is no purely deductive step from particular to general

Types of inference

P1: Socrates is a man

P2: All men are mortal

C: Socrates is mortal

Deduction

True premises guarantee the truth of the conclusion

Types of inference

P1: In January 1997, it rained in Paris

P2: In January 1998, it rained in Paris

P3: In January 1999, it rained in Paris

C: It rains every January in Paris

Induction

True premises make the conclusion plausible (but not certain)

Types of inference

P1: John loves beer

P2: there is an empty bottle of beer
on John's table

C: John has drunk a beer

Abduction / Explanatory inference /
Inference to the best explanation

True premises make the conclusion
plausible (but not certain)

Induction and abduction

Induction and abduction are non-deductive inferences

They are very common in scientific and in everyday reasoning

Any examples?

Induction in science

(Enumerative) Induction

Swan 1 is white, swan 2 is white...
swan n is white (**O**)

Therefore

All swans are white
(**H**)



Abduction in science

Abduction / Explanatory infer.

There are unusually high levels of some rare chemical elements, such as iridium, in layers of the earth's crust that are about 65 million years old (**O**)

Therefore (**H**)



Induct. logic and form

NOTICE: while inductive logic (unlike deductive l.) cannot provide certainty, some logical empiricists (Hempel) tried to develop a theory of confirmation based on modeling inductive logic on deductive logic in the sense of stressing its formal aspects

Induct. logic and form

P1: Socrates is a man

P2: All men are mortal

C: Socrates is mortal

P1: A is B

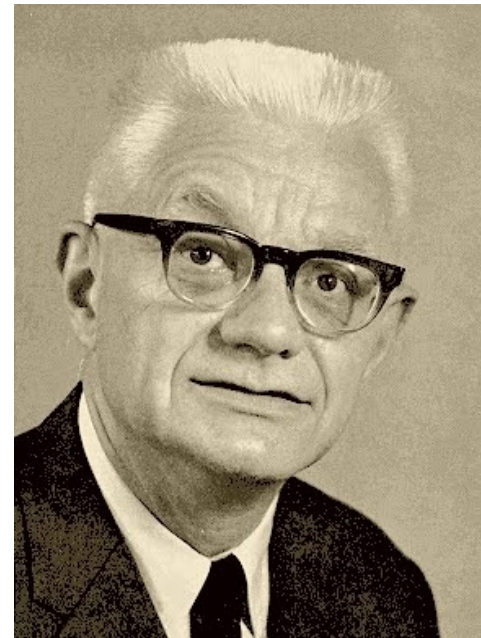
P2: All Bs are D

C: A is D

Induct. logic and form

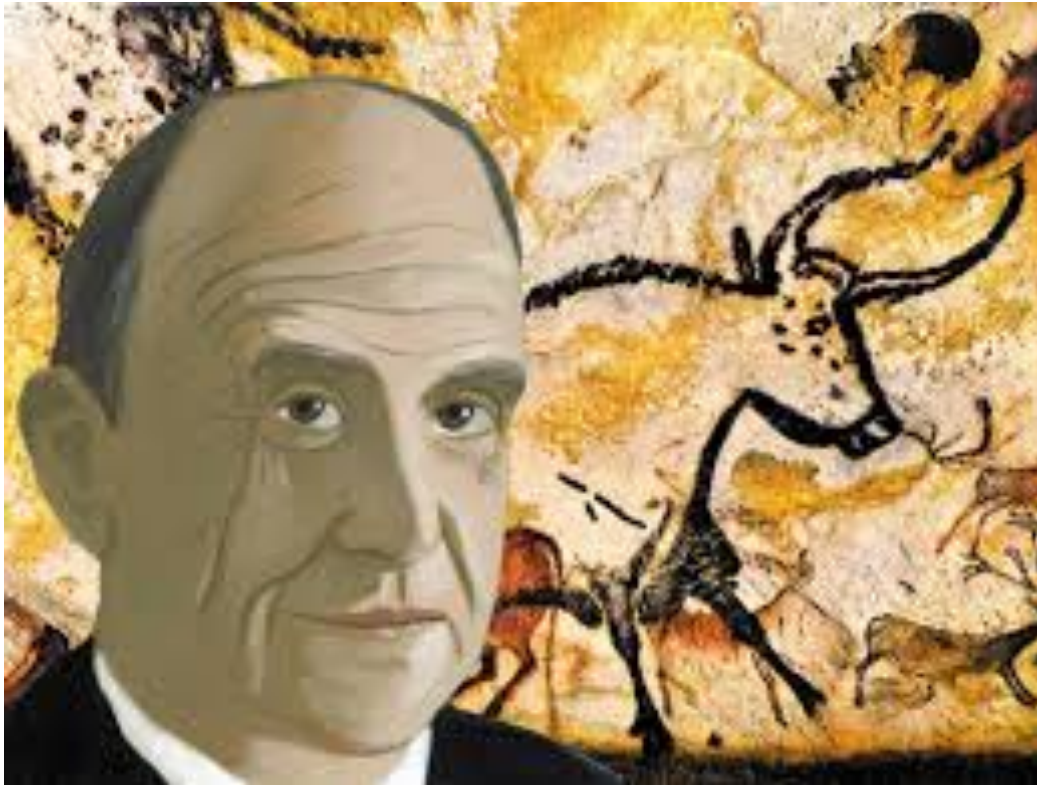
Logical empiricists like Hempel tried to develop a purely formal theory of confirmation – in which inductive inferences can be assessed on the basis of their form

