Kant for Physicists

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General goals:

- Provide an overview of the core aspects of Kant's theoretical philosophy, especially as they pertain to his philosophy of science.
- Trace his influence on some of the more important thinkers and developments in physics and mathematics in the 19th century and beyond.

General outline:

1. Kant's "metaphysics"
    a. Introduction; Kant's pre-critical period
        - Principles for the possibility of metaphysical cognition
    b. Kant's Critique of Pure Reason
        - Synthetic a priori cognition
        - Pure intuitions
        - Pure concepts and their characteristic schemata
        - Principles of the understanding and of reason
        - Kant's reconceptualization of metaphysics
2. Kant's Metaphysical Foundations of Natural Science and the Critique of Teleological Judgement
3. Kant's successors
    - Neo-Kantians
    - *Naturphilosophie*
    - After the 19th century

Immanuel Kant
(1724–1804)

- Made enormous contributions to almost every area of philosophy: Epistemology, Metaphysics, Philosophy of Science, Ethics, ...
- Most important works: Critique of Pure Reason (1781, 2nd ed. 1787), Critique of Practical Reason (1788), Critique of Judgement (1790).
- At heart, and from his earliest days, Kant was a philosopher of science (and a very influential one!)
  - Many parts of modern physics and mathematics were motivated as a response to Kant
  - Other important influences: psychology, evolutionary theory, anthropology, astronomy, ...

Kant's concern (1755-1770): To make metaphysics more scientific,

- i.e., to provide it with principles through which to guarantee the legitimacy of its claims.

Only Possible Argument (1763): "What I am furnishing here is the materials for constructing a building ..."

Prize Essay (1763): two rules "by which alone the highest possible degree of metaphysical certainty can be attained."

"One ought ... to begin by carefully searching out what is immediately certain in one's object, even before one has its definition. Having established what is immediately certain in the object of one's inquiry, one then proceeds to draw conclusions from it. One's chief concern will be to arrive only at judgements about the object which are true and completely certain" (2:285).

Kant's Innaugural Dissertation (1770):

Sensible vs. intellectual cognition:

"... whatever cognition is exempt from such subjective conditions relates only to the object. It is thus clear that things which are thought sensitively are representations of things *as they appear*, while things which are intellectual are representations of things *as they are*." (2:392).

"[space and time] are not *rational* at all, and that they are not *objective* ideas of any connection, but ... they are appearances, and ... while they do, indeed, bear witness to some common principle constituting a universal connection, they do not expose it to view." (2:391).

"the *form* of the same representation is undoubtedly evidence of a certain reference or relation in what is sensed, though properly speaking it is not an outline or any kind of schema of the object ..." (2:393).

"[E]mpirical concepts do not ... in virtue of being raised to greater universality, become intellectual in the *real sense*, nor do they pass beyond the species of sensitive cognition; no matter how high they ascend by abstracting, they always remain sensitive (2:394)."

Principle of Reduction (paraphrase)

Any concept of the understanding to which we predicate anything belonging to sensibility—even only its pure forms (space and time)—must not be asserted objectively (i.e., asserted as having objective validity independently of all actual or possible experience of it.) (2:413).

The Formal Principle of the Intelligible World

(A kind of generalized principle of causality)

"to explain how it is possible *that a plurality of substances should be in mutual interaction with each other*, and in this way belong to the same whole, which is called a world" (2:407).

Kant's concern (prior to 1781):

- To provide a principled grounding for metaphysical cognition, i.e., what we can know with mathematical certainty about the "intelligible world", in order to transform metaphysics into a science.
- Two principles (1770) for metaphysical cognition:
  1. Generalised principle of causality ("The Formal Principle of the Intelligible World")
  2. Principle of reduction
     - Concepts that refererence sensibility—even only its pure form—are to be excluded from the domain of objectively valid concepts (Kant, 2002, 2:394).

