Is information a sufficient basis for cognition?

(Part 1: Critique of Dretske's Vision)
(Part 2: Physical Foundations)

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Sumary

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«Nihil est in intellectu quod prius non fuerit in sensu, nisi ipse intellectus»

1. Introdution
2. Dretske's approach
3. Physical Foundations (P2)
4. Limits of Dretske's approach and the foundations of cognition

1. Introdution

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- History of Philosophy:
  - *Tabula rasa*: intellection plays a passive role
  - Idealistic tradition: intellection as an autonomous faculty

- Fred Dretske (1981) *Knowledge and the Flow of Information*:
  - Developing a semantic theory of information to analyze the most important mental processes involved in cognitive behaviour: knowing and believing

2. Dretske's approach

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- Detske's approach:
  - Semantic theory of information
  - Definition of de re perceptual knowledge based on the theory of information
  - Notion of perception (different from the Causal Theory of Perception)

2.1 Information

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- Philosophical principle:
  - The commodity called "information" must be considered as something objective and natural, whose existence, generation or transmission does not depend on the cognitive interpretation of a possible agent

- Constraints:
  - (a) The signal carries as much information about s as would be generated by s's being F
  - (b) s is F
  - (c) The quantity of information the signal carries about s is (or includes) the quantity generated by s's being F (and not, say, by s's being G)

- (1) Definition of informational content:
  - A signal r carries the information that s is F = the conditional probability of s's being F, given r (and k), is 1 (but given k alone, less than 1)

- (2) Xerox principle:
  - If A carries the information that B, and B carries the information that C, then A carries the information that C

2.2 Knowledge

- (3) Definition of de re perceptual knowledge:
  - K knows that s is F =
    - K's belief that s is F is caused (or causally sustained) by the information that s is F

2.3 Perception

- S gives primary representation to B (relative to property G) =
  - S's representation of something's being G depends on the informational relationship between B and G but not vice versa

Part 2: Physical Foundations (§3)

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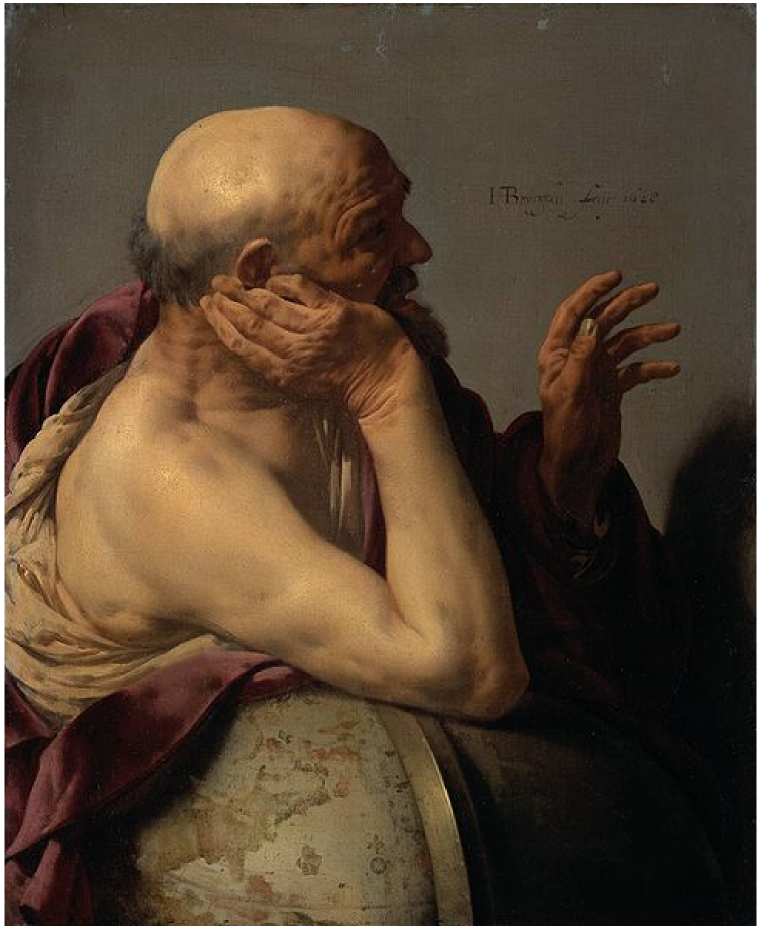


φύσις κρύπτεσθαι φιλεῖ
«Nature loves to hide»
Heraclitus of Ephesus (c.520BC – c.460BC), DK 123