(Carnap worked on the theory of probability)



Induct. logic and form

Nelson Goodman provided reason to believe that this cannot work



Historical digression: the problem of induction

What reason do we have for thinking that the future will resemble the past?



Historical digression: the problem of induction



What reason do we have for expecting the sun to rise tomorrow?

Historical digression: the problem of induction



P: the sun has risen every day so far

C: the sun will raise tomorrow

But in principle the future might differ from the past

Historical digression: the problem of induction



P: the sun has risen every day so far

C: the sun will rise tomorrow

Hume as an **inductive skeptic**:
Induction is psychologically natural,
but has no rational basis

Hume's skepticism: videos

Hume's Skepticism and
Induction, Part 1

<https://www.youtube.com/watch?v=-QpUrSn3cWU>

Hume's skepticism: videos

	Relations of ideas	Matters of fact
Metaphysical	Necessary	Contingent
Semantical / Logical	Analytic	Synthetic
Epistemological	A priori	A posteriori
Example	" $2+2=4$ "	"Some cats are black" <small>22</small>

Hume's skepticism: videos

Hume's Skepticism and
Induction, Part 2

<https://www.youtube.com/watch?v=dPINsyXI-0c>

How to understand confirmation in science

2 proposals (and related problems):

- Hypothetico-deductivism
- Confirmation by instances (Hempel's view)

Hypothetico-deductivism

Hypotheses in science are confirmed when their logical consequences turn out to be true

Hypothetico-deductivism

Logical consequence

A: 210000 people live in Padua

B: more than 150000 people live in Padua

If A is true, B cannot be false; If A is true, then necessarily B is true; B follows logically from A

Hypothetico-deductivism

Logical consequence

P1: Socrates is a man

P2: All men are mortal

C: Socrates is mortal

The conclusion of a deductively valid argument is a logical consequence of the premises

Hypothetico-deductivism

A: All swans are white



B: Swans 1, 2... n are white

B is a logical consequence of A

Hypothetico-deductivism

H: All swans are white



O: Swans 1, 2... n are white

Observational statement is a logical consequence of the **H**ypothesis

Hypothetico-deductivism



Observational statement is a logical consequence of the **H**ypothesis

Hypothetico-deductivism: if observational statements derived from H are true, then H is confirmed

Hypothetico-deductivism

If observational statements derived from H are true, then H is confirmed

ISN'T THIS CLEARLY TRUE?

NOT SO FAST!

