Back to Deduction: The Logic of Falsification

***Karl Popper****: Radical change in the deductive reasoning.*

It comes from **Karl Popper**, who came up with a statement saying he had “solved the problem of induction”.  He was a philosopher of science, also a social and political philosopher, an opponent of all forms of skepticism, conventionalism and relativism in science and in human affairs, and a staunch defender of the ‘Open Society’.  He covered many many fields, but our focus is on induction and what use of induction can be made in science.

**The overall problem: What is the justification for inductive inferences?**

His formulation is better because he takes a critical approach. He watches at the problem behind the traditional formulation (the belief that the future will be, largely, like the past).

*Popper’s reformulation as “critical”: Look at the problem which lies behind the traditional formulation*

The roots of traditional formulation lies on:

* Hume’s criticism of induction
* The common sense theory of knowledge (the view that takes for granted that beliefs in regularities are justified by repeated observations).

We form laws of nature or theories via the same paradoxical root. Popper wonders “How can these beliefs have a reason?”.

**Common Sense View**

The common sense view is an uncritical view because it takes for granted the justification of repeated observations.

*Hume’s problems*

Hume had two problems:

1. The logical problem. Are we justified in believing in induction? Induction does not lead to any good conclusion (also in the form of probable conclusion) not probable nor true.
2. The psychological problem:  It depends on the habits of the mind. We form habits of the mind, we’re not applying any reason for believing in these regularities. Hume is forced to take on an Irrationalist epistemology, because repetition is not a good argument (since it is a psychological trick) and reason plays a minor role in forming our beliefs.

*Russel enforcing Hume*

Russel then states that if no solutions can be found, without going over human borderlines, then there is no intellectual difference that we can think of between sanity and insanity.

*Hume is right on the logical problem…but [Popper’s Position]*

Popper believes that Hume is actually right about the logical problem but dislikes the fact that Hume tries to solve the problem from a psychological point of view.

***Expectations born out of repetitions?* No!**

Popper rejects the idea that our expectations are born out of repetition. Habits like walking, speaking or feeding ourselves begin before repetition actually kicks in. They might deserve being called habits after being repeated, but not before, habit is not the origin.

Popper thinks that Hume is fundamentally wrong, he comes up with an example that shows us how wrong Hume is:

\*Puppies sniffing a cigarette\*

These puppies reacted just to the sight of the cigarette by coughing, running away ecc.

*Repetition and similarity*

Repetition doesn’t seem to explain the behavior of the puppies, one exposure was enough. What Hume does not realize is the fact that it is only a repetition for us of events that appear similar to us that have an effect on us.

There is no need, as he think, fro an event to be the same (plus perfect cases of sameness are impossible)… The similarity between two different events is enough.

*Point of view before repetition*

The puppies recognize the second situation **being similar** to the first, so expecting to find the same unpleasant factors which they were exposed to in the first instance. This is because they “**had a system of expectations, anticipations, assumptions or interests. Before there can be any repetition**” or better, a point of view. \*\*Popper is against Empiricism\*\*

The second repetition was similar to them. “Repetition only for a certain point of view”.

*Similarity for us*

* We actively impose regularities upon the world
* We try to discover regularities and similarities without waiting for the premises, we jump to conclusions, which we will discard later if the get contradicted

Repetition is the result of our interpretation which allows us to make connection and find similarities (for us!). We have to replace this idea of events which are similar by the idea of interpreting events that seems to be similar.

But by doing so it becomes impossible to understand similarities and to discover regularities.

Popper plays a Kantian game, with us imposing rules to what we see. So we actively impose regularities upon the world, we try to discover regularities, we jump to the conclusion which we will discard if they are proven wrong.

In other words we need to proceed by “**Trial and Error**” (in a critical way). We try to find regularities, we have the propensity to look for regularities in the world, and they could not be there and we could be wrong about this attitude we have.

