Ontological Imperialism

Barry Smith

Presented at GIScience 2000: First International Conference on Geographic Information Science, Savannah, Georgia

October 28, 2000

information systems
databases
organizations
language-communities
sciences
religions
maps

Each involves a certain *conceptualization*

= a system of concepts pertaining to a given domain

... concepts that are more or less coherently *specified*

‘An ontology is a specification of a conceptualization’ (Gruber)

Why make ontologies?

To provide a stable forum for
translation and interoperability
as between different conceptualizations

– a common system of concepts
in terms of which different
information communities can talk to
each other and exchange data

Ontology, for Gruber, is a branch of KR

It starts with our conceptualizations,

and sees how far we can push through from there to a description of corresponding domains of objects ('models')

KR Ontology

deals with the generated correlates of both good and bad conceptualizations

– with surrogate created worlds

– with ‘universes of discourse’

Not all conceptualizations are equal

Bad conceptualizations: story-telling, myth-making, legacy information systems based on insecure foundations ...

Good conceptualizations:

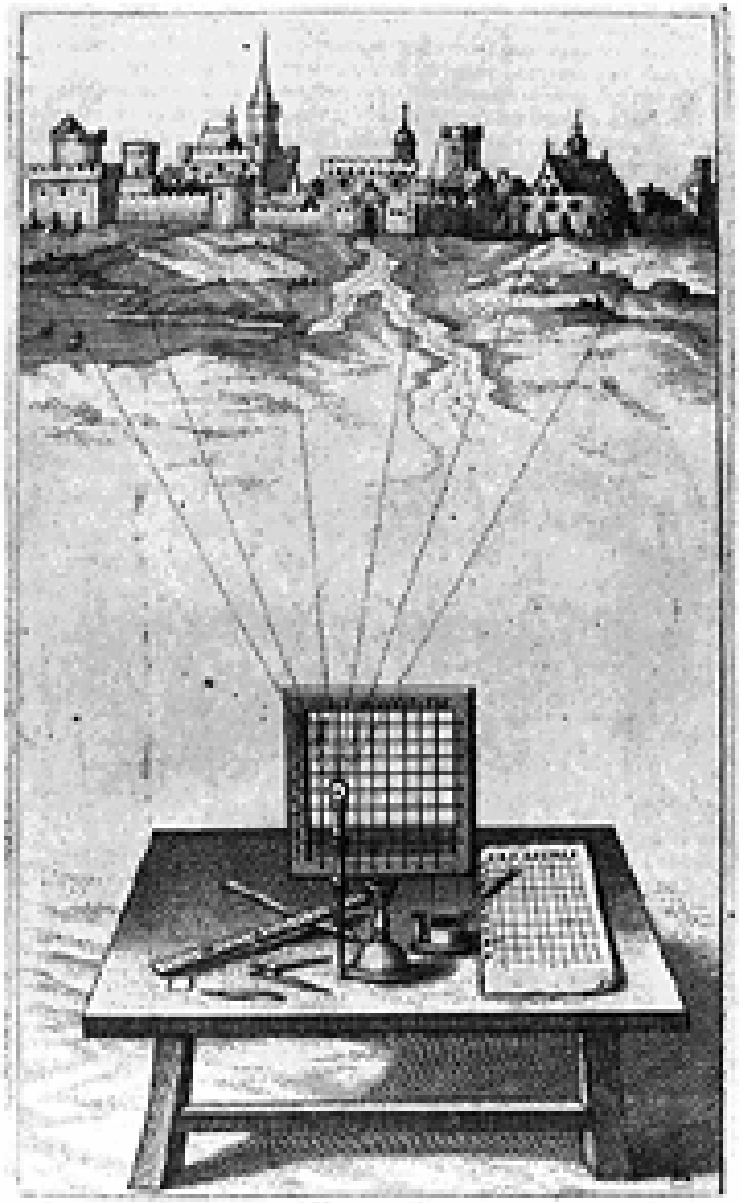
science (mostly)

what else?

bad conceptualizations = relate *merely* to a created, surrogate world

good conceptualizations = transparent to some independent reality beyond

A transparent conceptualization is a **partition of reality**



Alberti's Grid

Ontology should foster transparent conceptualizations (*veridical* perspectives on reality)

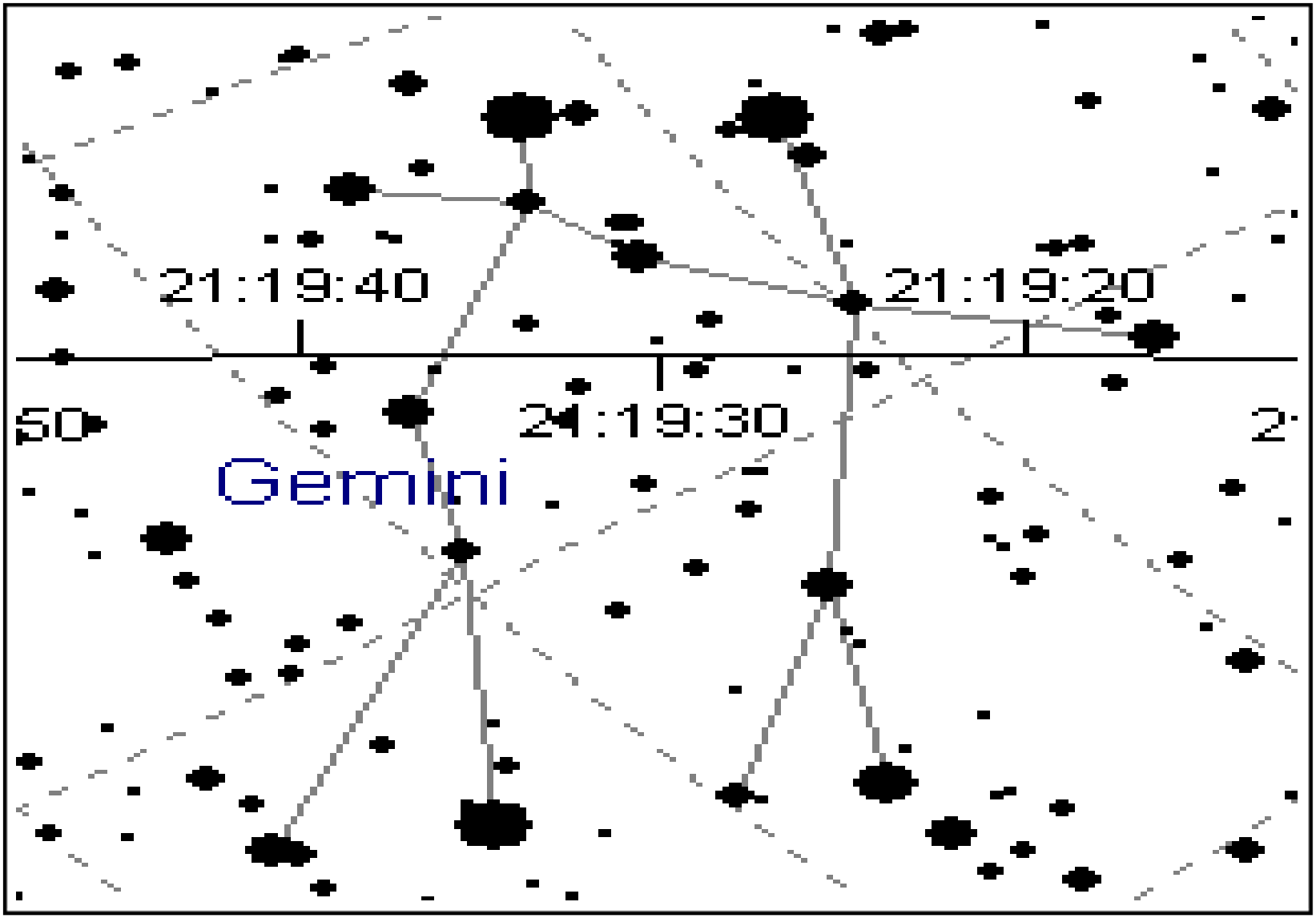
It should provide a constraint on conceptualizations (Guarino)

Transparent conceptualizations

The sciences provide us with a good first clue as to what these are

Scientific conceptualizations

= those based on theories which have survived rigorous empirical tests

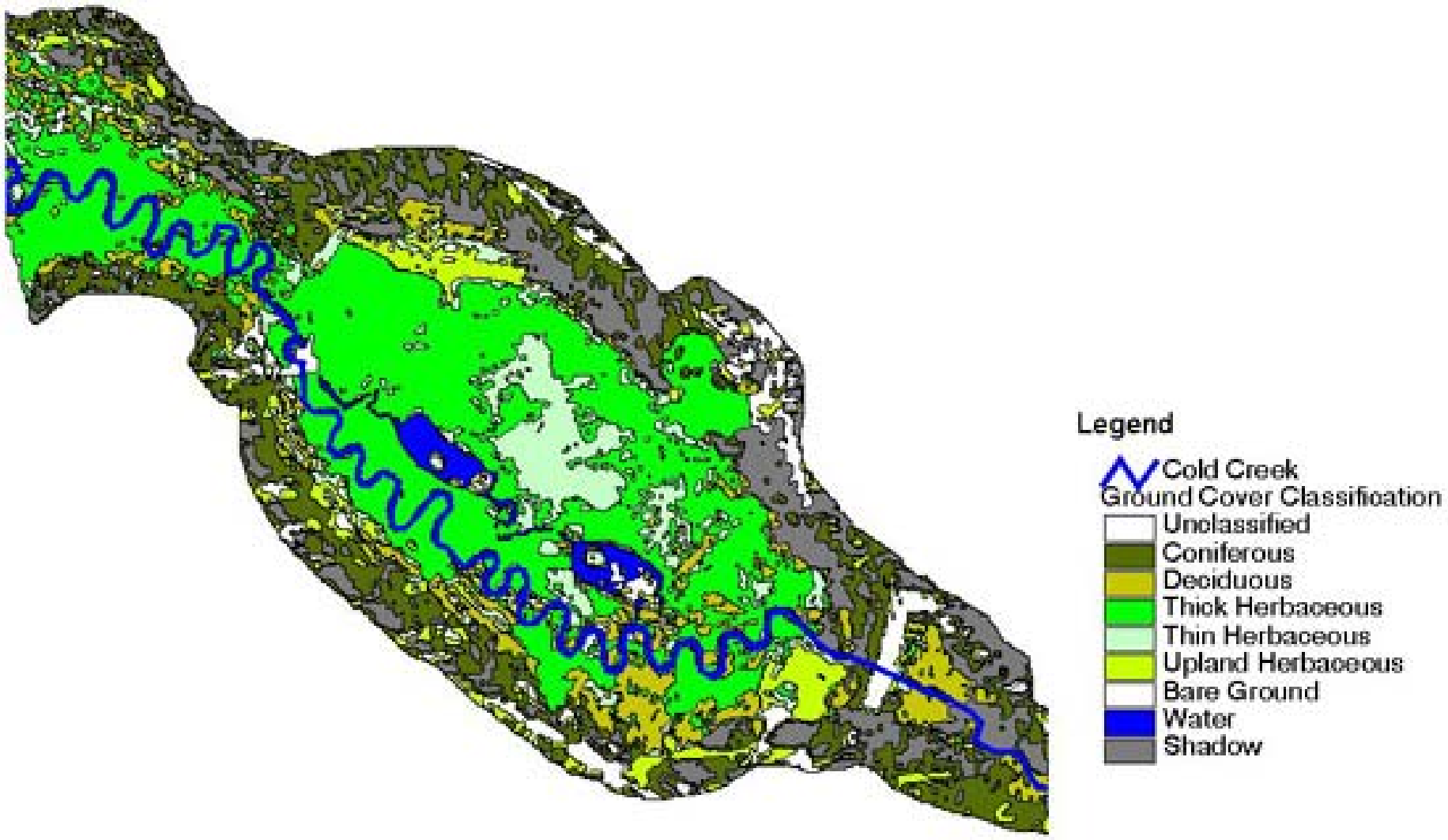

21:19:40
21:19:20
50
24:19:30
2
Gemini

H 1																	He 2
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	**Au** 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
Fr 87	Ra 88	Ac 89	Rf 104	Ha 105	?? 106												
Lanthinide Series		Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71		
Actinide Series		Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103		