Problems from simple logic

Logical disjunction (OR)

A: Padua is in Italy

T

B: Stefano Cossara is male

T

$A \vee B$: Padua is in Italy or Stefano Cossara is male

T

Logical disjunction (OR)

A: Padua is in Italy

T

B: Stefano Cossara is female

F

$A \vee B$: Padua is in Italy or Stefano Cossara is female

T

Logical disjunction (OR)

A: Padua is in France

F

B: Stefano Cossara is male

T

$A \vee B$: Padua is in France or Stefano Cossara is male

T

Logical disjunction (OR)

A: Padua is in France

F

B: Stefano Cossara is female

F

$A \vee B$: Padua is in France or Stefano Cossara is female

F

Logical disjunction (OR)

A	B	A∨B
True	True	True
True	False	True
False	True	True
False	False	False

A∨B is false if and only if both A and B are false

Logical disjunction (OR)

A	B	A∨B
True	True	True
True	False	True
False	True	True
False	False	False

If A is true, then necessarily A∨B is true [the same applies to B]

Logical disjunction (OR)

A	B	A∨B
True	True	True
True	False	True
False	True	True
False	False	False

A∨B is a logical consequence of A
[the same applies to B]

Hypothetico-deductivism

$A \vee B$ is a logical consequence of A

$H \vee B$ is a logical consequence of H
(H being any scientific hypoth.)

H : The speed of light is 186,000
mi/sec

B : Stefano Cossara is male

Hypothetico-deductivism

$A \vee B$ is a logical consequence of A

$H \vee B$ is a logical consequence of H
(H being any scientific hypoth.)

“The speed of light is 186,000 mi/sec or Stefano Cossara is male” ($H \vee B$) is a logical consequence of “The speed of light is 186,000 mi/sec” (H)

Hypothetico-deductivism

“The speed of light is 186,000 mi/sec or Stefano Cossara is male” (HvB) is a logical consequence of “The speed of light is 186,000 mi/sec” (H)

Hypothetico-deductivism says that hypotheses in science are confirmed when their logical consequences turn out to be true.

Hypothetico-deductivism

“The speed of light is 186,000 mi/sec or Stefano Cossara is male” (HvB) is a logical consequence of “The speed of light is 186,000 mi/sec” (H)

Hypothetico-deductivism says that H is confirmed when (HvB) turns out to be true.

Hypothetico-deductivism

“The speed of light is 186,000 mi/sec or Stefano Cossara is male” (HvB) is a logical consequence of “The speed of light is 186,000 mi/sec” (H)

How to establish when (HvB) is true?

Hypothetico-deductivism

H	B	HvB
True	True	True
True	False	True
False	True	True
False	False	False

If B is true, then necessarily HvB is true

Hypothetico-deductivism

If B is true, then necessarily $H \vee B$ is true

In order to establish that $H \vee B$ is true, I just need to check that B is true (Stefano Cossara is male): very easy!

Hypothetico-deductivism

According to hyp-deduct, if HvB is true, then H is confirmed

According to hyp-deduct, if “The speed of light is 186,000 mi/sec or Stefano Cossara is male” is true, then “The speed of light is 186,000 mi/sec” is confirmed

Hypothetico-deductivism

According to hyp-deduct, if H_vB is true, then H is confirmed

According to hyp-deduct, if “Stefano Cossara is male” is true, then “The speed of light is 186,000 mi/sec” is confirmed

ABSURD: confirmation too easy!

The ravens problem



(For Hempel's view)

The ravens problem

How is it that repeated observations of black ravens can confirm the generalization that all ravens are black?

Hempel: all observations of instances of black ravens confirm the generalization that all ravens are black

The ravens problem

All observations of an F that is also G supports the generalization
"All F's are G"

The ravens problem

All observations of an F that is also G supports the generalization "All F's are G"

ISN'T THIS CLEARLY TRUE?

NOT SO FAST!

Logical equivalence

Two sentences that say the same thing with different words

Two sentences such that, if the first is true, then the second cannot be false

Logical equivalence

1. John went to the store after he washed the dishes
2. John washed the dishes before he went to the store

The ravens problem

Or 'paradox': a set of ideas that seem individually plausible, but give rise to an apparently implausible conclusion

The ravens problem

1. Observations of black ravens confirm the generalization that all ravens are black
2. Any observation that confirms hypothesis H also confirms a logically equivalent hypothesis H'
3. "All ravens are black" equivalent to "All nonblack things are not ravens"

The ravens problem

Observing a nonblack thing that is not a raven confirms “All nonblack things are not ravens”

In virtue of logical equivalence, it also confirms “All ravens are black”



The ravens problem

Thus, observing a nonblack thing that is not a raven (e.g., a white shoe), confirms “All ravens are black”

ABSURD! “Indoor ornitology”



The ravens problem

Reactions

Hempel: bite the bullet (Observing a white shoe does confirm the hypothesis that all ravens are black, though presumably only by a tiny amount)

The ravens problem

Reactions

Good (1967): Perhaps observing a white shoe or a black raven may or may not confirm “All ravens are black.” It depends on other factors.