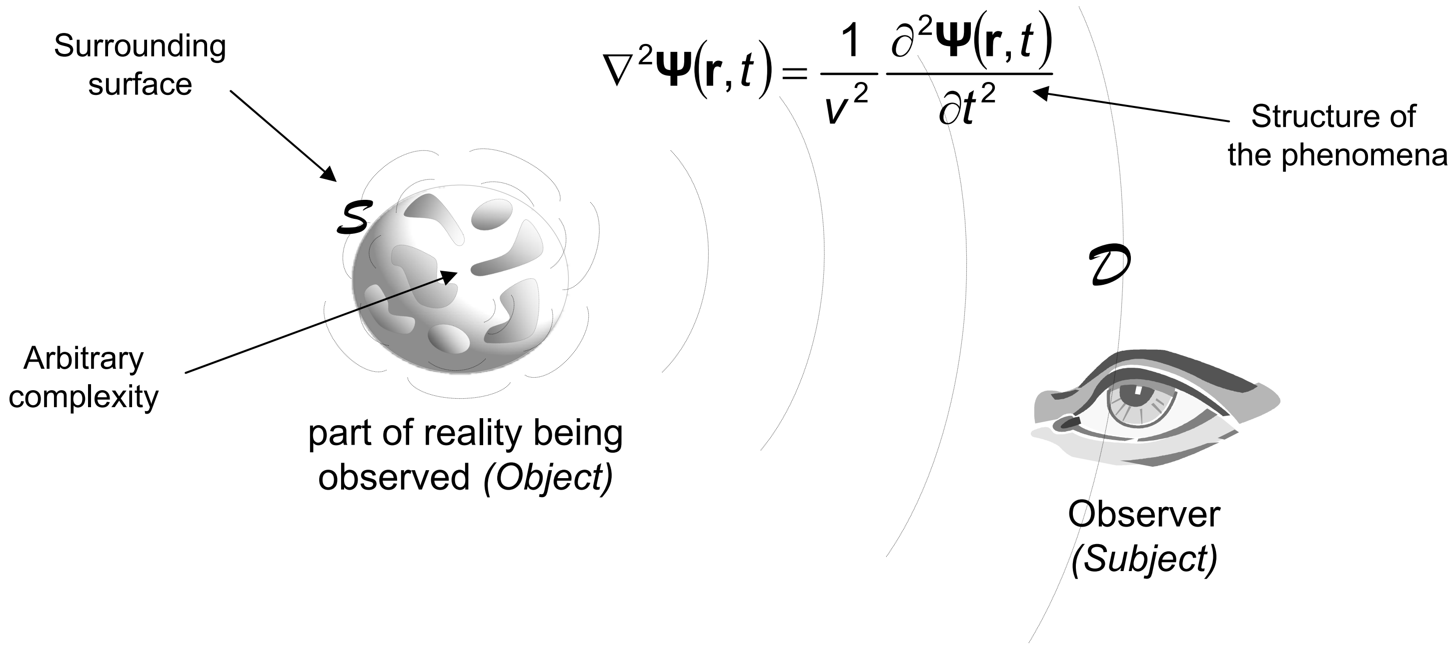
3.1 The nature of the manifestation of reality

3.2 The limits of observation
- Discretizability
- Dimensionality
- Forward and inverse problem
- Observational limits

3.3 The nature of perception

3.1 The nature of the manifestation of reality

- Simplistic and classical case of an object surrounded by an homogeneous space.



3.1 The nature of the manifestation of reality

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- Wave equation: (x, y, z, t) symmetry
- Smoothing complexity: Fourier theorem → Linear combination of harmonic distributions, each of them satisfying Helmholtz equation ($k = 2\pi f / v = 2\pi / \lambda$)

$$\nabla^2 \boldsymbol{\Psi}(\mathbf{r}) + k^2 \boldsymbol{\Psi}(\mathbf{r}) = 0$$

$$\boldsymbol{\Psi}(\mathbf{r}, t) = \int_{\forall f \in B} \Re\left\{ \boldsymbol{\Psi}_f(\mathbf{r}) e^{-i2\pi ft} \right\} df$$

- Applying again the Fourier theorem: we can express the spatial variations as a linear combination of harmonic distribution in each space direction:

$$\boldsymbol{\Psi}(\mathbf{r}) = \boldsymbol{\Psi}_x(\mathbf{r}) \cdot \boldsymbol{\Psi}_y(\mathbf{r}) \cdot \boldsymbol{\Psi}_z(\mathbf{r})$$

$$\text{with} \quad \boldsymbol{\Psi}_{u,k_u} = \mathbf{A}_{u,k_u} e^{-ik_u u}$$

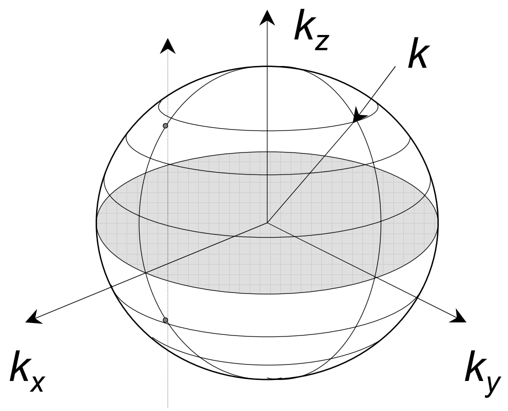
Spatial wave number

Spatial direction

$$k_x^2 + k_y^2 + k_z^2 = k^2$$

3.2 The limits of observation - Discretizability

- Basic constraint in the spatial variations
  (apparently 3D, actually 2D)