Perspectivalism

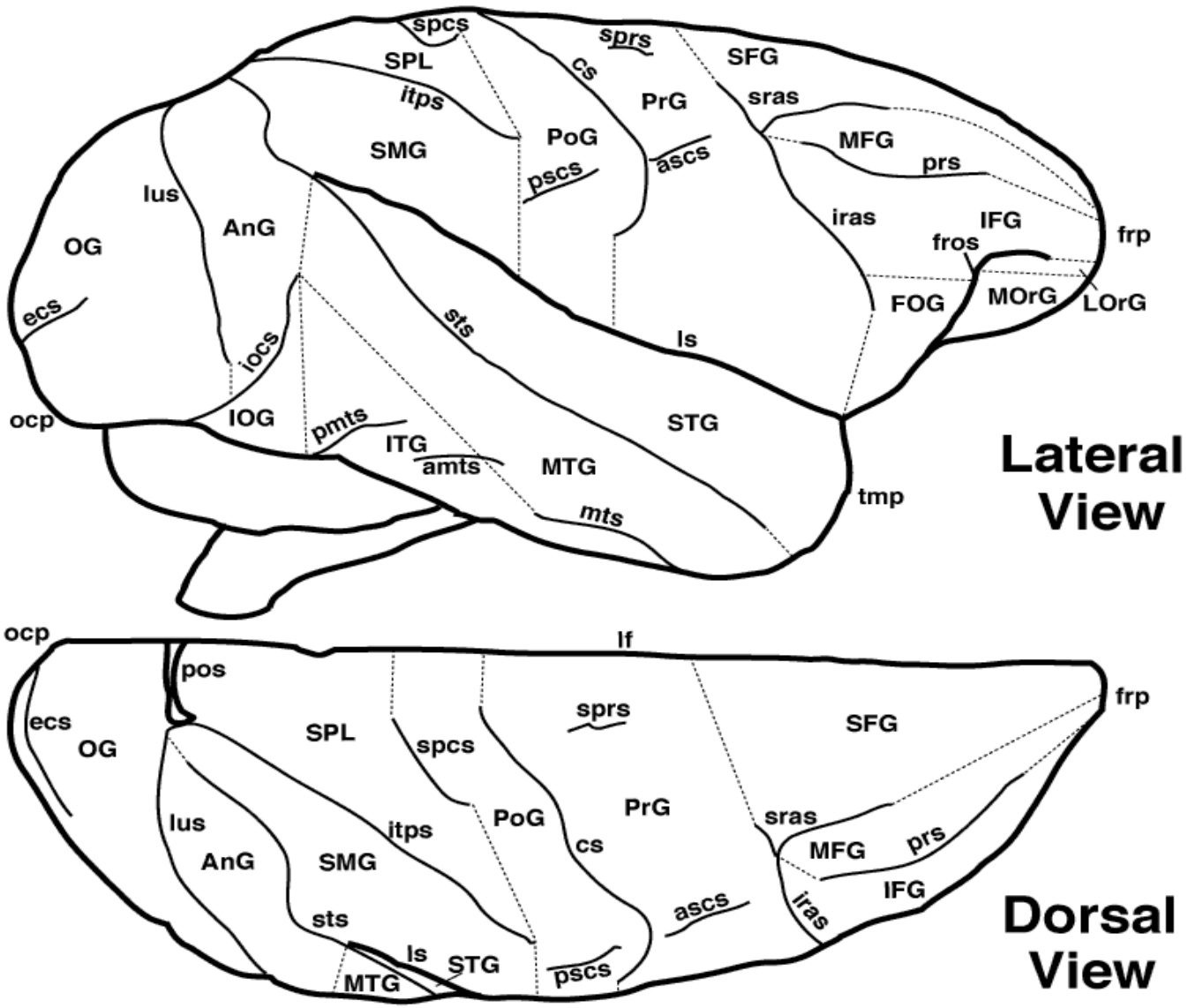
Different conceptualizations may represent cuts through the same reality which are skew to each other

... astronomy ... chemistry ...



Complementary perspectives

All veridical perspectives are equal, but some are more equal than others


spcs
sprs
SPL
cs
SFG
itps
PrG
sras
PoG
MFG
SMG
ascs
prs
pscs
lus
AnG
iras
IFG
frp
OG
fros
ecs
FOG
MOrG
LOrG
sts
ls
iocs
ocp
IOG
pmts
STG
ITG
amts
MTG
tmp
mts
Lateral View
ocp
lf
pos
frp
ecs
sprs
SFG
OG
SPL
spcs
PrG
PoG
sras
lus
itps
cs
MFG
prs
AnG
SMG
IFG
ascs
iras
sts
ls
STG
pscs
MTG
Dorsal View

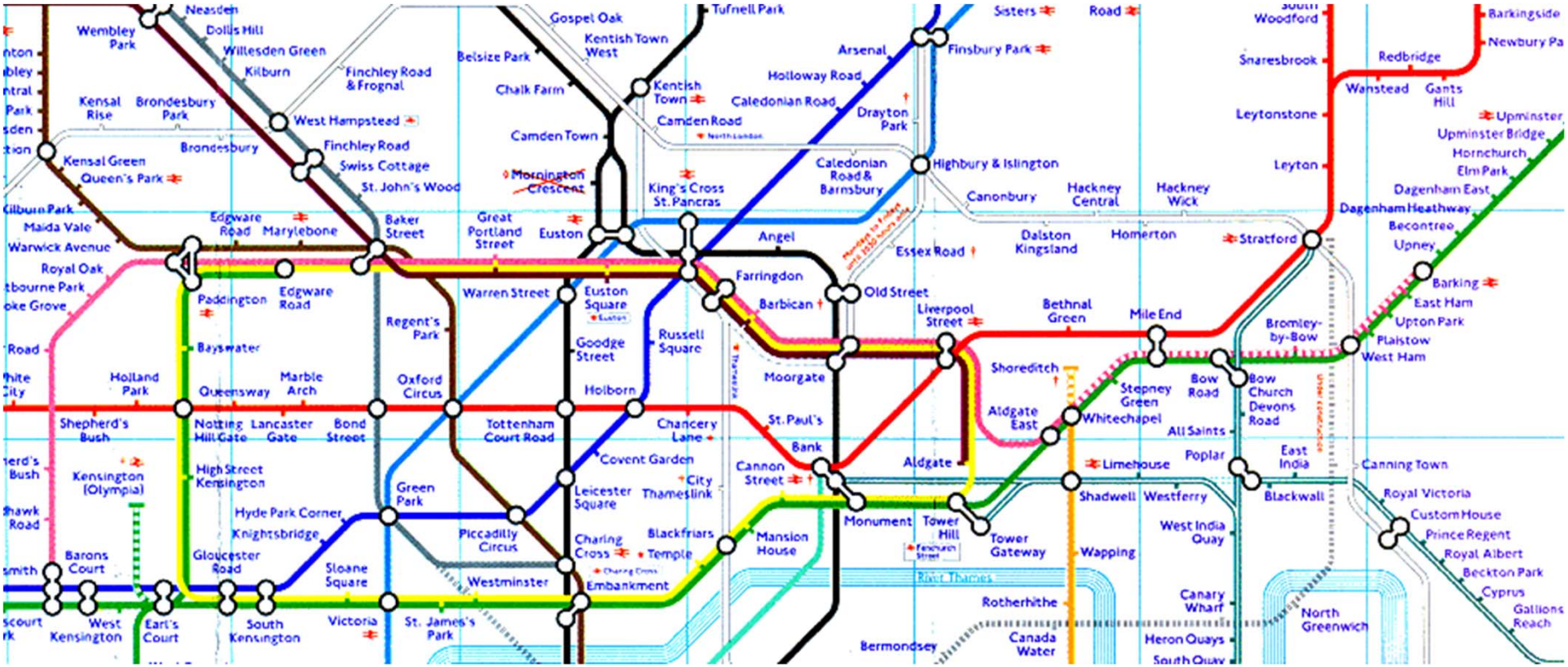
Science and prediction

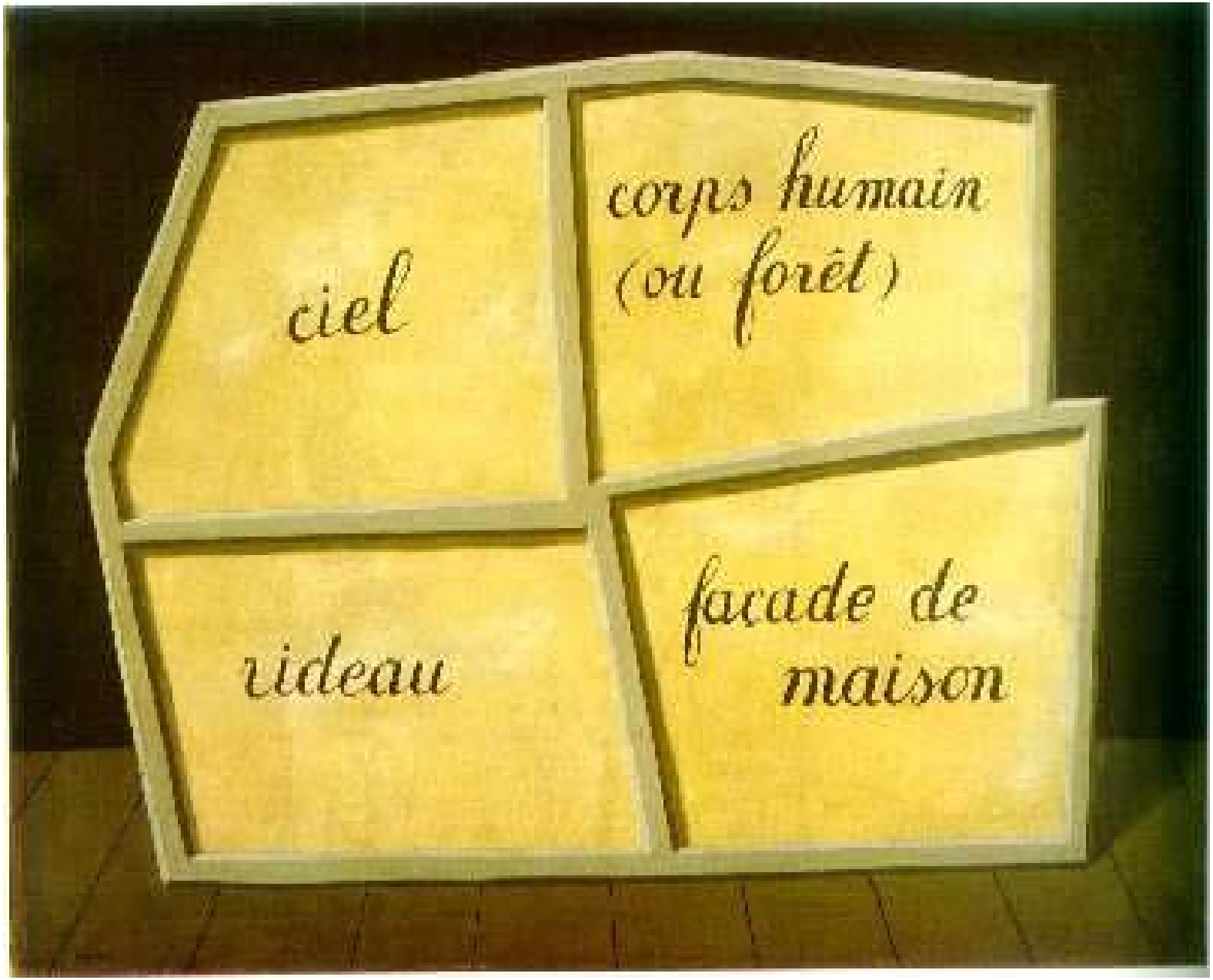
The perspectival cuts through reality yielded by the different sciences capture dimensions of reality *in relation to which we can develop predictive theories*