(Holism)

The ravens problem

Reactions

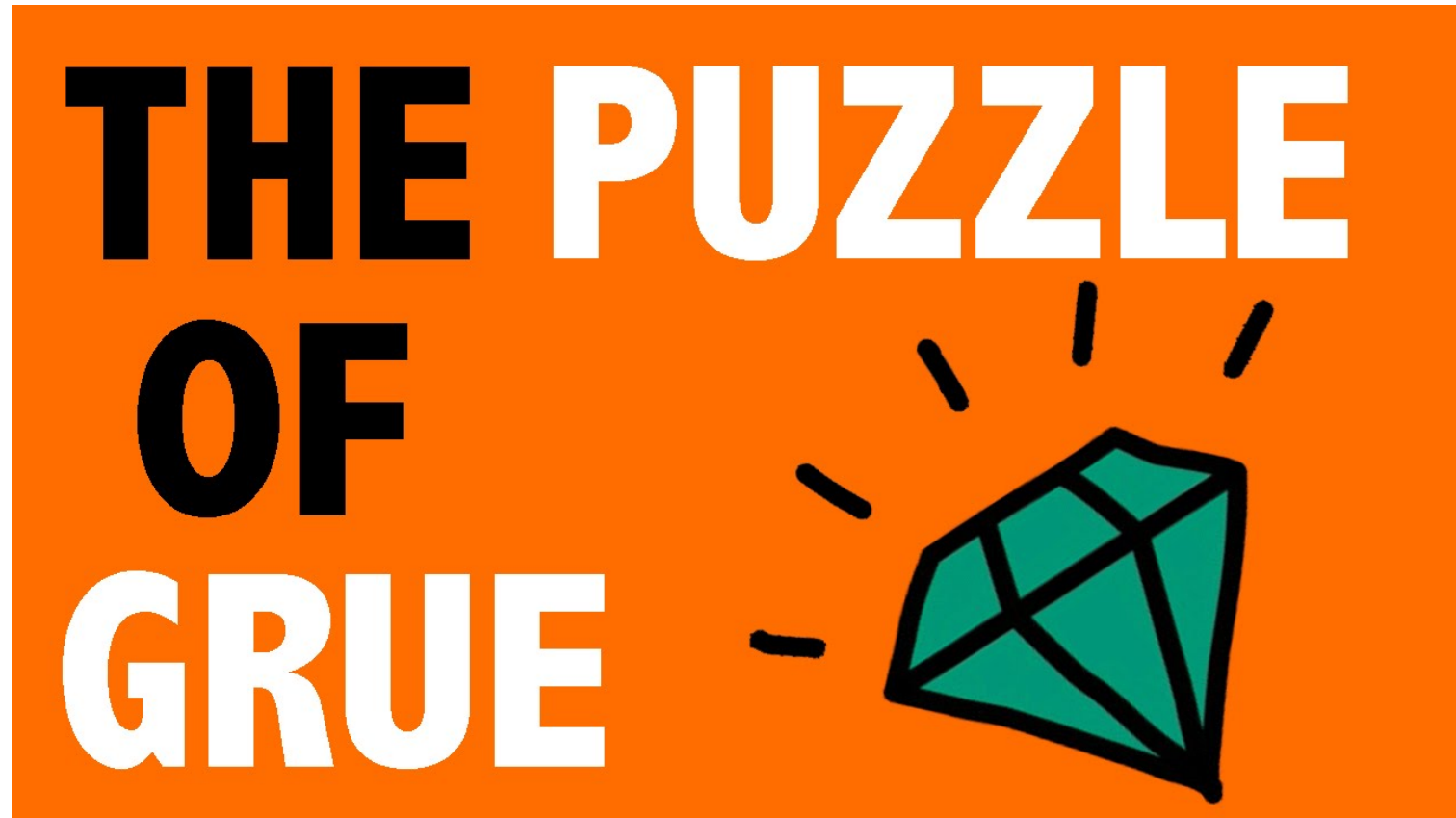
GS: Whether or not a black raven or a white shoe confirms “All ravens are black” might depend on the order in which you learn of the two properties of the object.

