

## Notes - Aristotle's Metaphysics

### Hylomorphism

Challenge: how to explain change?

Change is always a change in *properties* (qualities), from old to new

Ex: The house used to be yellow, but now it's blue (it was painted)

Ex: Fluffy used to be a kitten, now she's a full-grown cat (she grew up)

One possibility: there is no change

the yellow house goes out of existence and the blue house comes into existence.

Kitten fluffy goes out of existence and full-grown cat Fluffy comes into existence

Here we have nothing changing, just things popping into and out of existence

Aristotle thinks that's impossible: nothing comes into existence *ex nihilo*, and nothing goes out of existence

Aristotle's account:

3 things ('principles') involved in the change

1. The property lost
2. The property gained
3. The object that gained one property and lost another

(3) is important: there's always some object that persists through the change

----- (properties)  
----- (persisting object)

This is unproblematic when the change in the object is a small one, e.g. painting the yellow house blue

In Aristotle's language, this the property changed is an *accidental property*, and the object that persists through the change is a *substance*

We'll come back to substance.

For now, it's just an object of some type or other: cat, table, house, etc.

It's more problematic when instead of a substance gaining or losing an accidental property, the substance itself is created or destroyed

Call those *substantial changes*

Ex: a house is built out of some bricks and lumber

Ex: Fluffy is born or dies

(for Aristotle, when Fluffy dies her body stops being a cat's body - it's something else that looks really similar. We will revisit this)

Aristotle rejects creation ex nihilo, so what's happening here?

To avoid creation out of nothing, we need some underlying stuff that:

1. Existed before the substance was created
2. Continues to exist after the substance is created, and *is the substance*

Aristotle: what persists through the change is ***matter*** of some kind (bricks, proto-cat cells)

All change involves losing a property and gaining another

In substantial change the property is special: it's a substantial property called a ***form***: *being an oak tree* or *being a cat*

***Hylomorphism: substances = matter + form***

Interestingly, the analysis of change yields a theory of metaphysics of ordinary physical objects

**Matter:**

So what is matter?

Consider fluffy the cat:

Fluffy is a substance: a combination of matter and form

Fluffy's matter consists in the parts of her body: paws, fur, brain, eyes, etc.

The cat-parts are themselves substances that can come into and out of existence

Now we can run Aristotle's argument to show that cat-paws (and other parts) must be combinations of form and matter

1. Cat paws can come into existence and go out of existence
2. Going out of existence is a substantial change
3. Substantial change = matter losing one substantial property (form) and gaining another
4. So, Fluffy's paws are composed of matter + form

What's the matter in the paws? Bones, muscle, claws, etc

We can run the same argument on each of those things.

Where does it stop?

Aristotle thinks there are four terrestrial elements: earth, air, fire, and water (+aether, the matter of super-lunar celestial bodies. We'll come back to that)

Every physical object is composed of atoms

They're *atoms* in virtue of the fact that they do not have physical parts: they're *simples*

Problem: Aristotle thinks that an atom of air can change into an atom of water (his explanation of where rain comes from)

Why is that a problem?

1. air atoms can come into existence and go out of existence
2. Going out of existence is a substantial change
3. Substantial change = matter losing one substantial property (form) and gaining another
4. So, air atoms are composed of matter + form
5. There is no ordinary matter more basic than air atoms
6. So, air atoms must be composed of *prime matter* + form

But what's this matter like?

Possible contemporary answer: protons, neutrons, electrons, i.e. other substances

Problem: what are electrons things made of? And what are *those* things made of?

NB: could avoid this problem altogether by denying that atoms can undergo substantial change; no substantial change, no need for underlying matter

If you don't take that route, you have three possible responses:

1. Infinite regress: there is no smallest bit, goes on forever
  1. Is that plausible?
  2. Aristotle didn't seem to consider it
2. The regress stops somewhere with a true, unchanging simple atom (no parts)
  1. No substantial change, no need for matter underlying atoms
  2. Aristotle rejects this (not in our reading) as inconsistent with observations
3. The regress stops with smallest bits of *ordinary matter* that can undergo change, but these are themselves composed of something else that isn't ordinary matter and can't undergo change: **prime matter**

## Prime matter

Prime matter is 'pure potentiality': it has the *potential* to have lots of different properties, *but does not have any actual properties*

The properties of an object come from its *form*, and prime matter (qua prime matter) has no form

So: it's stuff with no properties at all.