Scientific conceptualizations are transparent

they illuminate some features of the underlying reality and trace over others

Are there transparent conceptualizations outside science?




ciel
corps humain
(ou forêt)
rideau
façade de
maison

the conceptualization of **core common sense**

= the conceptualization shared by children and adults in everyday perceiving and acting

... it, too, is transparent

... it, too, illuminates some features of the underlying reality and traces over others

Common-sense reality

= the world as apprehended via the conceptualization of core common sense (the middle-sized world)

= the world of *mothers, chairs, cats, rivers, and trees*

= the normal environment or *niche* which human beings share in common

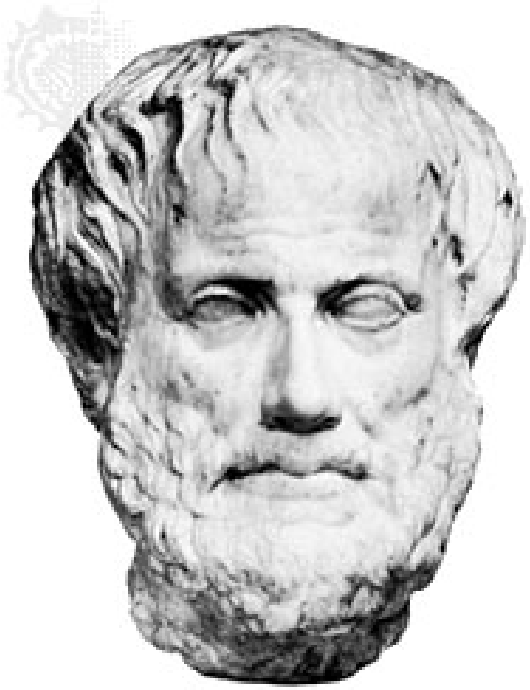
core common sense is true

mothers, chairs, cats, rivers and trees *exist*

if we did not have many true beliefs about such objects we would all be dead

All human beings are experts as concerns common-sense reality

... but our shared knowledge is tacit only, it does not take the form of explicit theory



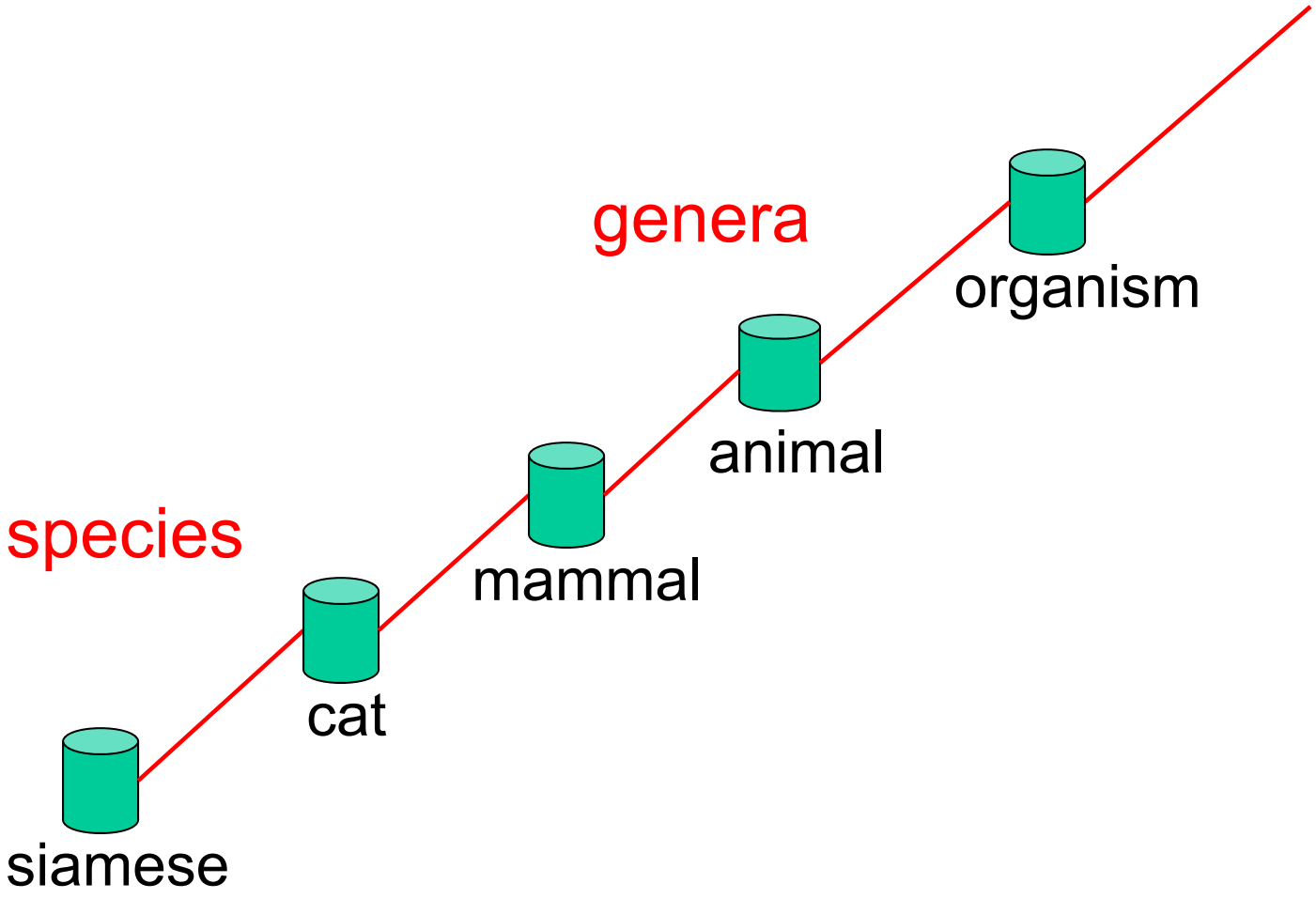
Aristotle, the world's first ontologist,

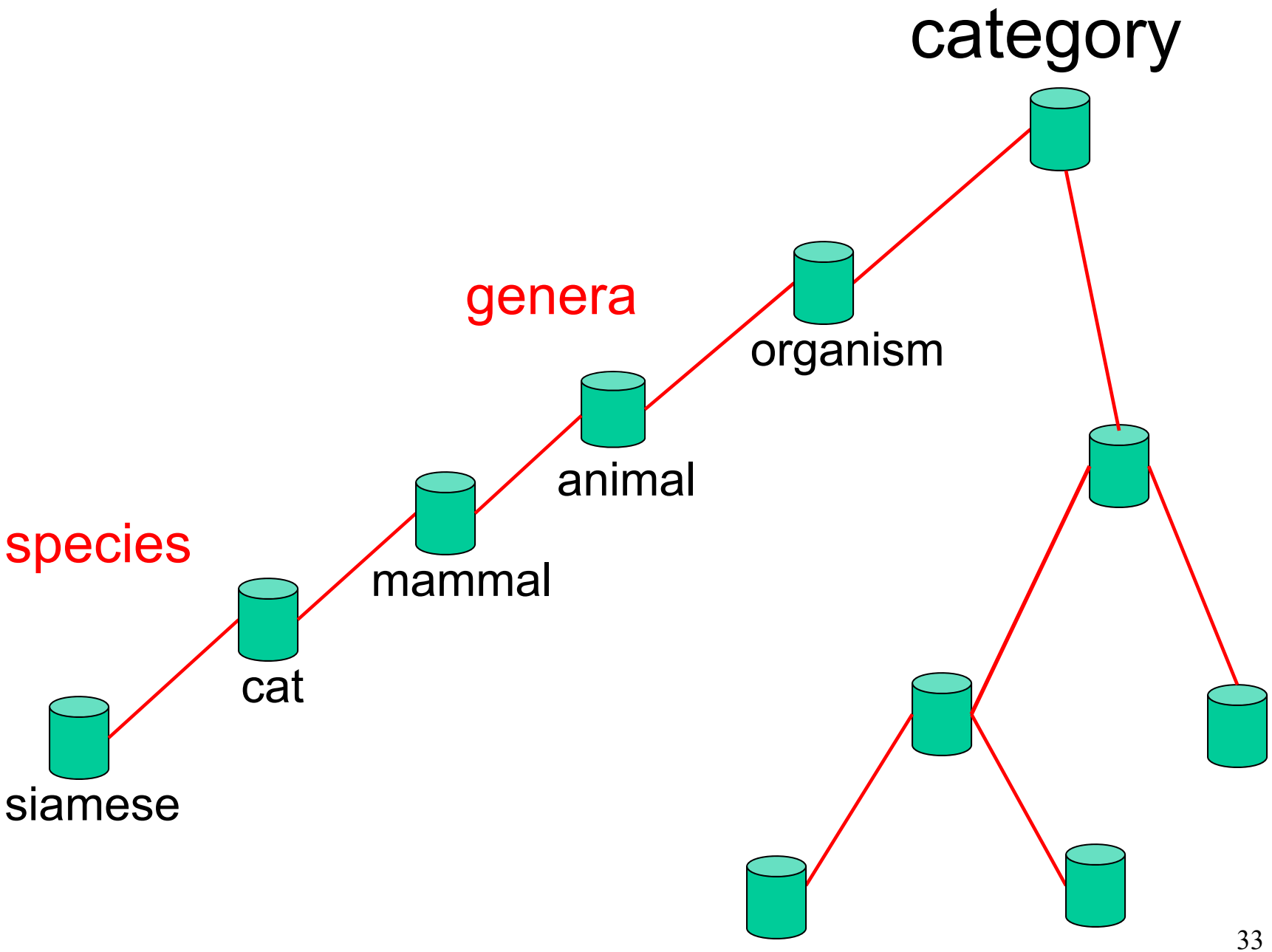
provides an explicit theory of common-sense reality