The ravens problem

Video

[https://www.youtube.com/watch?
v= SKmqh5Eu4Y](https://www.youtube.com/watch?v=SKmqh5Eu4Y)

The new riddle of induction

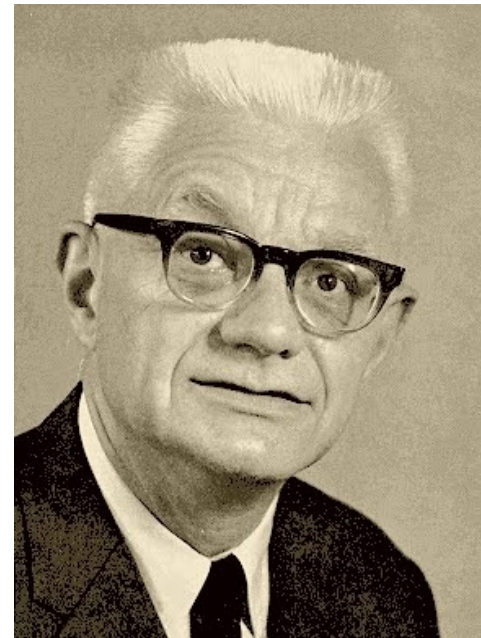


By Nelson Goodman

The new riddle of induction

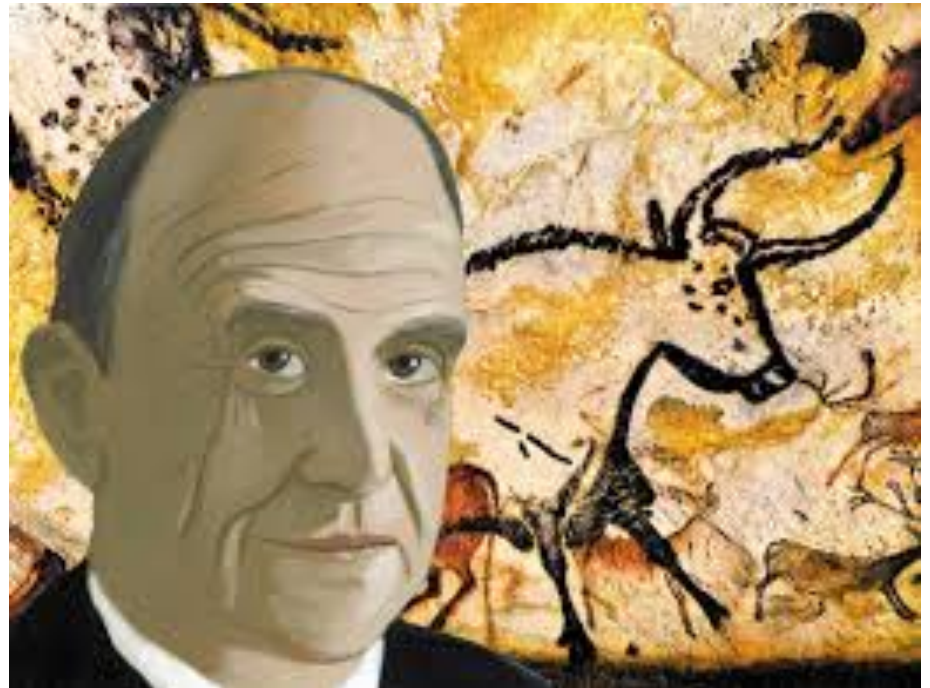
Logical empiricists like Hempel tried to develop a purely formal theory of confirmation – in which inductive inferences can be assessed on the basis of their form

(Carnap worked on the theory of probability)



The new riddle of induction

Nelson Goodman provided reason to believe that this cannot work: there cannot be a purely formal theory of confirmation



The new riddle of induction

Socrates is a man

All men are mortal

Therefore, Socrates is mortal

Socrates is a man

All men are carrots

Therefore, Socrates is a carrot

The new riddle of induction

(The first only contains true premises are true, the second also contains one false premise) BUT
They are both valid: same form

A is B

All Bs are Cs

Therefore, A is C

The new riddle of induction

- The moral: when it comes to validity, only form matters
- The logical empiricists would like a theory of confirmation (based on inductive logic) in which only form matters
- Goodman: no such theory can be constructed

The new riddle of induction

Goodman's reasoning:

- There are ind. arg. with the same form, but one good and one bad
- Therefore, form is not sufficient to distinguish good from bad ind. arg.
- Therefore, a theory of confirmation exclusively focused on form ('purely formal') cannot work

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been green
- Therefore, all emeralds are green

Inductive or deductive? Good or bad?