Transcendental idealism (1781):

- Metaphysical cognition (in the traditional, i.e., fully general, sense) is impossible
  - Causality requires a reference to the forms of our intuition (space and time).
  - Yet the forms through which objects appear to us cannot be taken to be the forms of things themselves.
  - Once the principle of reduction does its work there is nothing left.

Kant on Hume:

"The question was not whether the concept of cause was right, useful, and even indispensable for our knowledge of nature, for this Hume had never doubted; but whether that concept could be thought by reason *a priori*, and consequently whether it possessed an inner truth, independent of all experience ... This was Hume's problem. It was a question concerning the *origin* of the concept, not concerning its indispensability in use. Were the former decided, the conditions of its use and the sphere of its valid application would have been determined as a matter of course." (Prolegomena 4:258-259)

Synthetic a priori cognition:

- Cognition of distinct concepts as being necessarily connected
- Metaphysical cognition (if it existed) would be a kind of synthetic a priori cognition.
- Mathematical cognition is also synthetic a priori.
- How it is possible: The forms of possible experience are known a priori and are also synthetic (since appearances are ordered through them).
- Limits: synthetic a priori cognition is only possible in relation to possible experience.

"In the solution of the above problem there is at the same time contained the possibility of the pure use of reason in the grounding and execution of all sciences that contain a theoretical *a priori* cognition of objects" (B20).

(i.e., the exact, or mathematical, sciences)

Kant's framework for theoretical cognition:

I. The pure forms of sensible intuition: space and time

II. The pure forms of thought
   - In relation to possible experience:
     - Logical forms of judgements (the Categories of Quantity, Quality, Relation, and Modality), their characteristic schemata and associated synthetic a priori principles.
   - When they transcend possible experience:
     - Logical forms of inferences (the Ideas of Reason) about concepts of the understanding as such, and their associated absolute principles
     - Although useful, they unavoidably give rise to transcendental illusion.

Kant's discursivity thesis:

"Thoughts without content are empty; intuitions without concepts are blind. Hence it is just as necessary that we make our concepts sensible (i.e. that we add the object to them in intuition) as it is necessary that we make our intuitions understandable (i.e., that we bring them under concepts). Moreover, this capacity and this ability cannot exchange their functions. The understanding cannot intuit anything, and the senses cannot think anything. Only from their union can cognition arise." (A51/B75–76).

"Anthropocentric paradigm" of cognition:

- Cognition involves contributions from understanding and sensibility
- No standpoint-independent perspective from which to know.

"Theocentric paradigm"

- True cognition is absolutely independent of any perspective.

These are norms—standards by which to judge—cognition (Allison, 2004, ch. 2).

Transcendental idealism: a metaphilosophical doctrine, ascribes to the anthropocentric paradigm.

Transcendental realism: ascribes to the theocentric paradigm.

Intuition:

- The 'this' and 'that' of experience.
- Mediated by our 'faculty of sensibility', i.e., our mind's capacity to be affected by objects (A19/B33).
- The effect on sensibility of some object is called sensation, and with sensation we associate the empirical aspect of our intuition.

"The undetermined object of an empirical intuition is called *appearance*" (A20/B34).

- E.g., consider a shape against the wall in a dark room.
  - Before we determine it to be a chair (upon closer scrutiny), we can say merely that it is the appearance of something indeterminate.

Two aspects to every appearance:

- Its matter, i.e., *what we sense* in it,
- The (pure) *forms* through which the manifold of the appearance is represented as ordered: space and time.
- Kant also calls space and time pure intuitions in the sense that they refer to the form of the appearance as such.

"Now what are space and time? Are they actual entities? Are they only determinations or relations of things, yet ones that would pertain to them even if they were not intuited, or are they relations that only attach to the form of intuition alone, and thus to the subjective constitution of our mind, without which these predicates could not be ascribed to anything at all?" (A23).