Is that possible?

## Substance

Substance =df a thing of which properties can be predicated, but cannot be predicated of anything else

(This is only one of Aristotle's definitions of 'substance' - he has several)

Substance is the product of Prime Matter + Form

Neither prime matter nor form are substances, so neither can have properties

So, *by definition* of prime matter and nearby terms, prime matter is stuff with no properties

(Same for Form, but Aristotle, is really unclear on this point, sometimes writing as if form is the ultimate substance. Hard to square this with the other things he says.)

NB: some definitions are not satisfied

- Round square
- My enormous pile of gold
- The barber that shaves everyone in town who doesn't shave himself

So: definability doesn't imply existence

But Aristotle thinks prime matter - stuff with no properties - exists. Does it?

**First objection:** we characterize/ understand things, and types of things, in terms of their properties:

triangles in terms of three-sidedness; cats in terms of mammality and meow-ing

But prime matter has no properties at all - even in principle it can't be positively characterized.

That's absurd.

Maybe contradictory:

prime matter has no properties *and* it has the property of combining with forms to create substances?

**Second objection:** prime matter isn't cold and wet (the essential properties of the element *water*)

But when water turns into fire, the result is hot and dry (the essential properties of the element *fire*)

According to Aristotle's theory of change, there's something that persists through that change

Suppose that's right: wouldn't we normally say that the thing that persists stopped being cold and wet, and started being hot and dry? I.e., it lost some properties and gained some others?

That's the story we (and Aristotle) would tell about a house that persists through being painted a different color

But Aristotle can't say that - he has to say:

1. the things that lost and gained properties were substances: water and fire
2. the thing that persisted through the change was prime matter

Weird, right?

## Forms, substance, and essence

What forms do:

- combine with matter to produce a substance
- unify parts into a whole
- Determine the species or type of the substance produced
- Define or determine the essence of the substance produced
  - Do we think that things have essences?
- Resulting substances are the subjects of predications that aren't predicated of anything else

Weirdnesses:

- combine some prime matter with a form and you get a substance, an object with a bunch of essential properties. But you don't yet have any accidental properties. So: a human-form combined with some prime matter is a human being, but it's a human with no height, weight, hair color, etc...
- Form+prime matter determine substance-type, but not singular identity: determines that one is human, but not that one is Aristotle or Descartes or Justin Bieber. What does that work?
  - Aristotle doesn't say
  - Duns Scotus (14th c. Scholastic) posited Haecceities to do that work.

- Methodological weirdness here: there's a puzzle (personal identity), solve the puzzle by positing a basic, otherwise unmotivated metaphysical entity to do the work
  - Is Aristotle's approach any different? Many early moderns didn't think so...
  - But, even Leibniz, who wanted to give up on forms as causally efficacious and hence needed for scientific explanation of observable phenomena, thought we still needed forms to unify parts into a whole

## Forms and Causation

Aristotle aims to answer simple questions about the world:

- Why do houses have doors?
- Why does plants have roots that reach down instead of up?
- Why do humans have pointy teeth in the front and flat teeth in the back?

Answer we'll see later: mechanism - it's all a matter of tiny particles bumping into one another

(Contemporary version: it's all a matter of tiny particles interacting according to four fundamental forces)

Aristotle thinks there are four types of causation:

Material cause: causal power of the matter of which an object is composed

Why is the statue the way it is? Due to the bronze from which it was made

Efficient cause: principle source of the change

Why did the the statue come to be? Due to the the sculptor's hammer blows

NB: this is effectively mechanistic causation

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Formal cause: causal power of the form - makes an object the type of object that it is

What makes it a squirrel? It has the form of a squirrel

Final cause: the purpose for which something happened

Why did he take a walk? Too get some exercise.