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been green
- Therefore, all emeralds are green

A good inductive argument

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been grue
- Therefore, all emeralds are grue

Grue: An object is grue if and only if it was first observed before 2018 and is green, or if it was not first observed before 2018 and is blue

The new riddle of induction



Before 2018

Before 2018

Not bef. 2018

Grue: An object is grue if and only if it was first observed before 2018 and is green, or if it was not first observed before 2018 and is blue

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been grue
- Therefore, all emeralds are grue

Inductive or deductive? Good or bad?

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been grue
- Therefore, all emeralds are grue

A bad inductive argument

The new riddle of induction



A - Before 2018

B - Not Before 2018

All emeralds observed before 2018 are like A... Therefore, all emeralds observed starting from 2018 will be like B: **BAD!**

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been grue
- Therefore, all emeralds are grue

A bad inductive argument:

It suggests that emeralds observed in the future will be blue on the basis of previously observed green emeralds

The new riddle of induction

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been green [good]
- Therefore, all emeralds are green

- All the many emeralds observed, in diverse circumstances, prior to 2018 have been grue [bad]
- Therefore, all emeralds are grue

But they have the same form!

The new riddle of induction

- Two inductive arguments with the same form, but one good, the other bad
- Hence, form is insufficient to distinguish good from bad inductive arguments
- Therefore a purely formal theory of confirmation cannot work – contra logical empiricism

The new riddle of induction

What's wrong with grue?

1) Reference to time (“before 2018 and is green, or if it was not first observed before 2018 and is blue”)

The new riddle of induction

What's wrong with grue?

2) 'Green' identifies a natural kind,
'grue' does not

Natural kind=grouping that reflects
the structure of the natural world,
as opposed to an artificial grouping

The new riddle of induction

Periodic Table of the Elements

Legend:

- Metals
- Transition Elements
- ☢ Radioactive
- Nonmetals
- Lanthanide Series
- ⚡ Synthetic
- Noble Gases
- Actinide Series

Callout for Oxygen (O):

- Group notation: VIA
- Atomic Number: 8
- Number of electrons in each shell: 2, 6
- Symbol: O
- Name: Oxygen
- Atomic Mass: 15.9994
- Period: 2

1 H Hydrogen 1.00784																	18 He Helium 4.00206											
2 3 Li Lithium 6.941	4 Be Beryllium 9.012182																	10 Ne Neon 20.1797										
3 11 Na Sodium 22.98977	12 Mg Magnesium 24.3050																	18 Ar Argon 39.948										
4 19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.9559	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.93805	26 Fe Iron 55.845	27 Co Cobalt 58.93320	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80											
5 37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29											
6 55 Cs Cesium 132.9054	56 Ba Barium 137.327	57-71 La-Lu Lanthanide Series										72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)		
7 87 Fr Francium (223)	88 Ra Radium 226.025	89-103 Ac-Lr Actinide Series										104 Unq Unnilquadium (261)	105 Unp Unnilpentium (262)	106 Unh Unnilhexium (263)	107 Uns Unnilseptium (264)	108 Uno Unniloctium (265)	109 Une Unnilenium (266)	110 Uun Ununnilium (269)	111 Uuu Unununium (272)									
		57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9303	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967												
		89 Ac Actinium 227.028	90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium 237.048	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)												