Trichotomy:

1. Actual entities ?
2. Actual relations between things in themselves ?
3. Subjective forms of our intuition.

Neglected alternative:

$$\frac{3}{\therefore 1 \text{ (or } 2)}$$

"... even if we concede the argument that space and time are demonstrated to be subjective conditions which, in us, precede perception and experience, there is still no word of proof to show that they cannot at the same time be objective forms." (Gardner, 1999, p. 107).

"Transcendental idealism is not a skeptical reminder that we *cannot be sure* that things as they are in themselves *are* also as we represent them to be; it is a harshly dogmatic insistence that we *can be quite sure* that things as they are in themselves *cannot be* as we represent them to be." (Guyer, 1987, p. 333).

"[Lambert objects that changes] are possible only on the assumption of time; therefore time is something real ... Then I asked myself: Why does one not accept the following parallel argument? Bodies are real (according to the testimony of outer sense). Now, bodies are possible only under the condition of space; therefore space is something objective and real that inheres in the things themselves. The reason lies in the fact that it is obvious, in regard to outer things, that one cannot infer the reality of the object from the reality of the representation" (Zweig, 1967, p. 75).

- While this may not be obvious to everyone, it was obvious to Kant, who was concerned with what we can say with mathematical certainty about the intelligible world.

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Logic in general:

- "contains the absolutely necessary rules of thought without which the understanding cannot be used at all" (A52/B76).

General logic:

- Abstracts away from all content of the propositions it relates. It "deals with nothing but the mere form of thought" (A54/B78).

Transcendental logic (A55–57/B79–82):

- Does not abstract away from all content.
- Its propositions refer, specifically, to objects of experience as such, which, as such, are given in pure intuition.

Kant's discursivity thesis:

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Concepts of the understanding:

- Rules governing the synthesis of the manifold of intuition
- E.g., "chessboard" (an empirical concept) corresponds to a rule whereby this particular bit of white, that particular bit of black, etc., can be associated together in one representation.
- The Categories: Logical forms of judgements (of *Quantity*, of *Quality*, of *Relation*, or of *Modality*) as they pertain to the objects of possible experience as such (A79/B105).
    - Function as "meta-concepts": Implicit in any empirical concept.

Consider:

- Generally speaking, O is subsumed by C implies that O and C share features in common.
- Problem: Although our empirical concepts presuppose them, we don't ever directly encounter the categories in intuition (cf. Hume).
- Solution: A transcendental time determination:
  - has something in common with the categories (because determination presupposes synthesis)
  - has something in common with the intuition (because it is a time determination)

Schemata:

- Schema for a category: The rule for the application of the category in the determination of time as such (A137-147/B176-B187).
- Categories and their characteristic schemata:
  - of Quantity: Schemata deal with time series:
    - In apprehending a manifold, determinate intuitions of time are produced with each act of synthesis, which can then be counted as a way of determining the extent of the object apprehended.
  - of Quality: Schemata deal with time content, i.e., with how we determine the degree of reality or intensity of what is apprehended in intuition at a given time.
  - of Relation: Schemata deal with time order, i.e., to the determination of the ordering of given perceptions in time.
  - of Modality: Schemata deal with time sum total, i.e., to the determination of whether a given object exists at some, one, or all times.

Categories	Synthetic a priori principles	Metaphysical principles of natural science
Of quantity	Axioms of intuition - Extension	Phoronomy - Composition of motions
	constitutive for appearances	
Of quality	Anticipations of perception - Intension	Dynamics - Moving forces
Of relation	Analogies of experience - Substance - Cause and effect - Interaction	Mechanics - Communication of motion
	regulative for appearances	
Of modality	Postulates of empirical thought as such - Modality	Phenomenology - Possible, actual, and necessary motions