**Popper’s aim: how all this matter for scientific reasoning?**

* Move to the context of scientific reasoning (advantages)
* Use the procedure of trial and error, a critical attitude to revise our beliefs and expectations
* Avoid being dogmatic, which is particularly important in science.

If we transpose this way of thinking in the field of science we will se the advantages both for science and for logic.

How does Popper reason? In science we apply this propensity of imposing order, regularities, expectations in nature in a critical manner (If we are uncritical we are like the empiricists, we are dogmatic).

The problem of induction comes from being dogmatic (since only uncritical people like empiricist wait to be it by whatever comes from the world). The attitude to turn into a habit, regularity, no matter what is a problem.

The task of Trial and Error is to use a critical attitude to revise our beliefs and expectation. We must be critical (“a black swan is always a possibility”)

*From Trial and error… To conjectures and refutations* (from everyday psychological attitude to scientific method

How do we do this? This procedure (Trial and Error) becomes in science “**Conjectures and refutations”**, what we can call the method of science.

*Logical error behind repetition*

Popper wants to find a solution for the problems of Hume’s reasoning (both psychological and logical).

**Logical side**:

* One way to frame the logical problem is:

Can the claim ‘X is true’ be justified by empirical reason?  Hume -> NO.

* The other way of framing it is:  But the answer can also change by means of empirical reasons  Can the claim ‘X is true or false’ be justified by empirical reason?  Popper -> sometimes YES.

We conclude we certainty because the base is not induction, rather inductive logic (even if empiricism is present

Can we make a deductive use of Experience? Back to material implication

Yes, we can retain the thrust of induction

He includes falsity to the function. The way to reach this conclusion is not based on induction, but on deductive logic, that’s why we could have the certainty of the justification.

In order to reformulate the problem of induction Popper needs to find an argument that avoids the vicious circularity of induction. Can we make a deductive use of experience? If we can, then we will retain the thrust of induction but we will avoid the problems connected to it.

Material implication can be used to represent syllogism.

**Modus Ponens**

If A then B

X is an Premises is True = Conclusion is True therefore x is B.

This way of reasoning is also called “Modus ponens” which is a shortcut for ‘Modus Ponendo Ponens’ (the mode of affirming by affirmation) **the method of affirming the antecedent.**

**This argument should NOT BE CONFUSED with an example of a fallacy, which is affirming the consequent** (C does not follow from P even if C happens to be true). Any Modus Ponens is not what Popper thinks can solve this problem.

**Modus Tollens**

If X then Y

Not Y Therefore not X

On the other side we have “**Modus Tollens**” (’Modus Tollendo Tollens’)**, The mode of denying what is denied, to deny the consequence**. Deduction from the truth of a singular statement to the falsity of a universal statement. Like in the previous case also Modus Tollens admits a fallacious interpretation, which is to deny the antecedent rather than the consequence.

**Why does Popper like modus?**

There are two types of statements:

* Singular existential statements (assertions about the existence of some particular thing) [SES]
* Universal statements (assertions that categorize all instances of something). [US]

*In the context of science*

SES is called ‘observational statements’.

- Inductively: universal statements inferred from observational statements = INVALID

Can we infer universal statements from observational statements? Yes, inductively we can, but with all the problems that we know. Making this inference is invalid because it leaves a great possibility of error.

*Alternatively…*

Can we validly infer a universal statement from singular existential statements? How can we make the passage valid?

First of all we need to put induction aside, and to find a **deductive** type of reasoning that helps us here. **There is Modus Tollens to do so!** We need to reason in terms of falsity, not truth.

Hypothetical deductive type of reasoning:

If U then O All swans are white

not O That swan is black

therefore not U Therefore not all swans are white

(U=universal, O=observation)

I conclude with certainty that not all swans are white (if I see a black one). This is a deductive certainty. Only one observation which is contrary is enough to deny the general view itself. This reasoning is also called “**hypothetical deductive**”.