For our purposes the important distinction is between material/ efficient causation (the stuff an object is made of, and what happens to that stuff) and formal/ final cause.

Aristotle's important claims are that

1. nature is imbued with purposes (understood as a natural phenomenon)
2. Those purposes cause/ explain observable phenomenon
  1. These are called *teleological explanations*

### **Teleology and human action:**

Simple model for purposes as a cause: human intentional action

These cases often involve *deliberation* prior to the action

- recognition by the agent that some outcome is desirable, and actions intended to achieve that outcome.
- Here the desirable outcome is in a sense a cause of the actions intended to achieve it

It's possible to conceive of human interaction purely in terms of material/ efficient causation: our bodies are bits of matter bumping together in a way that leads us to go for walks and such.

Aristotle finds this implausible.

Instead we must explain the action in part by appeal to the purpose of the action:

he went to the store for the purpose of getting milk.

She tied her shoes so they wouldn't fall off

### **Teleology and Artifacts:**

Explanations of human action are plausibly teleological

So are explanation of facts about artifacts:

Q: Why does the house have a door?

A: The purpose of the house is for people to have a place to live. The house would not serve that purpose well if people can't get in. So, the house has a door to serve a purpose: to let people in.

Plausibly, a house gets its purpose from it's builder, so ultimately artifactual teleology is merely a consequence a agential teleology, rather than an independent phenomenon. But...

### **Teleology and nature:**

Natural objects - oak trees, squirrels, rocks - also have purposes, and these have nothing to do with human agency.

How is that possible?

Take the example of the acorn and the oak tree.

Question: why do acorns always grow into oak trees, never into rock formations or dolphins?

First: What is an oak tree?

A hylomorphic compound of matter + the form of an oak tree

Focus on the form:

Job 1 of the oak-tree form: makes the oak tree the sort of thing that it is

(this is the *formal cause*)

Job 2 of the oak-tree form: the essential properties of the oak tree:

- that it has leaves and roots, that it grows from water and sunshine, that it reproduces to make other oak trees, etc.
- Being *like that* is the purpose of the oak tree, just as chopping wood efficiently is the purpose of the axe

Now: why do acorns grow into oak trees with roots that go down and branches that go up?

Possible answer: purely due to material/ efficient causes

Aristotle thinks that's implausible, amounting to a massive coincidence

Aristotle's answer: the acorn is a baby oak tree. In order to fulfill its purpose of drinking water from the soil its roots must go down. In order to fulfill its purpose of reproducing it must make more acorns with oak-tree forms. In order to grow it needs to absorb solar energy, so it grows upwards towards the sun

In sum: the acorn 'acts' for a purpose - to achieve the essential properties of an oak tree as defined by that form - just as humans act for purposes (but without deliberation)

Aristotle's argument for teleological causation:

1. Nature contains lots of regularities.
2. Two possible explanations for those regularities:
  1. Massive coincidences ('luck' as he calls them)
  2. Existence of formal/ final causes
3. Existence of formal/ final causes is the best explanation
4. So, formal/ final causes exist

NB: this is an inference to the best explanation

- There may be other possible explanations that he hasn't considered



## Scientific Method

Aristotle's definitions of scientific understanding:

We think we understand something *simpliciter* [=not incidentally]... when we think we know of the explanation because of which the object holds that it is its explanation, and also that it is not possible for it to be otherwise. (71a 10)

Scientific knowledge is obtained through *demonstration* from first principles

Demonstrations are deductive inferences that meet certain further criteria (see below)

What's a *deductive* inference?

An inference (or argument) is a set of sentences, at least one of which is the conclusion, the others meant to support that conclusion

Deductively valid = df the truth of its premises guarantees the truth of its conclusion  
or,  
= df it's impossible for the premises to all be true and the conclusion to be false

(NB: not all 'good' arguments are deductively valid (come back to this next time))

Contemporary deductive logic is very rich: truth functional, quantificational, modal, etc.

Aristotle's logic of science was more limited: dealt only with generalizations, e.g.