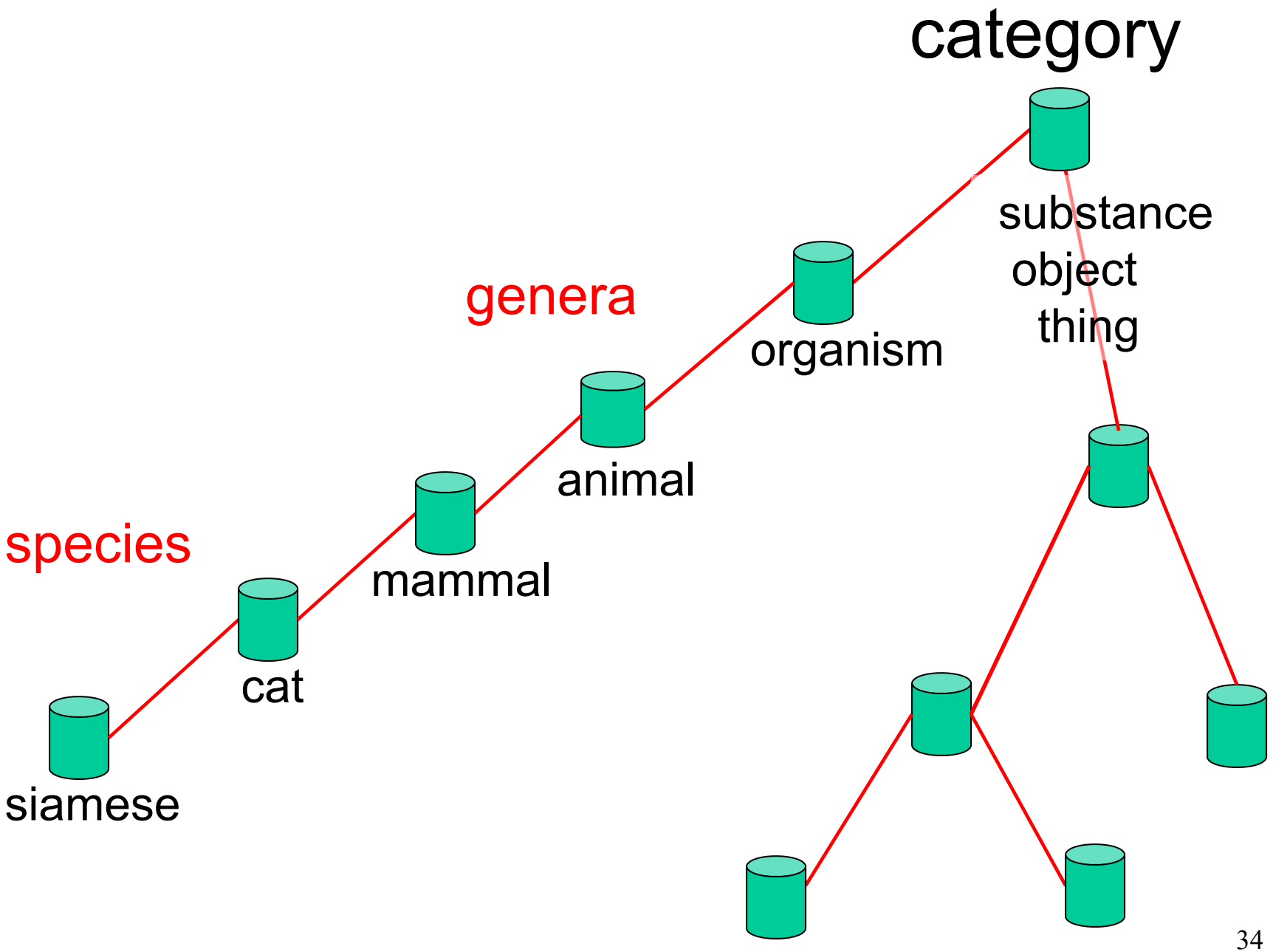
Common-sense reality is first of all the world of table-top space, of animals, furniture, toys ...

– a space centered on *objects*

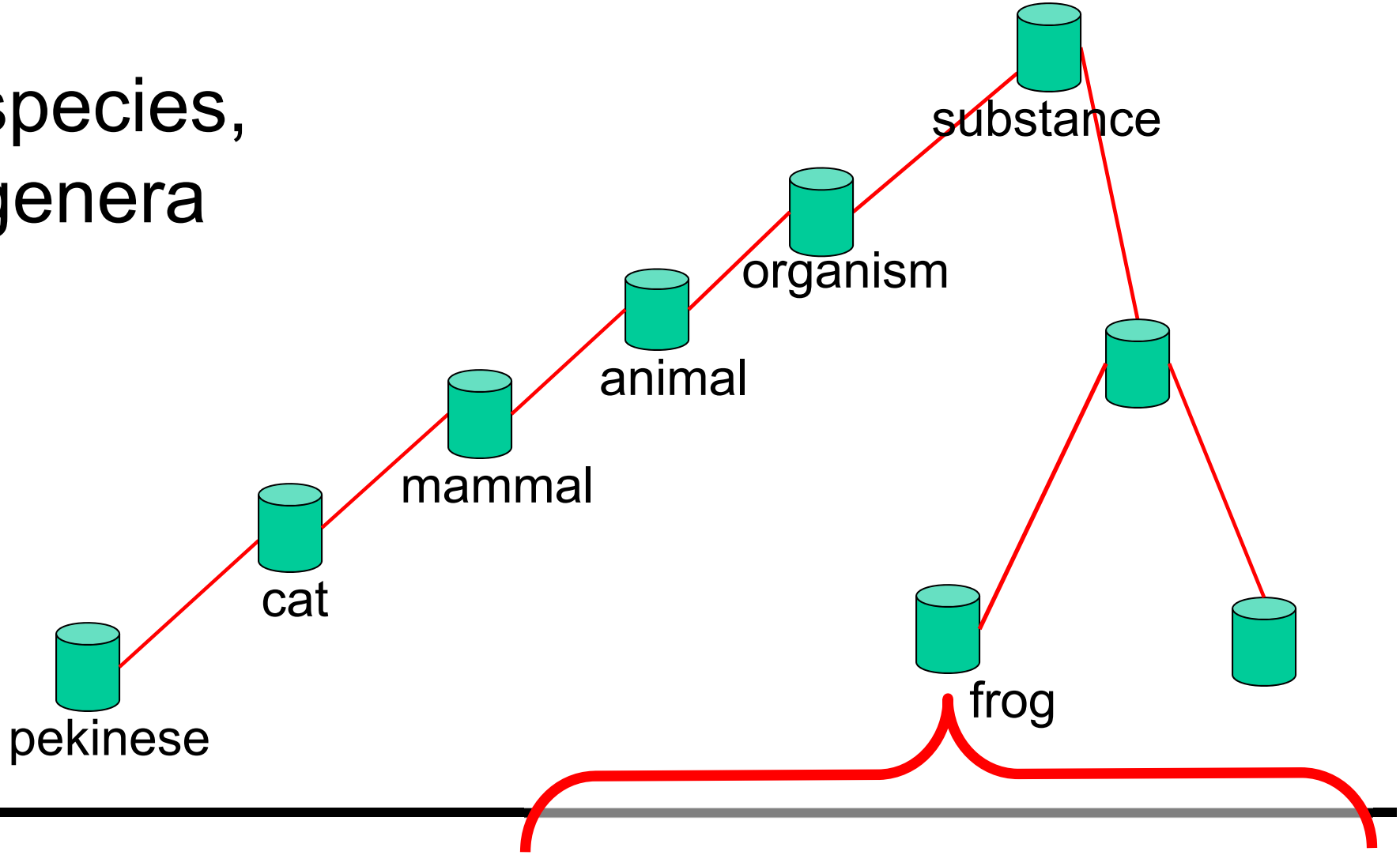
Aristotle's Theory of Categories
is a catalog system for the world of
objects of table-top scale


genera
species
organism
animal
mammal
cat
siamese


category
genera
organism
animal
species
mammal
cat
siamese

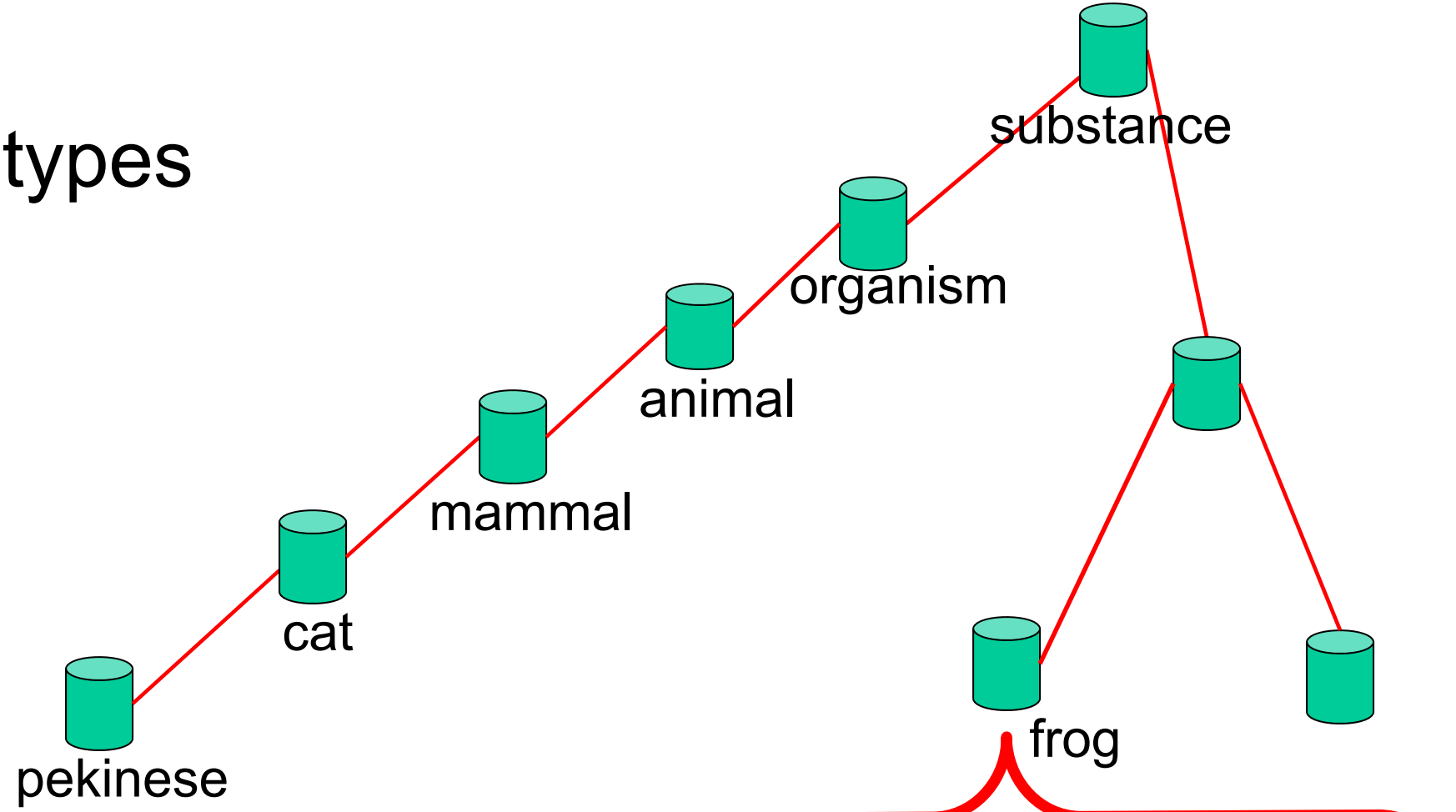

category
substance
object
thing
organism
genera
animal
mammal
species
cat
siamese