**Flow of the Argument:**

1. We start with an hypothesis or universal statement (U)
2. We make a prediction about a certain singular happening (U-O).
3. We wait for an observational statement that contradicts the expected prediction (-O)
4. Then we are able to falsify the universal statement (-U)

Just by means of one singular observation I’m able to reject entirely and conclusively the hypothesis I started from.

**Logic of Falsification**

Popper appeals to experience to assess the falsity of a universal statement. All we can be certain about is falsity. We will never claim conclusively, a statement is true since one argument against it can refute the whole thing.

T —> P

Not P (= potential falsifier)

Not T

The logic underlying the falsification is the logic of modus tollens, which entails the deduction from the truth of a singular statement to the falsity of a universal statement.

In Popper terminology this particular type of statement (not p) is called “**potential falsifier**”. Potential because it is a logical possibility, but if we find one, one only is enough to do the job. The argument from experience is a deductive argument which uses experience as a test to show that the universal statement is false.

Popper’s solution

* IF no matter how many empirical instances in favour of a regularity, the regularity cannot be proven to hold true (inductive circularity) THEN, CHANGE OF TACTIC
* Let us use one empirical instance against regularity to show that the regularity does not hold true (deductive certainty

In Popper’s own words

* The original problem of induction is the problem of justifying induction, which is always invalid
* The following problem is how to justify the method of trial and error
* Popper suggests to say: “the method of trial and error is a method of eliminating false theories by observation statements; and the justification for this is the purely logical relationships of deducibility which allows us to assert the falsity of universal statements if we accept the truth of singular ones”

**How did Popper arrive to this conclusion? Demarcation**

In science we’d expect to use a certain type of method, based on real observations (empirical method).

When we think of the empirical method we tend to associate it with inductive procedures.

Popper needs to decide what the real method of science is, because by doing so we would be able to demarcate between genuine science from pseudo-science. A

t the same time though, Popper grows impatient vis-a-vis induction.

*Demarcating by Induction*

He comes to believe that relying too much on induction often leads to an unscientific attitude, which is a desperate attempt of confirming some theories, by finding evidences that support it.

*Difference between science and pseudo-science (unlimited explanatory power)*

If you are like this, you become terribly dogmatic, you just focus on the positive, and evaluate your theories only by finding evidences in favor of them. Pseudo-scientists like Marx, Freud and Adler take inductive method to the very limit. These people always try to find instances of confirming evidences for their theories. And their theories in the end can make predictions, but this is a sign of weakness: they explain far too much (Unlimited explanatory power = weakness).

According to Popper any behavior can be explained by either theories, but this is not an advantage. Freud played it safe, by trying to protect his theories from serious criticism or attacks (opposite from Einstein).

Popper likes Einstein because he’s all about making bold predictions and taking big risks, to a large extent using falsification a lot. Einstein makes some predictions before observing the Phenomena

1. Einstein made bold predictions in advance/absence of any relevant observations. So he was making a conjectures
2. He was under the serious risk of being refuted. (i.e. the bending of starlight)

*In Popper’s own Words*

* “If observation shows that the predicted effect is definitely absent, then the theory is simply refuted.” Einstein starts from the theory/ a conjecture and wait for an observation to contradict it.
* While Freud tries to include and justify any possible anomaly inside his “system” (justificationism)

***Valuable Scientific Claims***

This explains why Popper was very interested in high-risk theories. What is interesting is when you make scientific claims which have **low probability** which are **highly falsifiable** and exposed to criticism. In the end if any of these claims are actually proved that they can survive all these test, at least we know that these claims are not false.