Type	Statement
A	All A's are B's
E	No A's are B's
I	Some A's are B's
O	Some A's are not B's

Statements of this sort are special to Aristotle because the structure of the statement mirrors the structure of the universe:

Forms determine the essences of types of things:  
- all cats are mammals  
- no rocks are dolphins

By taking statements of these forms as premises we can deduce conclusions that also mirror the structure of the universe.

Example:

1. All cats are mammals

2. All mammals are animals
3. So, all cats are animals

1. No cats are fish
2. All trout are fish
3. So, no cats are trout

These relations are best understood in terms of *Venn diagrams*

Example of invalid argument

1. Some cats are not male
2. Some males are not cats
3. So, some cats are not cats

Aside:

- Aristotle was probably the greatest logician ever
- Big insight: logic is about *form* rather than content
  - Barbara is valid because of the pattern of 'all's' and letters, not because of the particular values we might assign to the letters
  - *Any* values in that pattern produce a valid argument (compare: math)

Scientific demonstration requires more than just a valid deductive inference.

The mere fact that an inference is valid only shows that: *if* the premises are true *then* the conclusion is true as well

What Aristotle wants is a method that provides real scientific understanding of the conclusion, and not all deductively valid arguments do that.

**First requirement:** premises must be **necessarily** true

Example: arguments with false premises

1. All cats are fish
2. All fish are mammals
3. So, all cats are mammals

Valid, but the premises are false. So even though the conclusion is true, you can't come to understand it on the basis of this kind of inference.

That they must be *necessary* is super-important:

- what we come to understand is the conclusion of our deduction
- deductive inferences preserve truth *necessarily*
- So, if the premises must be necessarily true, then the conclusions must be necessarily true as well

- *I.e., science only provides knowledge of necessary truths, not particular facts*

**Second Requirement:** premises must be indemonstrable

This to avoid an infinite regress, amounts to a kind of foundationalism

NB: A really means that at least some every science must have its own first principles *somewhere*, not that those first principles be appealed to every time.

**Third requirement:** premises must be better known than the conclusion

The goal is *understanding*.

The model seems to be one of the *transmission* of understanding from premise to conclusion

This also presupposes something like foundationalism:

Alternative model: coherentist explanation

**Fourth requirement:** premises state the causes of the conclusion's truth

Compare (from Losee):

Good case:

1. All oxen are ruminants with four chambered stomachs
2. All ruminants with four chambered stomachs are animals with missing upper incisor teeth
3. So, all oxen are animals with missing upper incisor teeth

Here the premises bear an obvious causal relation to the conclusion: it's *because* they have the stomach they do (which allows them to regurgitate food for more chewing) that they don't need, and don't have, sharp incisor teeth

Bad case:

1. All oxen are *ruminants with cloven hoofs*
2. All *ruminants with cloven hoofs* are animals with missing incisor teeth
3. So, all oxen are animals with missing upper incisor teeth

Here the premises are true, and might be better known and indemonstrable, but they don't lead to *understanding* because there's no causal relation between have cloven hoofs and missing incisors

Problem: how to determine when you've got a genuine causal relation? Aristotle:

1. If relationship between A and B is causal, there are no exceptions
  1. Metaphysical objection: What about smoking?
2. Is true of the subject precisely and not as part of a larger whole
  1. e.g., if you want to know why *cats in particular* are warm blooded, you
3. Is 'essential to' the subject

Recap:

- Scientific knowledge results from demonstrations
- Demonstrations are deductions whose premises are
  - necessary truths
  - indemonstrable
  - Are better known than the conclusion
  - Whose truth is the cause of the truth of the conclusion

Questions: how do we come to know the premises of such a demonstration?

Plato's answer: doctrine of recollection

Aristotle rejects recollection, thinks knowledge of first principles comes from perception (somehow)

Problems:

1. First principles involve universals, but we perceive only particulars
2. We don't perceive necessities, only contingencies
3. We don't perceive causal connections
  1. (Hume makes a big deal of this)

Aristotle's answer: induction

Aristotelian induction is very unusual:

- inductive inferences usually described as not deductively valid
  - Since conclusions are necessary, it's impossible for them to be false, so it's impossible for the premises to be true and the conclusion is false
  - (Logical consequence vs necessary consequence)

So how to characterize induction at all?