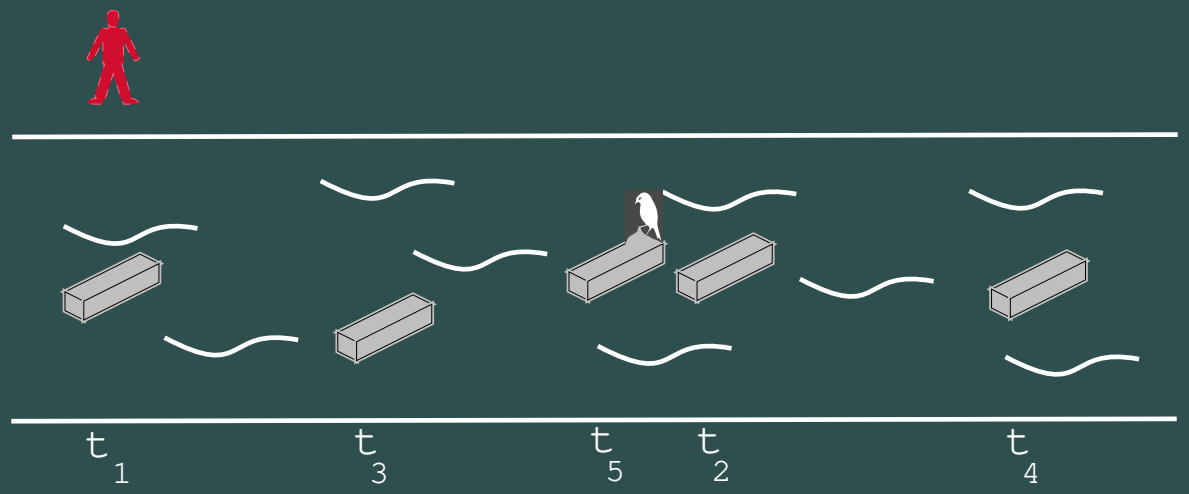
Synthetic a priori principles:

- General principles governing the use of the categories in accordance with their characteristic schema.
- Also (thereby) the general principles for the cognition of objects and their relations in accordance with a possible experience.

Synthetic a priori principles (cont'd)

Constitutive vs. regulative (for appearances):

- Constitutive (mathematical principles): Tell us what an appearance must be like if it is to exist for us at all.
  - I.e., it must have a determinate extent and a particular degree of intensity.
- Regulative (dynamical principles): Govern how given appearances must be connected together in time in order for it to be possible to cognise some object.
  - I.e., as the appearances of possible, actual, or necessary substances that interact with one another and evolve through time in accordance with the principle of cause and effect.



E.g., Kant's Principle of causality tells us that the states of an object are ordered uniquely and objectively (A191/B236),

- as opposed to the series of our subjective perceptions of the object through which we apprehend it.