The attempt is not to obtain a high number of rejected theories, but to obtain theories that are not false, the more tests they survived to, the more we can say that they are “**corroborated** (survive a large number of attempts of falsification) **by evidence at a time ’t’”.**

*“Corroborated”, not “true”…A further interesting point for Popper*

Popper also remarks that theories will display different degrees of corroboration, which are *“reports about the state of discussion at time t*”. It says that at a certain time “t” I should prefer the theory which survived to the larger number of attempts of falsification since it is acceptable to work with it not because it is proven to be true but because it is not proven to be false yet. Anyway this says nothing about “ultimate reliability of a theory”.

* Falsifiability as a a sign that a claim is empirical (crucial feature in science)
* The hallmark of genuine science, the criterion of scientific status of a theory, it its refutability, testability or falsifiability.

The conjecture itself is empirical because it can respond to an empirical test. The criterion of the scientific status of a theory is its refutability, testability or falsifiability.

**RECAP of Popper’s View**

* Induction is a myth in science;
* Actual procedure of science is jumping to conclusion;
* It is not true that in order to be empirical, scientific method should be inductive;
* Repetition comes only at the stage of testing a conjecture, not in putting together my claim;
* Induction is the wrong criterion, falsification is the right one.
* In finding the right criterion of demarcation we find the correct way to make the argument from experience work

Criticism of Popper’s view

1. Logical objections: falsification does not exclude induction
2. Historical objections: falsification does not represent nor explain how science actually progresses
3. Methodological objections: philosophy of science issues

Logical Objections

Does falsification really exclude induction?

To answer we should clarify:

* What the empirical status of potential falsifiers’ basic observation is
* What their role is in deductive type of reasoning.

**Potential falsifiers**

They are a special class of (observational statements) basic statement: a form of singular existential statement. (i.e. an existential assertion about some definite spatio-temporal region)

*“Basic” for Popper*

They are basic not in the sense of being final, but because **they belong to that class of statement which are used in testing our theories**. If a theory has to be having empirical content, then it must forbid something.

*Potential Falsifiers as basic statements.*

What is their role in falsifying theories? Why do we need them?

Difference between verification and falsification.

* To verify an universal statement we need to have an infinite number of observations (induction is inconclusive).
* To falsify an universal statement one observation is enough (deduction is logically conclusive).

*First logical problem: quantity of falsifiers*

Theory (T) admits of an infinite number of potential falsifiers. How can we decide which theory is better (T1 or T2) on the basis of this kind of indefinite pool of possible rejection considering the criterion of choice is the degree of corroboration?

At time “t” only a finite set of observable consequences of a theory are testable and tested.

**Inductivist move! (Not forward looking though)**

- Judging a theory performance on the basis of here and now.

Up to now we are only acquainted with a final set of observable consequence. If we reason this way we reintroduce an inductive criterion.

Popper defends his position by saying that the way in which we choose comes in degrees (degrees of corroboration). “The degree of corroboration at a time t says nothing about the future”.

But if so it keeps being difficult to see why we should prefer a certain theory over another one basing our choice on the degree of corroboration.

*Second logical problem: truth of potential falsifiers*

We can deduce the falsity of a universal statement from the truth of a singular statement.

**What allows us to accept the basic statement as true?** *Truth as a decision?*

Popper says that “from a logical point of view the testing of a theory depends upon basic statements whose acceptance or rejection depends upon our decisions”.

Basically he is saying that we decide what truth to choose. A decision is conventional.

*Piles on a swamp*

* “The empirical basis of objective science has nothing ‘absolute’ about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or ‘given’ base; and if we stop driving the piles deeper, it is not because we have reached firm ground. We simply stop when we are satisfied that the piles are firm enough to carry the structure, at least for the time being.”

**Final comments**

* Role of positive experience
* Decision/ Role of Consensus/ Positive Support
* Trust on observation

According to Popper we are as certain as we can be at a certain t time. We use experience in a positive way, we are making use of a positive type of evidence (which is an inductive type of view). But the acceptance of the potential falsifier is not really a matter of experience, but also a matter of decision. Acceptance itself is a positive evidence, and the building of positive support can be seen as an inductive move.