Aristotle: induction is an inference from particular premises to general conclusions. E.g.:

1. Socrates is a man and Socrates is mortal
2. Plato is a man and Plato is mortal
3. Euthyphro is a man and Euthyphro is mortal
4. ...
5. So, all men are mortal

NB: 1-4 are statements about particular objects (Socrates, Plato, Euthyphro), 5 is about a general class of objects

So how does this work?

And this is clearly true of all animals: they have a connate [innate] discriminatory capacity, which is called perception. Given that perception is present in them, in some animals the percepts are retained and in others they are not. If they are not, then the animal has no knowledge when it is not perceiving... But some can still hold the percepts in their soul after perceiving them. When this occurs often, there is then a further difference: some animals come to have an account based on the retention of these items, and others do not.

Thus from perception there comes memory, as we call it, and from memory... experience; for memories which are many in number form a single experience. And from experience, or from all the universal which has come to rest in the soul..., there comes a principle of skill or of understanding - of skill if it deals with how things come about, of understanding if it deals with how things are. (Posterior Analytics B19)

The mental state of recognizing the necessary first principles is called *nous*

Big picture:

Scientific explanation involves

1. Induction (as described), which produces knowledge of first principles
2. Demonstration (= deduction from necessary, indemonstrable, well known, causal first principles) to some conclusion - the explanation

## Ancient Astronomy

### Aristotle:

- The Earth is a sphere located at the center of the universe
- The moon is the closest body to Earth, marks the boundary between the sublunar world composed of ordinary atoms (earth, wind, fire, water).
- Natural motions of objects are determined by their forms, and by the natural motions of the atoms that compose them: rocks are made primarily of earth, whose natural motion is downward towards the center of the earth/ universe. That's why the rock falls downward.
- Above the moon is the superlunar world of stars and planets composed of *ether*.
- *Ether* is a fifth element with its own essential nature and final cause.
- Planets and stars are essentially the same sort of thing - balls of ether. The only difference is that planets move differently (across the 'fixed' stars), and so are thought to be closer. The sun is a planet.
- The natural, innate motion of Ether is circular
- Ether naturally clumps into perfect spheres

- Nothing ever changes in the superlunar world: all planets continue on their circular paths, remain perfect spheres forever

### **Ptolemy:**

Roman writing around 150 ce.

Establishes his conclusions about the nature of the universe on the basis of inferences from ordinary observations.

### **That the earth is spherical:**

Observations consistent with a spherical earth, inconsistent with a *flat* earth:

- Stars and planets appear in the sky later for you than for observers to your east
  - (I'm not sure how he knows this, given that they would be measuring the start of the day at each respective place relative to the apparent location of sun/ stars *at that place*)
- Eclipses appear later for you than for people to your east
- These differences are proportional to the distance east: the further you go, the greater the time difference
- If the earth were flat, phenomena would occur to everyone on earth at the same time

Observations consistent with a spherical earth, inconsistent with a *cylindrical* earth

- Which stars are visible changes as you move north to south
- Sails appear before hulls on the horizon, whether the ship appears from east/ west or from the north/ south. This is expected on a spherical earth, not expected on flat or cylindrical earth

What's wrong with these arguments? (Nothing)

### **That the earth doesn't move**

Ptolemy considers and rejects that the earth moves

First argument:

He (and Aristotle) knew that the earth is roughly 25,000 miles in circumference

If it spins once in 24 hours, a point at the equator travels over 1000 mph

The earth revolves around the sun at around 70,000 mph (Ptolemy didn't know how far apart the sun and earth are, so he couldn't calculate that number. Still, he knew it would have to be really really fast.)

When we travel at much lower speeds (e.g. when riding a horse) we feel wind in our faces, forces of acceleration. Traveling at 70,000 mph or even 1000 mph you'd expect the wind in our faces and the forces on our bodies to be much more powerful than riding a horse. But that's not what we experience, so we're probably not traveling that fast.