The new riddle of induction

JOBS



Accountant



Barber



Barman



Builder



Butcher



Chef



Cashier



Dentist



Engineer



Fireman



Doctor



Judge



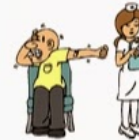
Hairdresser



Lawyer



Optician



Nurse



Policeman



Postman



Reporter



Scientist



Vet



Plumber



Waiter/Waitress



Carpenter

The new riddle of induction

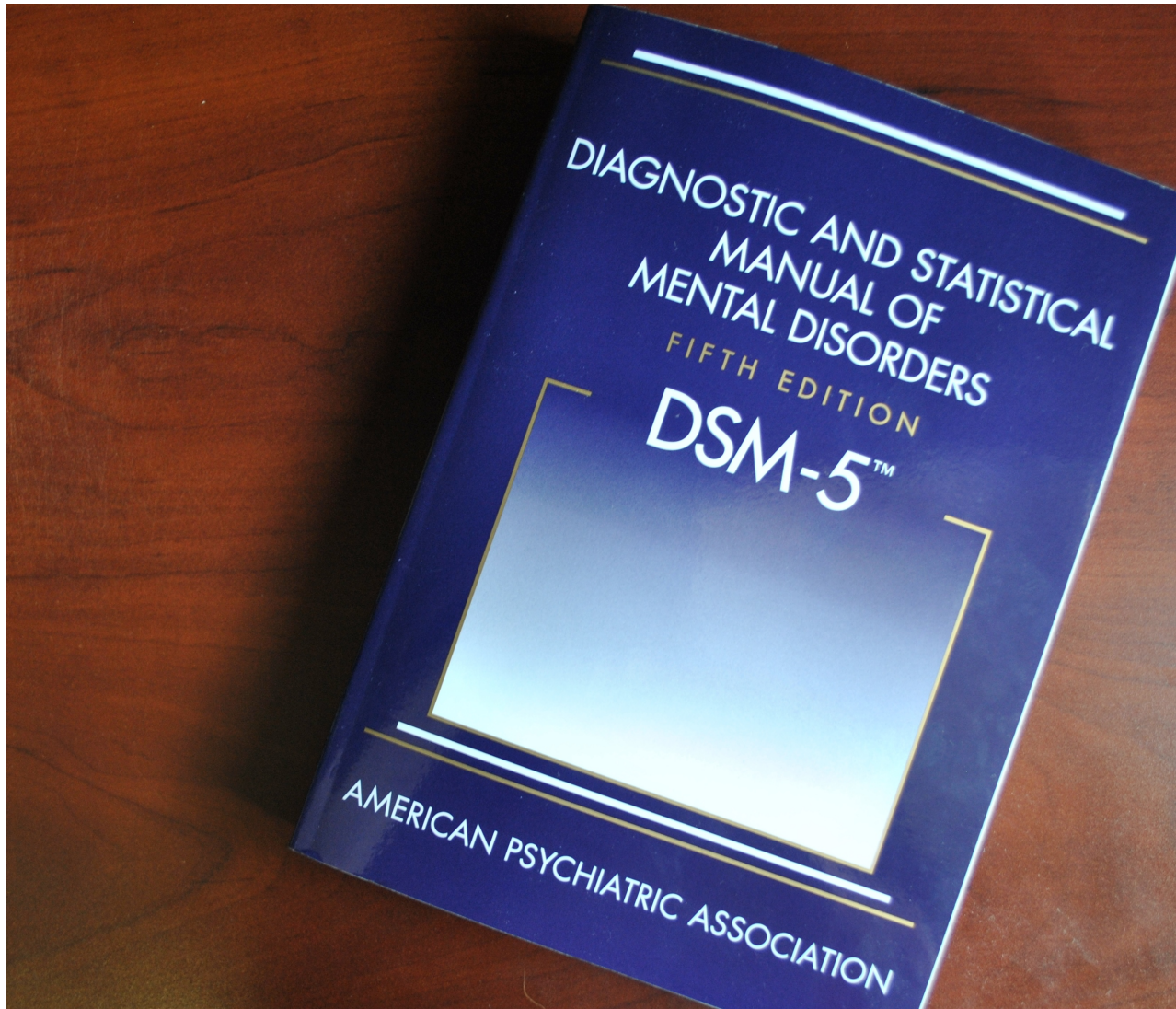
What's wrong with grue?

2) 'Green' identifies a natural kind,
'grue' does not

Natural kind=grouping that reflects
the structure of the natural world,
as opposed to an artificial grouping

PROBLEM: not always clear which
kinds are natural

The new riddle of induction



The new riddle of induction

Video

<https://www.youtube.com/watch?v=1rUCyg4Ppso>