species,
genera



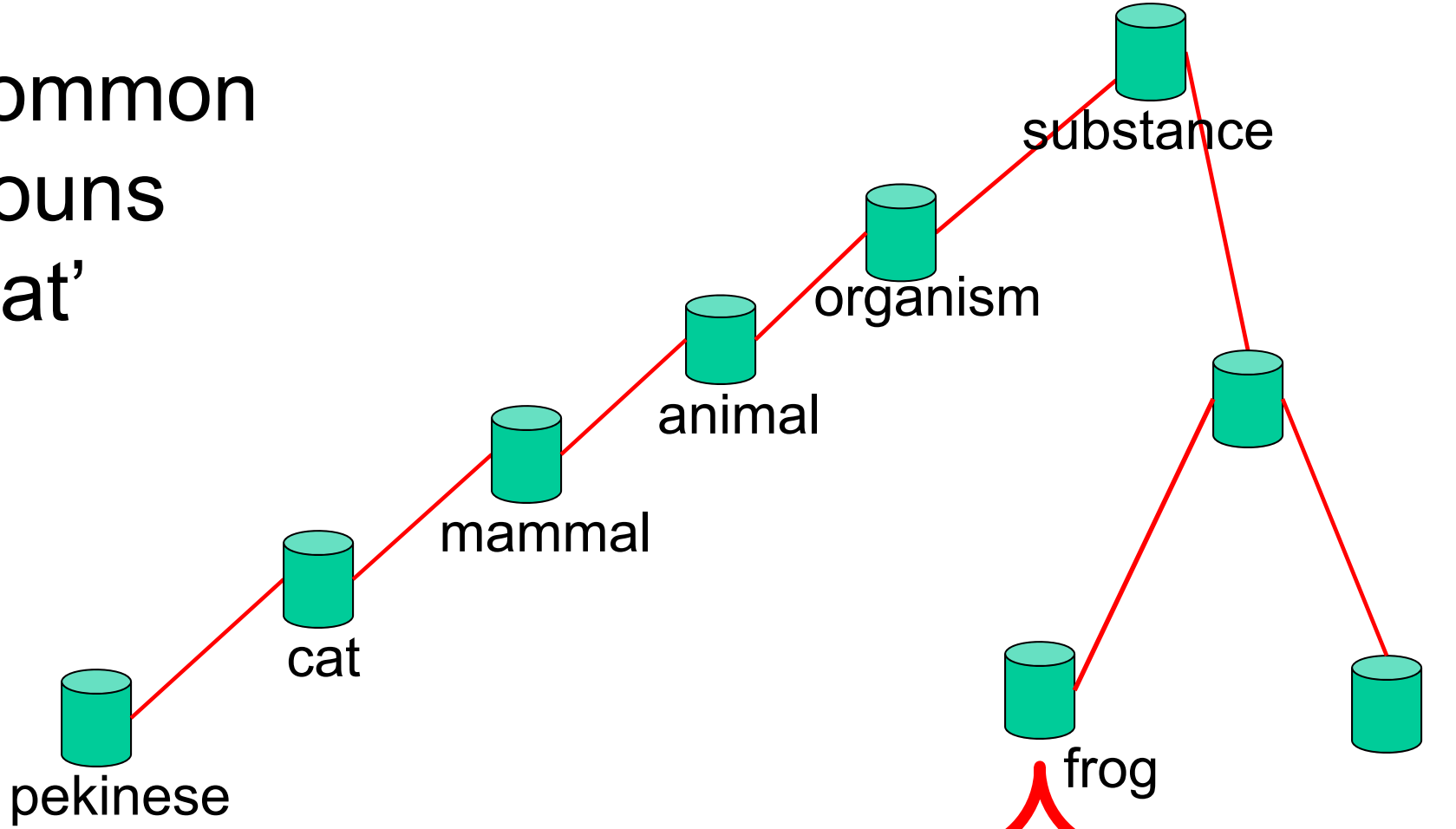
instances

types



tokens

common
nouns
‘cat’



proper names
‘Kermit’

Our common-sense knowledge involves substances

which pertain to *what* a thing is:

a cat
a man
a planet

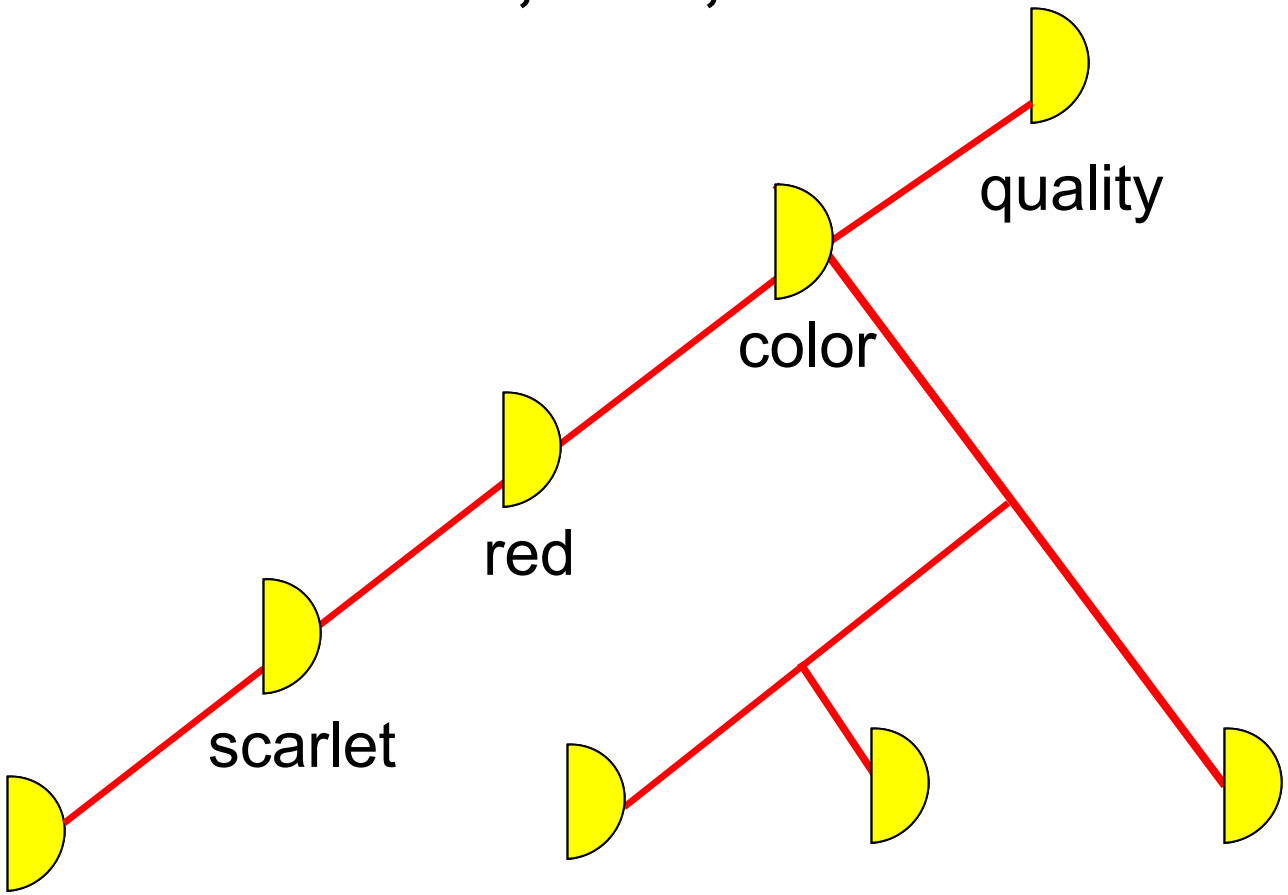
and accidents,

which pertain to *how* a thing is at some time:

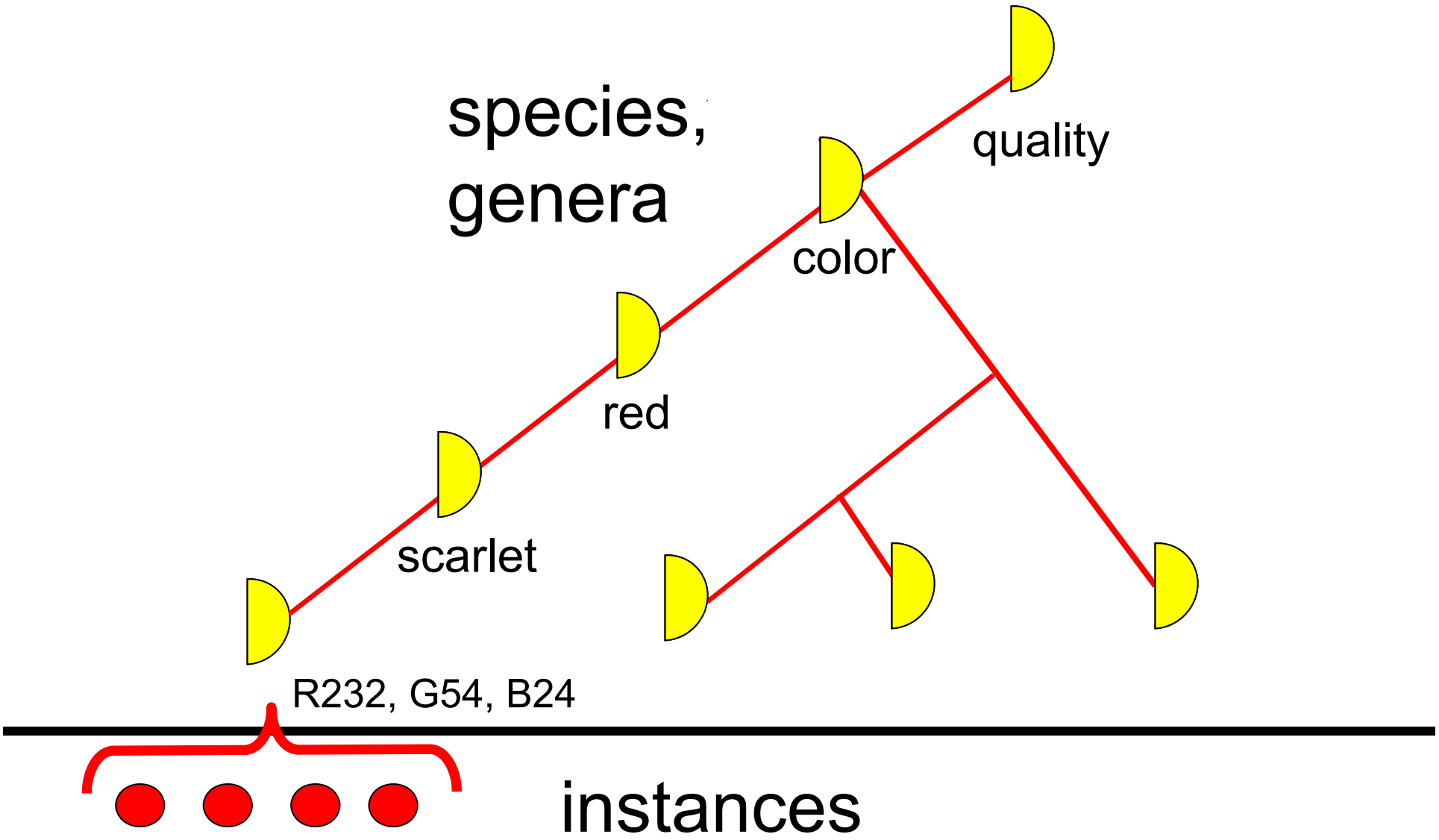
red
hot
in the agora
sun-tanned
spinning

} attributes plus processes

Accidents, too, form trees



R=175, G=54, B=24



(this or that token instance of redness here, now)