Second argument:

Suppose I drop a rock straight down, and it takes 1 second to fall from my hand to the ground.

In that second the earth will have spun about 150 feet (at the equator, somewhat less in Houston).

So, if the earth were spinning, you'd expect the rock to land about 150 feet west of where the point directly below where I dropped it.

But it doesn't: it lands right on that spot. So the earth isn't spinning.

[similar argument can show the earth isn't traveling 70,000 mph around the sun, but rock should land 19 miles west]

What's wrong with this argument? (Assumption about motion: that things stop moving when a force is removed, i.e. when you stop pushing on it)

Third argument:

If the earth were moving, it moves A LOT. So, in that case we should observe stellar parallax.

But we don't. So we're not moving

What's wrong with this argument?

1. You wouldn't observe stellar parallax if the stars were all equally distant (they aren't, but still)
2. You wouldn't observe stellar parallax if the stars were super far away (they are)

### **Ptolemy's model of the universe**

Aristotle's model of the universe - simple circles around the earth - doesn't accord with observations very well

Retrograde planetary motion:

- due to the rotation of the earth, visible planets drift from west to east across night sky
  - It looks like this **[SHOW PIC of photos of retrograde motion]**
- Earth years are shorter than Mars years, so
  - From the perspective of an earth observer, the position of Mars relative to the background stars changes throughout the year

- Change is usually eastward, relative to the fixed stars
  - But since Earth completes its orbit faster than Mars, it overtakes Mars (roughly once every two years)
    - When it does, the apparent position of Mars seems to drift *west* for a few weeks, before resuming its (apparent) eastward drift
- [show diagram of retrograde motion]**

Given Aristotle's model of the universe, that shouldn't happen

Ptolemy tries to build a model that

1. Better agrees with observations (especially retrograde motion)
2. Retains Aristotelian ideas of perfectly circular orbits, earth at the center of the universe, uniform orbital speed, etc

Solution: Epicycles!

Mars model explanation: **[show mars model pic]**

- Mars orbit is circular around point A
- Point A falls on an *eccentric* circle centered on point B
  - NB: point B is not the center of the universe (i.e. the center of the Earth)
  - If it were, then point B's circle would be called a *deferent*
  - So, Mars' orbit is not centered in the sphere of fixed stars [draw picture]
  - (Equant point it needed to specify the speed of travel of the center of Mars' epicycle around the eccentric
    - Ptolemy (and contemporaries and Copernicus) are committed to uniform speed of travel
    - Speed is relative to some reference point. Which one?
    - If the reference point is the earth, or center of the eccentric, the model makes inaccurate predictions
    - But, we can calculate a point that produces accurate predictions while respecting uniform motion
    - That's the *equant point*

So how does all this explain retrograde motion of planets?

**[Show Ptolemy's retrograde explanation]**

Putting this all together it looks like this:

**[show video of Ptolemy's model]**



## Copernicus

Big move: heliocentrism

### [show Copernicus model of Mars]

Explanation:

- Mars travels on an eccentric (=circle not centered on the center of the universe, here the sun) centered on point A
- Point A travels around point B
- Position of point B is fixed relative to point C
- Point C is the center of Earth's eccentric
- C circles point D
- D circles the sun

Super complicated!

But: no equant points!

- Geocentric models (with uniform motion) need them to account for retrograde motion
- Heliocentric models (with uniform motion) don't
- Copernicus thought this was a huge advantage for his model

Forget that we know the end of the story. In 1550, which model is better?

- Model are about equally accurate in their predictions!
- Copernicus's model is a bit simple for avoiding equant points
  - But both are super complicated
- Both models explain retrograde motion
  - BUT: Copernicus' model further explains the fact that Mars, Jupiter, and Saturn appear largest (brightest) during their retrograde motions: that's when Earth is closest to them
    - **[Show picture of Copernicus and orbits/ retrograde motion]**
    - NB Copernicus makes a big deal about he apparent sizes of the planets in the reading for today

Thin reed!