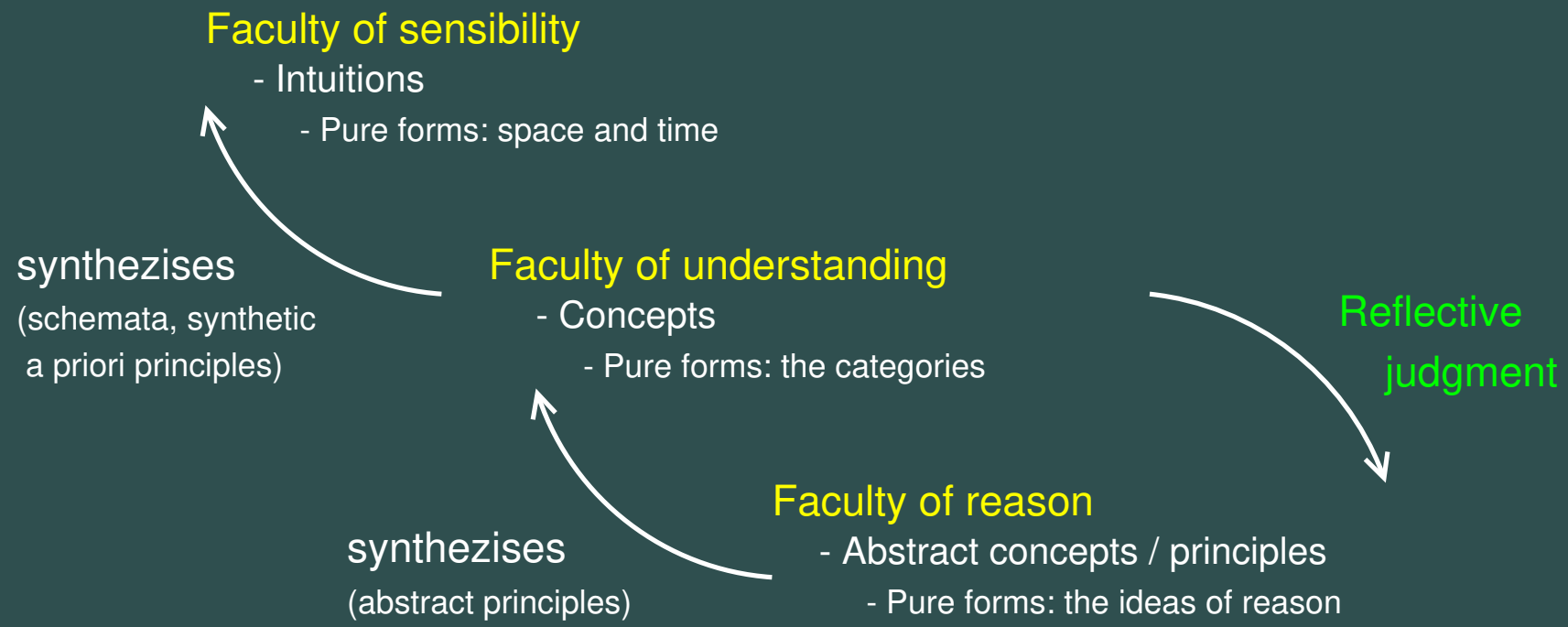
"we see that appearance, as contrasted with the presentations of apprehension, can be presented as an object distinct from them only if it is subject to a rule that distinguishes it from any other apprehension and that makes necessary one kind of combination of the manifold." (B236).

Recall:

- Mathematical principles: constitutive for appearances
- Dynamical principles: regulative for for appearances

All synthetic a priori principles:

- Constitutive for particular objects,
  - i.e., of what it means to provide an objective description of some thing: If an objective description of our any given part of our experience is to be had at all, according to Kant, then the corresponding appearances better be determinable in accordance with the synthetic a priori principles (both mathematical and dynamical).
- Regulative for experience in general.
  - I.e., they don't imply that all of our experience is objectively characterizable.
  - For finite rational cognisers constrained by the forms of sensible experience such as ourselves, that would be impossible to know (A509/B537).


Faculty of sensibility
- Intuitions
- Pure forms: space and time
synthezises
(schemata, synthetic
a priori principles)
Faculty of understanding
- Concepts
- Pure forms: the categories
Reflective
judgment
Faculty of reason
- Abstract concepts / principles
- Pure forms: the ideas of reason
synthezises
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Reason:

- Aims to comprehend experience, i.e., to organise it all into a comprehensive system (A311/B367).
- However such a system, which cannot itself be conditioned by any possible experience, cannot in turn be an object of experience.
- This has pitfalls, according to Kant, which we will do well not to be deceived by.

The Ideas of Reason:

- Logical forms of inferences regarding the understanding's concepts of things as such
- By definition, unconditioned or absolute, i.e., universally valid irrespective of any particular condition characterising a thing
- Associated with a number of absolute principles, falling into three classes (B379, B391):
  1. Concerning the unconditioned unity of the thinking subject; i.e., the object of psychology
  2. Concerning the absolute unity of the series of conditions of appearance; i.e., the object of cosmology
  3. Concerning the absolute unity of the condition of all objects of thought as such; i.e., the supreme condition of the possibility of everything, or the object of theology
- The Ideas of Reason are required for gauging the degree of success of a particular activity (B372).
- But they (unavoidably) give rise to transcendental illusion.