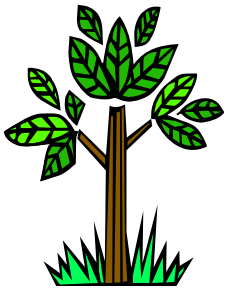
Substance as *object, thing*

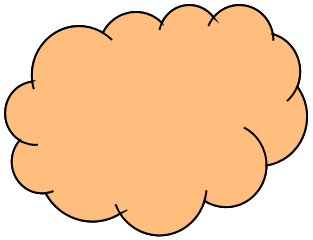
this statue
this cocktail
this frog

vs. Substance as *stuff, matter*

clay
vodka
organophosphate

Objects vs. fields

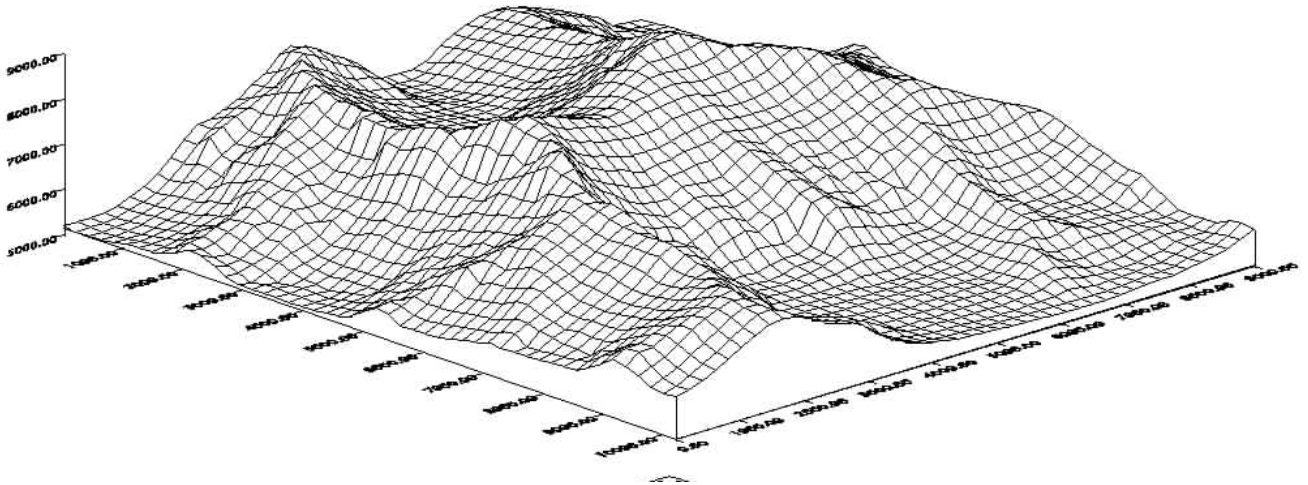




form

---

matter



common-sense reality = objects

plus attributes and processes

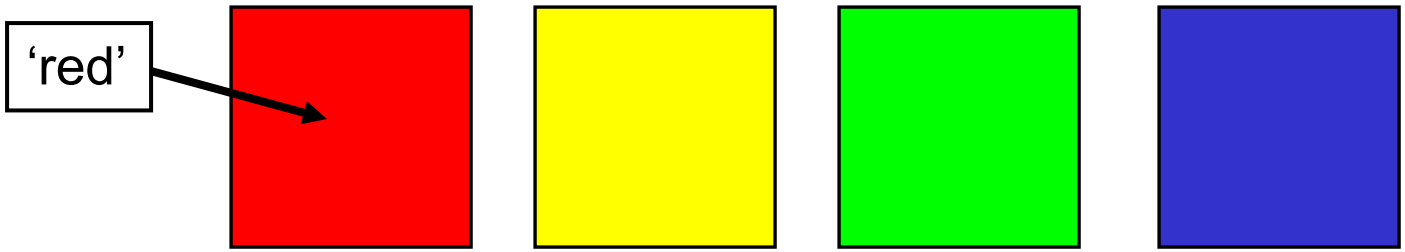
---

quantitative

scientific reality = (roughly) fields

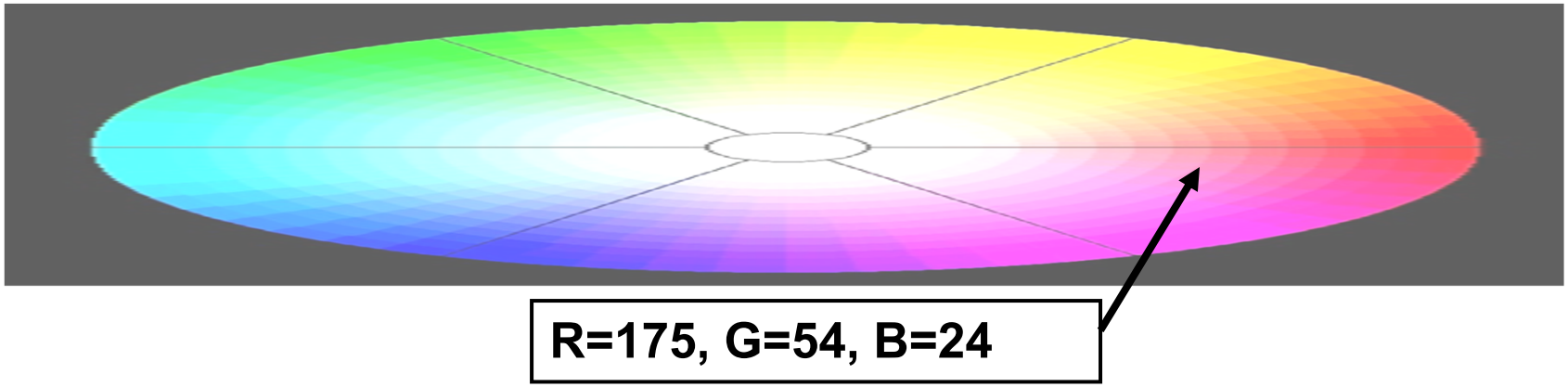
(matter + energy)

The opposition objects vs. fields in the realm of accidents too



form

matter



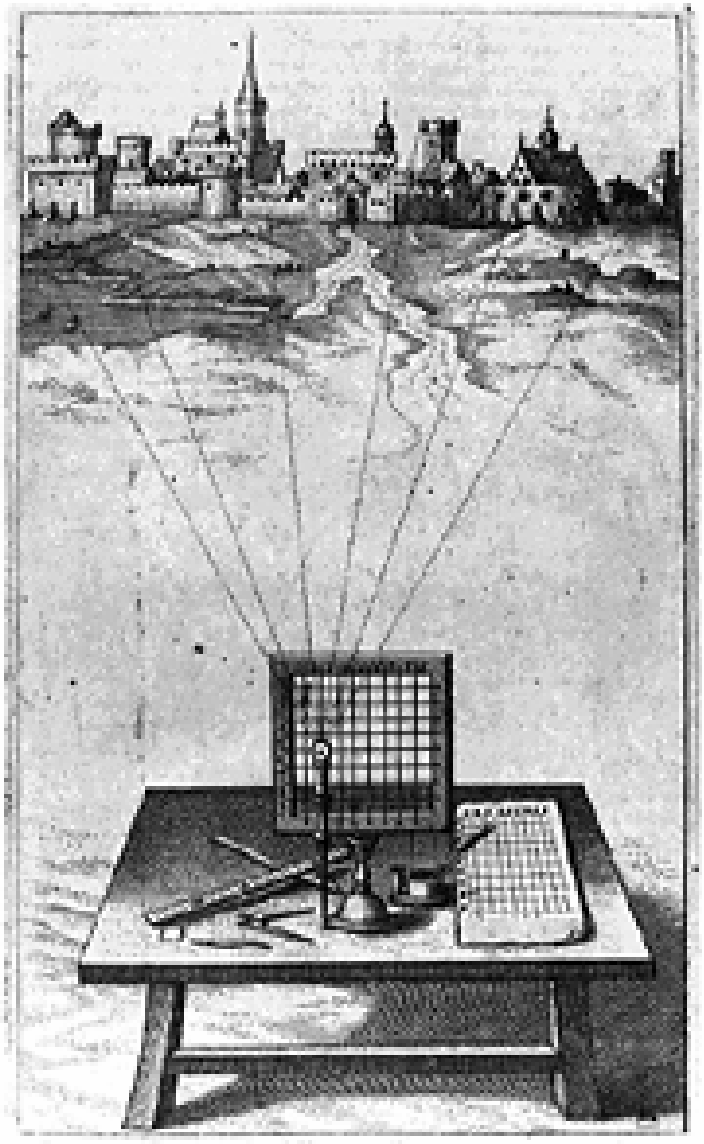
Two different perspectives on reality:

the **qualitative** (objects, attributes, processes)

the **quantitative** (fields: matter, energy)

both transparent to the reality beyond

(one is cruder, coarser than the other)



science brings a finer mesh

Aristotle helps us with the **qualitative** perspective (of objects, attributes, processes)

Science helps us with the **quantitative** perspective (of fields)

Serious theoretical problems confront the attempt to bridge the divide between these two perspectives

– these have analogues in the practical problems confronting cartographers who need to transform quantitative field data into qualitative forms

... and in the practical problems confronting builders of user interfaces for GISystems

But more:

we face serious theoretical problems in extending Aristotle's ontology to the geospatial realm

We still lack a good theory of the geographic realm as this is cognized in ordinary human cognition

Mark and Smith

NSF Grant BCS-9975557:

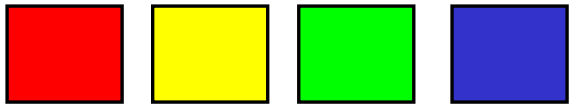
“Geographic Categories: An Ontological Investigation”

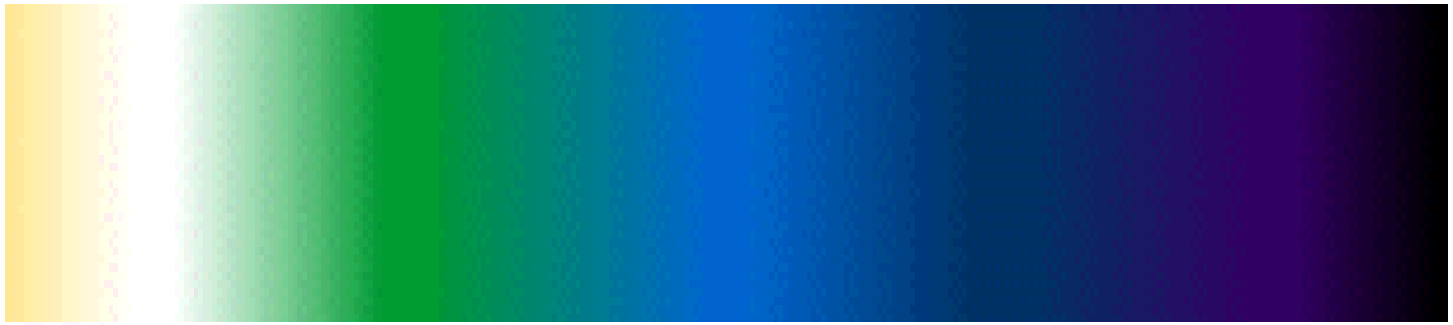
How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

How to produce a theory of the common-sense geographic realm ?

1. **theory of vagueness**
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

How can  -based conceptualizations be transparent, if the world is shaped like this



?

via some sort of distortion ?

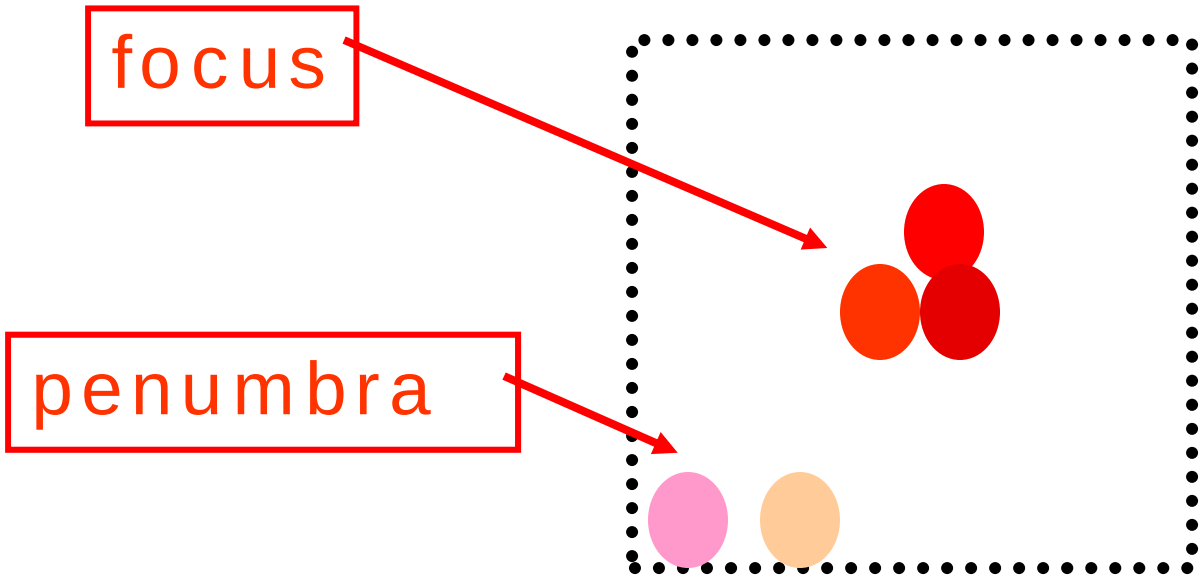
(so that common-sense concepts would be like cookie-cutters, cleaving reality at non-existing joints) ?

No: common sense does not lie

... our common-sense concepts are soft at the edges

and are employed by us accordingly

they have a built-in sensitivity to the difference between focal and borderline instances



Fuzzy logic

illegitimately transforms this **qualitative** space into a **quantitative** field of precise probability assignments

x is red with probability 93.748 %

How to produce a *qualitative* theory of vagueness ?

– a theory of the way in which our common-sense concepts apply to reality in such a way as to comprehend an opposition between focal and penumbral instances ?

open problem
... implications for the understanding of error, approximation ...

How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

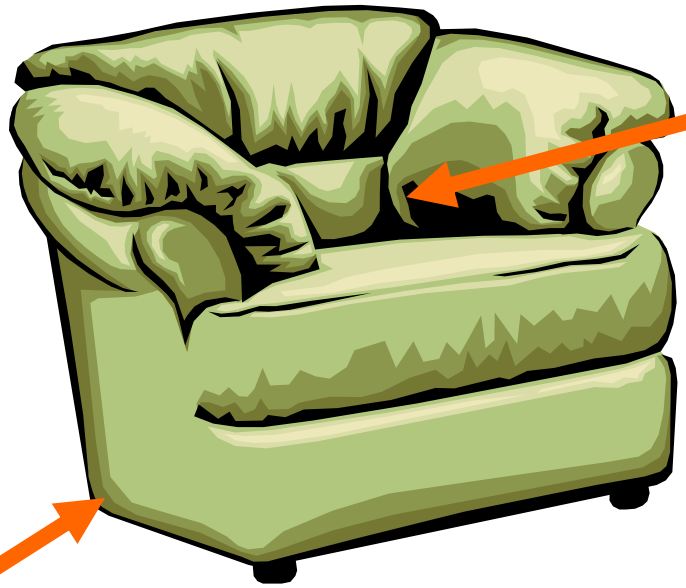
How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. **mereology (theory of wholes and parts, including negative parts)**
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

Is everything in common-sense reality either a substance or an accident?

Armchair Ontology

Armchair Ontology



negative part or *hole* (*not* made of matter)

positive part (made of matter)

Aristotle neglects features of the common-sense world not made of matter

Examples: property rights
obligations
institutions
spatial regions
spatial boundaries

How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. **the theory of fiat boundaries**
4. qualitative geometry and qualitative topology

In the realm of table-top space boundaries are not ontologically problematic:

table-top objects have clear boundaries

they never share boundaries

they never overlap

they do not flow, merge, split

they do not change their genus as they grow

they do not change their genus from season to season

they do not change their genus according to what they abut

contrast: *mountain* – *valley*

Bona Fide Objects

The objects of table-top space have **bona fide boundaries**

= boundaries which exist independently of our cognition

Fiat Boundaries

= boundaries which exist only in virtue of our demarcations

Fiat objects = objects with fiat boundaries

Two-dimensional fiat objects:

census tracts

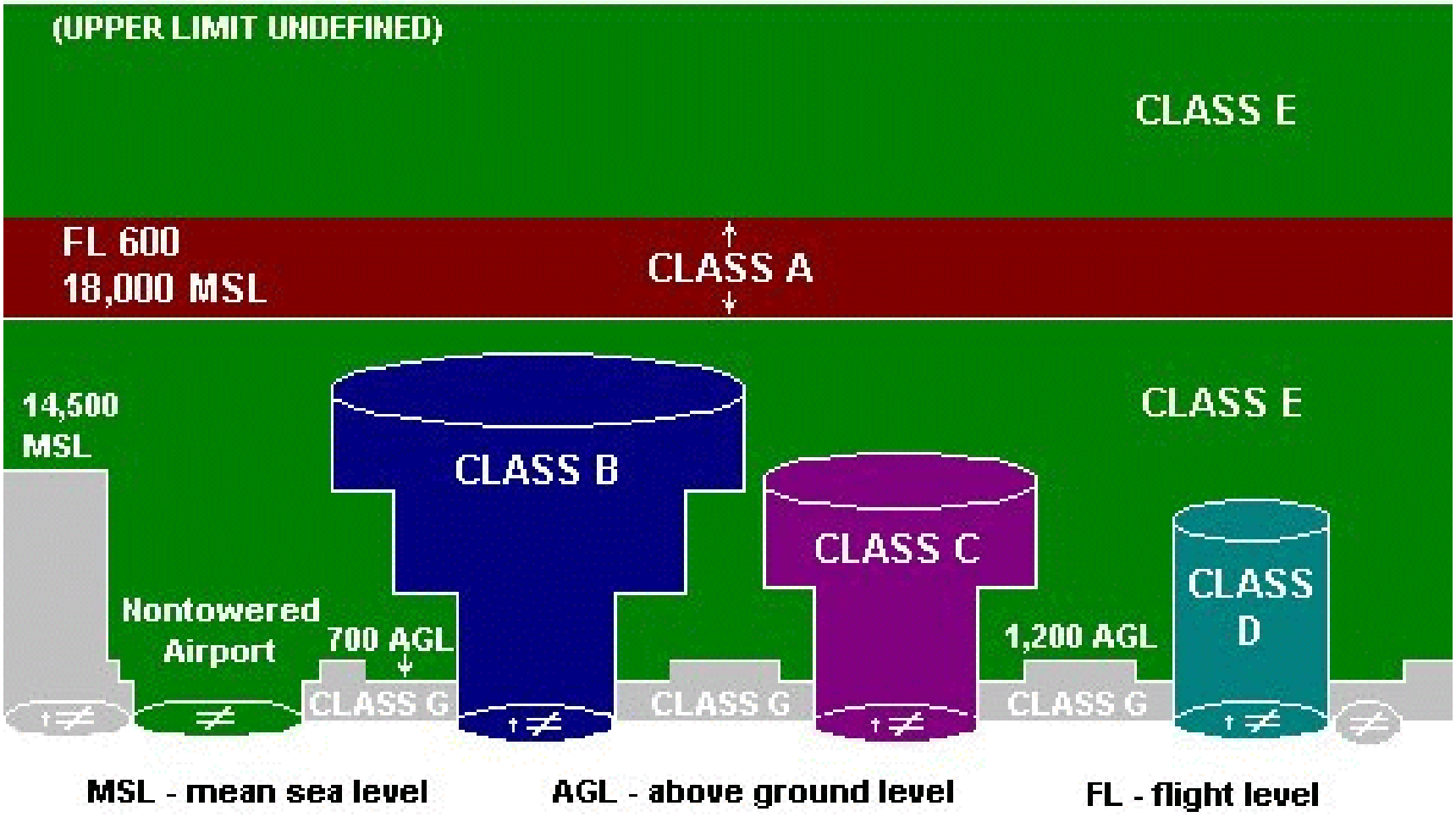
postal districts

Wyoming

Three-dimensional fiat objects

- the Northern hemisphere
- the 3-dimensional parcels to which mineral rights are assigned
- the Klingon Empire

Controlled Airspace



How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. qualitative geometry and qualitative topology

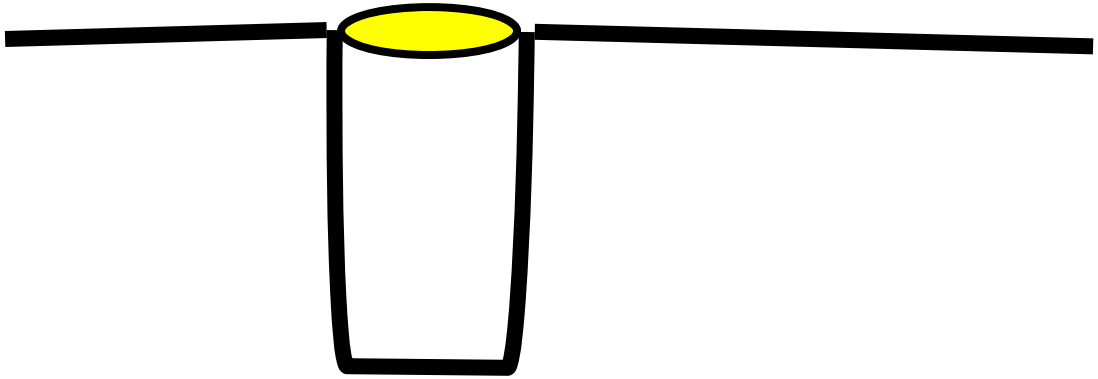
How to produce a theory of the common-sense geographic realm ?

1. theory of vagueness
2. mereology (theory of wholes and parts, including negative parts)
3. the theory of fiat boundaries
4. **qualitative geometry and qualitative topology**

Holes in the ground

Bone fide boundaries at the floor and walls

with a fiat lid



What is a valley ?

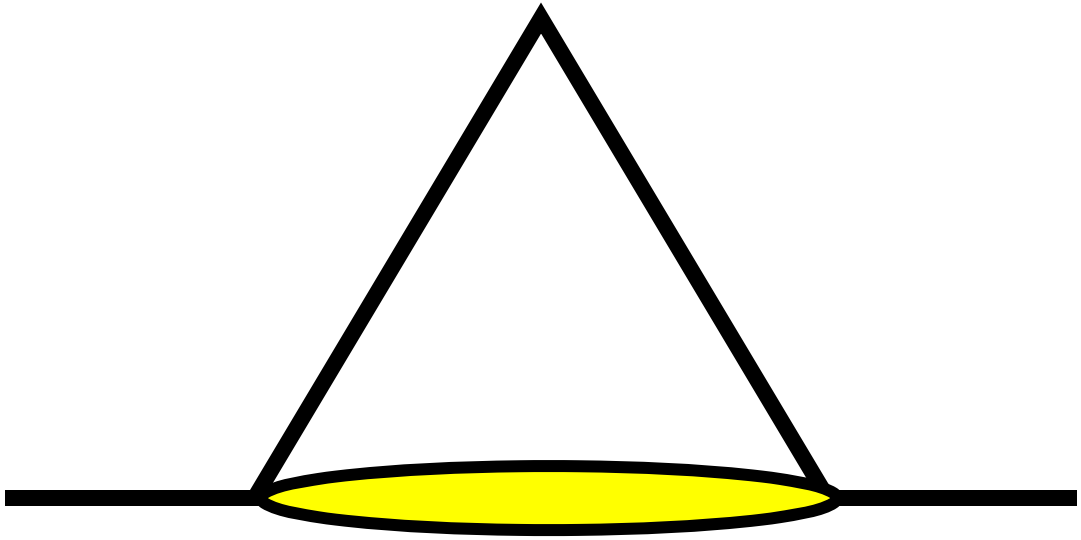
What is a mountain ?

mountain is the most prominent kind of geographic object in the common-sense ontology. But it is absent from the scientific ontology as a kind of thing

... the latter includes slope steepness and direction at every point, but represented as fields