- The Paralogisms of Pure Reason in regards to our knowledge of the soul or psychology (A341/B406–A404/B432).
- The Antinomies of Pure Reason (A405/B432–A566/B594).
  - Mathematical antinomies:
    - Concerning the finitude or infinitude of the world as a whole
    - Concerning the infinite divisibility of substances
  - Dynamical antinomies:
    - Concerning freedom vs. determinism
    - Concerning the requirement for a necessary being
- The Ideal of Pure Reason in regards to the supreme condition of the possibility of everything, or the object of theology.

E.g., Second antinomy

- Thesis: Every composite substance is made up of simple parts.
- Antithesis: No composite substance is made up of simple parts.

Kant's resolution (A523–527/B551-555):

- On the one hand, both thesis and antithesis assume that the spatiotemporal attributes of an object pertain to the object as it exists in itself, but there are reasons to deny this.
- On the other hand, completed infinities are not to be found in the succession of appearances of the object as we divide it in thought (or in reality).
- The (appearances of) parts of the object are, rather, produced successively with each act of synthesis.

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The upshot of Kant's mature theoretical philosophy for metaphysics:

- Metaphysical cognition, as a system of fully general constitutive principles in the sense required by a transcendental realist is impossible.

That said,

- Although metaphysics is impossible in that fully general sense, it is still possible in a more restricted sense, i.e., with respect to some specific precisely (mathematically) delineated domain.
- Kant's system of synthetic a priori principles is itself a kind of metaphysics. It is just not one in the traditional sense, but rather a metaphysics of experience as such.
- Kant's *Metaphysical Foundations of Natural Science* concerns the metaphysics of, specifically, *outer* experience.

Kant's Metaphysical Foundations of Natural Science (1786):

- Identified with the metaphysical principles for the possibility of matter, i.e., the matter of appearance, in general.
- Material objects appear to us only through their motion.
  - Phoronomy: Governs how motions as such are composed.
  - Dynamics: Governs how a given movable matter, through fundamental forces of attraction and repulsion, comes to occupy a given space.
  - Mechanics: Governs how motion is communicated between movables.
  - Phenomenology: Governs how a given motion is represented as the (possible, actual, or necessary) motion of an object.