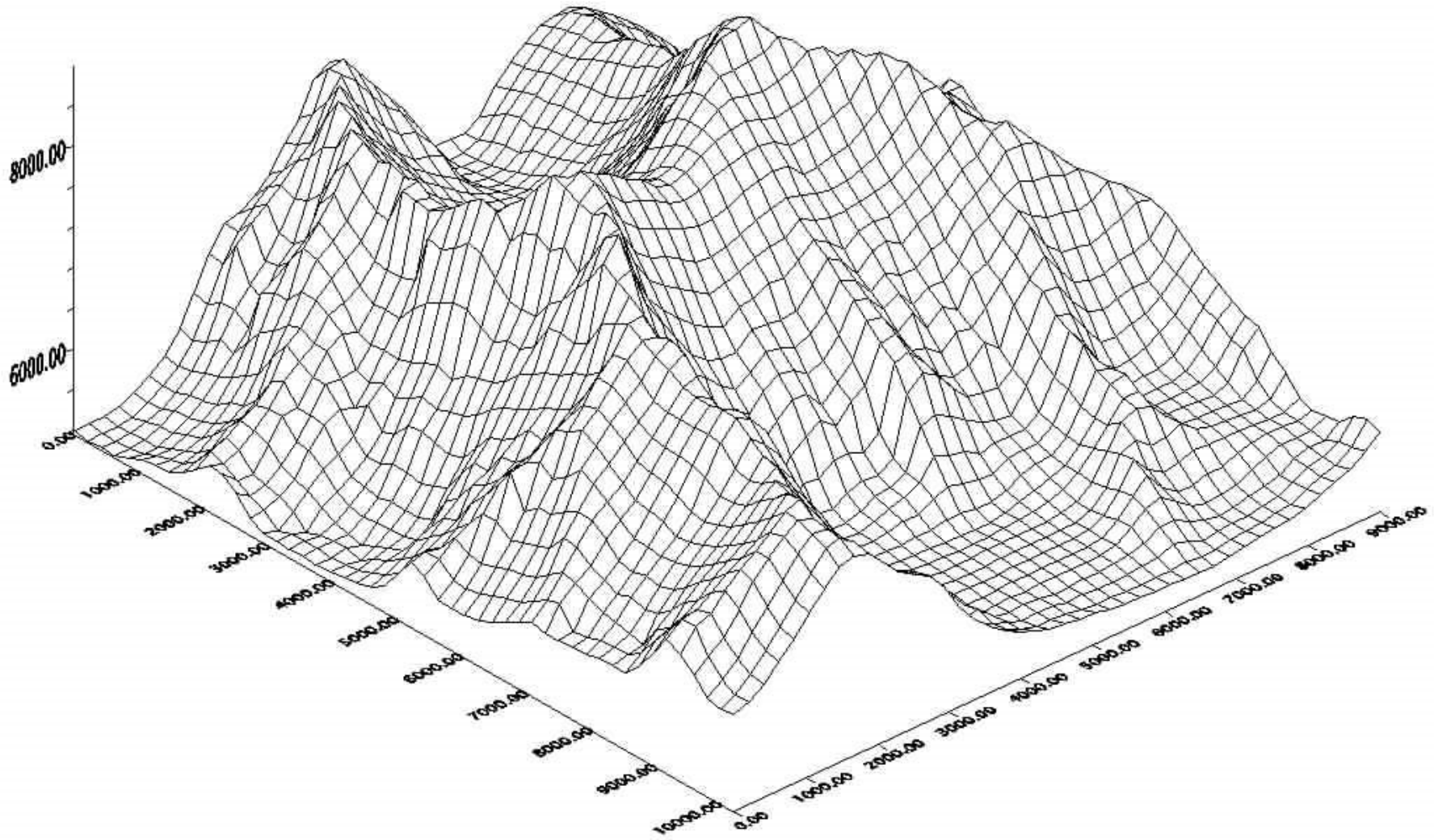
Mountain

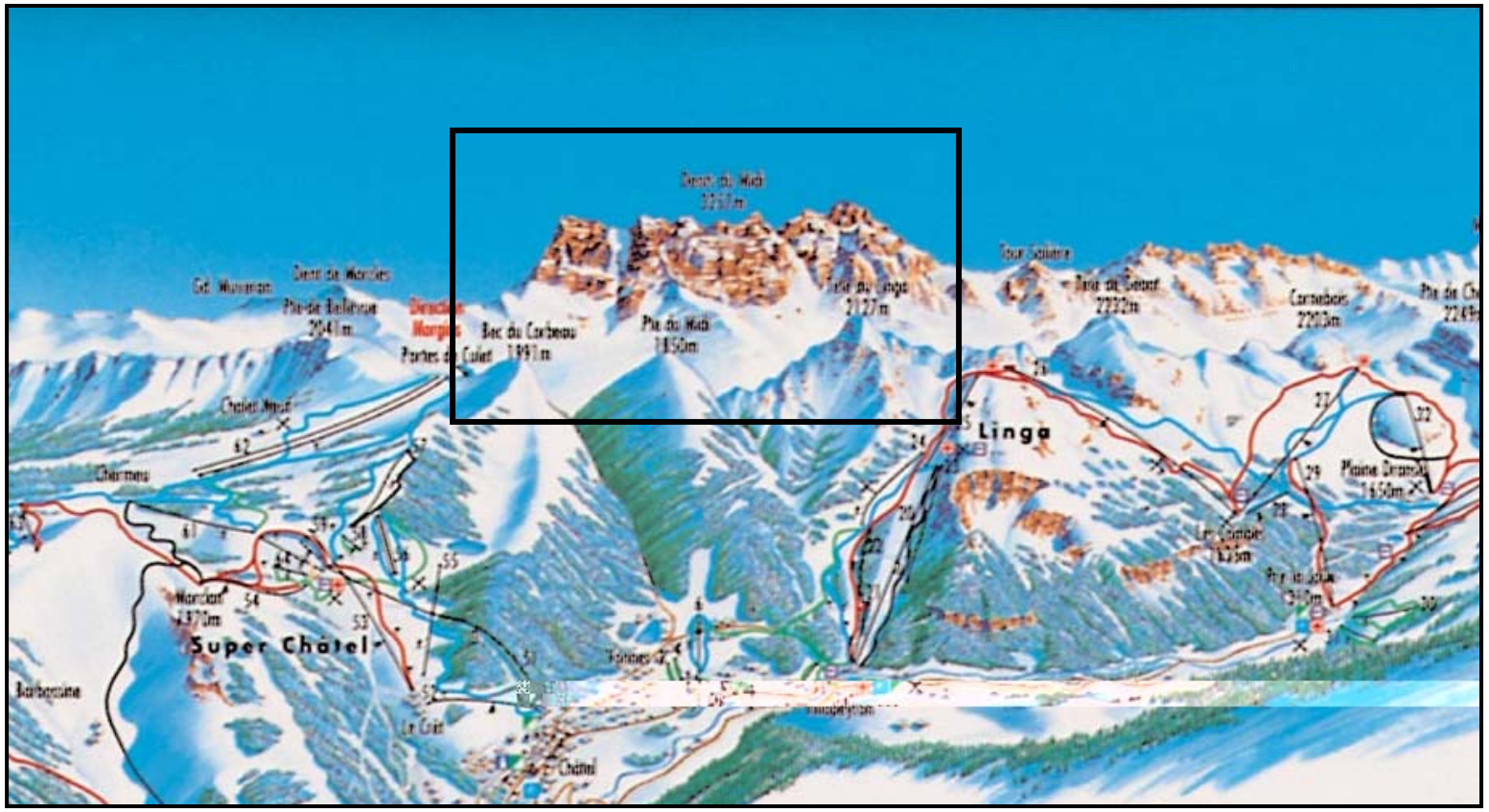
bona fide upper boundaries with fiat base:



where does the mountain start ?

Mount Everest




Linga
Super Châtel
Chatel

Question:

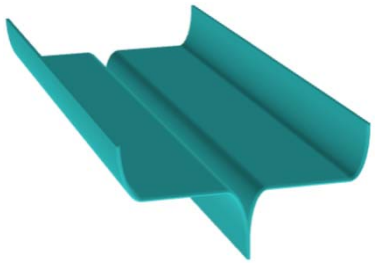
Are mountains bona fide or fiat objects?

Did mountains exist before human cognitive agents came along?

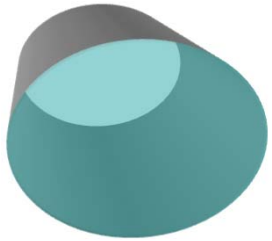
Bona fide mountain (tops)

Are all holes fiat objects ?

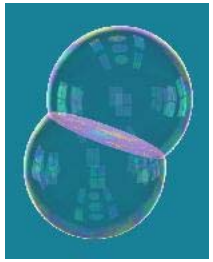
hollows



tunnels



cavities



Did *hollows* and *tunnels* exist before human cognitive agents came along?

Rabbit holes, worm holes

Geospatial forms as precursors of evolution

What is a lake ?

A filled hole ?

1. a three-dimensional body of water ?

2. a two-dimensional sheet of water ?

3. a depression (hole) in the Earth's surface (possibly) filled with water ?

are dry lakes *lakes*?

or merely *places where lakes used to be*?

Each of these has problems:

If we take:

1. a lake is three-dimensional body of water

then a lake can never be half full

Open problem: ontology of liquids

What’s the point ?

Why is it important for GIScience that we get the ontology of common-sense reality right?

Well,

... it's important that we get the ontology of *physics* right because physics is a basis for engineering:

... bridges and airplanes are engineering products in which physical reality is embedded

It’s important that we get the ontology of common-sense reality right ...

... because GISystems are engineering products in which common-sense reality is embedded

We need to keep track of form because that's what users know

Many biological sciences relate to the common-sense world of qualitative forms:

Ecology (need for ontology of niches or habitats)

Biogeography

Palaeontology = science of common-sense reality as it existed before human beings evolved

Many spatial science and engineering disciplines need to span the bridge between the qualitative perspective of common sense and the quantitative, field-based perspective:

Meteorology

Hydrology

Demography

Epidemiology

Urban Systems

Geomorphology

– here, too, different ways of slicing up reality

1. landscapes are continuous (fields) – view of contemporary geomorphology
2. landscapes consist of mountains, valleys, lakes – view of ordinary cognitive agent

What is the relation between these two ?

Can science just ignore mountains, valleys, floodplains ?

The interest of geomorphologists in micro-processes (entrainment and transport of sediments, groundwater effluxes, weathering, etc.)

... **is motivated precisely by attempts to understand form**

(*morphe* = Greek ‘form’)

Ontological Imperialism (Modest Version)

as far as possible our theories, information systems, databases should be compatible with the ontology of common sense

This constraint

can lead to better standards

The U.S. Spatial Data Transfer Standard (SDTS) defines a lake as:

"any standard (sic) body of inland water"

Applied to information systems it can

reduce errors (natural frames and slots)

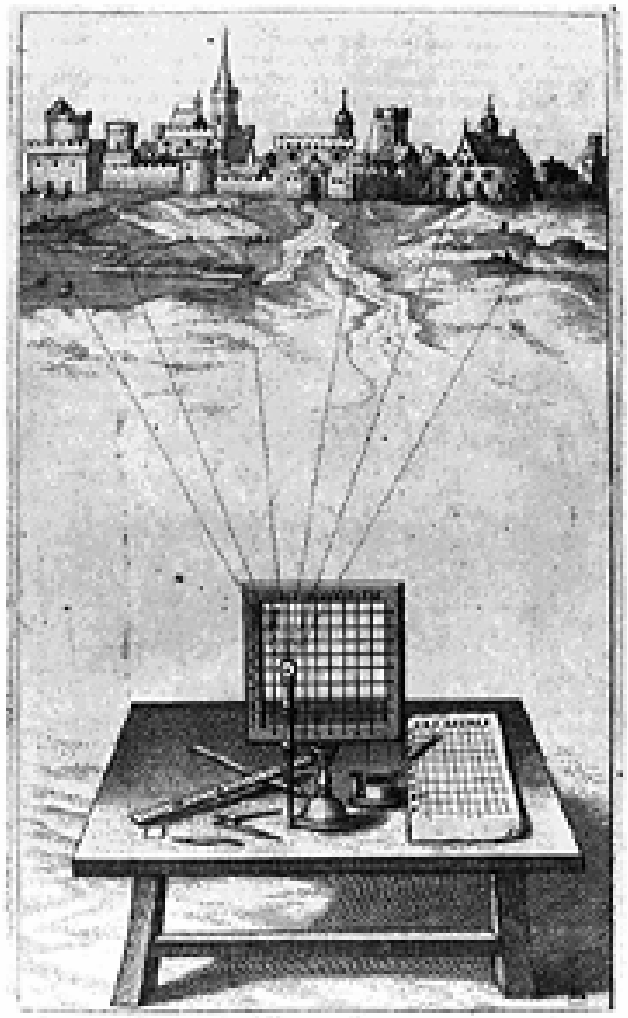
increase robustness (remember Aristotle)

bring better user interfaces (at both ends)

... boost virility

... cure all known ailments

... clean ovens



http://ontology.buffalo.edu