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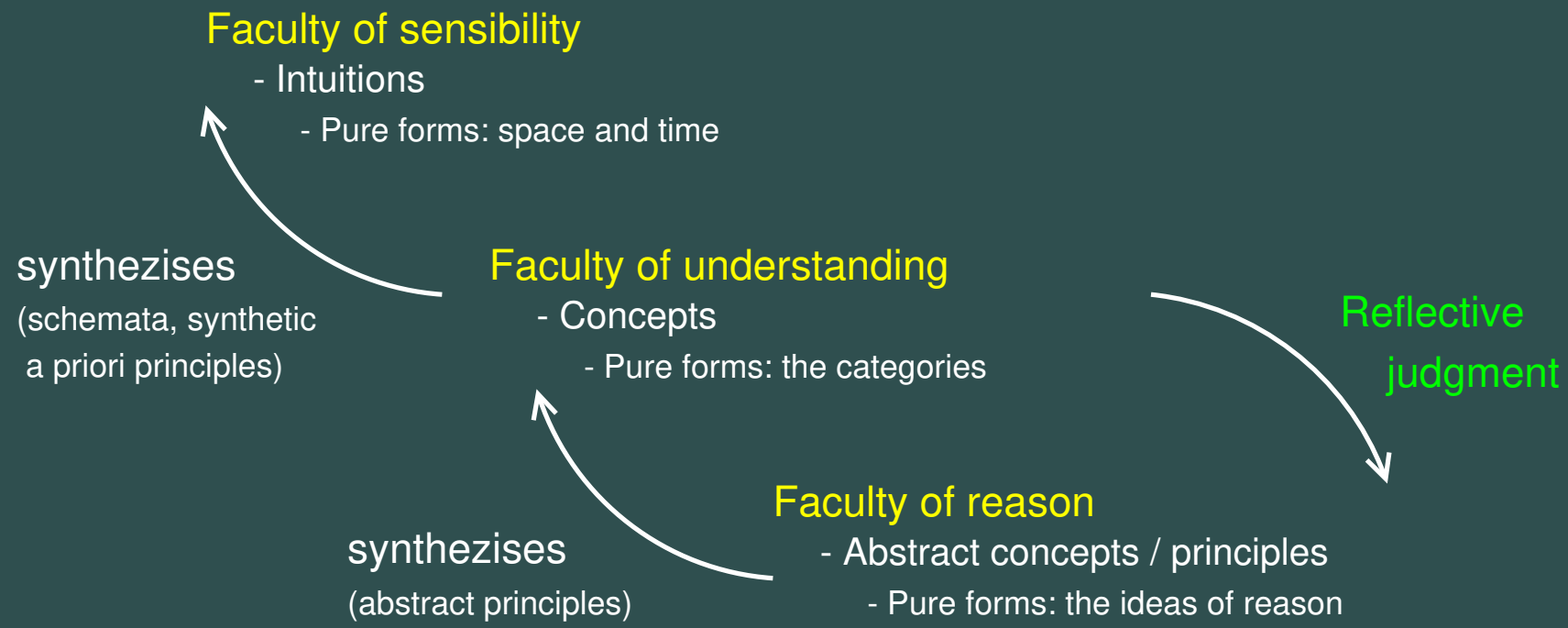
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Critique of judgement (1790):

- Judgement, in general, is the ability to subsume a particular (which can be an empirical regularity) under a universal rule.
- When the rule is not antecedently given, judgement has to reflect on a given empirical regularity in order to find a rule / concept under which to subsume it.
- In some cases, judgement has no choice but to reflect upon the empirical regularities that it finds in nature as if they were part of a purposively designed unified system.

Natural purpose:

- Its various parts and their relations are understood to be based upon the idea of the thing as a whole (analogously to a work of art).
- Unlike a work of art, a natural purpose is a self-organising being, such that its parts reciprocally produce one another

Antinomy of teleological judgement (Kant, 1790):

R1: "Some products of material nature cannot be judged to be possible in terms of merely mechanical laws", but rather must be judged in teleological terms (Kant, 1790, 387).

R2: "All production of material things and their forms must be judged to be possible in terms of merely mechanical laws" (ibid., 387).

Resolution:

- It does not follow from the fact that something must be reflected upon in some way X that it is explainable in those terms.
- O must be judged in terms of X is compatible with O must be judged in terms of Y even when X and Y, construed ontologically, disagree in some way Z, as long as Z is not determinable on the basis of a possible experience.
- The merely logical contradiction between the (subjective) principles, R1 and R2, is harmless for the methodological purposes that we actually use them for in science.

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Kant's successors:

Recall that according to Kant's transcendental idealism, the forms through which objects appear to us are not to be taken to be the forms of things themselves.

Two ways of understanding TI's significance:

1. Ontological lesson: things as they exist in themselves are not spatiotemporal (and thus not cognisable in accordance with synthetic a priori principles).
    - Criticism: It doesn't follow from the fact that space and time are necessary forms of our sensibility that they cannot also be forms of things in themselves.
2. Metaphilosophical/epistemological lesson: Our standard for (mathematically certain) objective cognition needs to be "anthropocentric" rather than "theocentric".
    - Criticism: Kant has failed to adequately characterise the structure of our cognition.

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