Theorem 1: *The minimal distance between independent intensity values of a field generated by an arbitrary object is λ/2*.

$$1/2b = 1/(2k/2\pi) = \pi/k = \pi\lambda \,/\, 2\pi = \lambda/2$$

3.2 The limits of observation - Dimensionality

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Theorem 2: *The maximum number of details of an object, inscribed in an sphere of radius a, which is causing an observed field distribution is 16 $\pi(a\chi/\lambda)^2$. This is the essential dimension of the observation problem*.

N independent subdomains of area $(\lambda/2\chi)^2$ on $\mathcal{S}$ which completely determine: (i) the field on $\mathcal{S}$; (ii) the field on the homogeneous space –uniqueness theorem for Helmholtz equation-

3.2 The limits of observation – Far observation

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Theorem 3: *The minimal distance between independent values of the field corresponding to the manifestation of an object inscribed in a sphere of radius a, whose centre is at a distance d, is:* $\lambda d/2a\chi$.

Same radial decay for all spherical harmonics for $r > \lambda$

Distance between independent **angles** of observation: $(\lambda/2\chi)/a = \lambda/2a\chi$

3.2 The limits of observation - Direct & Inverse problems

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- Phenomena observed at $\mathcal{D}\ (u,v)$ corresponding to a set of sources

Green equation
$x', y', z' \rightarrow u, v$
Source (object) — Observation domain

$$\begin{pmatrix} \Psi(u_1,v_1) \\ \vdots \\ \Psi(u_M,v_M) \end{pmatrix} = \begin{pmatrix} G(u_1,v_1,x'_1,y'_1,z'_1) & \cdots & G(u_1,v_1,x'_N,y'_N,z'_N) \\ \vdots & \ddots & \vdots \\ G(u_M,v_M,x'_1,y'_1,z'_1) & \cdots & G(u_M,v_M,x'_N,y'_N,z'_N) \end{pmatrix} \times \begin{pmatrix} f(x'_1,y'_1,z'_1) \\ \vdots \\ f(x'_N,y'_N,z'_N) \end{pmatrix}$$

Phenomena — Source

Wave function

$$\mathbf{\Psi} = \begin{pmatrix} \Psi_1 \\ \vdots \\ \Psi_M \end{pmatrix} = \sum_{n=1}^{N} \begin{pmatrix} \psi_1 \\ \vdots \\ \psi_M \end{pmatrix} \cdot f_n = \sum_{n=1}^{N} \mathbf{\Psi}_n \cdot f_n = \mathcal{T} \cdot f \quad \text{where} \quad \mathbf{\Psi}_n = \begin{pmatrix} G(u_1,v_1,x'_n,y'_n,z'_n) \\ \vdots \\ G(u_M,v_M,x'_n,y'_n,z'_n) \end{pmatrix}$$

Direct problem (manifestation of reality) $\quad \mathbf{\Psi} = \sum_{n=1}^{N} \mathbf{\Psi}_n \cdot f_n = \mathcal{T} \cdot f$

3.2 The limits of observation - Inverse problem

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- Theorem 3 → The grasped details of the observed phenomenon does not depend on how detailed the observation is, but how far the independent values are.
- Theorem 2 → The essential dimension does not depend on the volume($\propto a^3$) but on the bounding surface($\propto a^2$) → the volumetric distribution of the object is inscrutable... What might we know about the object?
- Huygens principle (1690): "*each point on a primary wavefront can be considered to be a new source of a secondary spherical wave and that a secondary wavefront can be constructed as the envelope of these secondary spherical waves.*" → It suffices to refer to the secondary sources ("equivalent sources") *i.e.* **a projection of the inside**.

3.2 The limits of observation - Inverse problem

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- A good way to suit our problem (to be invertible) is locating N punctual sources over $\mathcal{S}$ regularly spaced at a distance $\lambda/2\chi$

$$\mathbf{\Psi} = \begin{Bmatrix} \mathbf{\Psi}_{OBSERVED} \\ \mathcal{T} \cdot f_{\text{projection}} \end{Bmatrix} \Rightarrow$$

$$\exists f_{\text{projection}} = [\mathcal{T}^{+} \cdot \mathcal{T}]^{-1} \mathcal{T}^{+} \cdot \mathbf{\Psi}_{OBS.} \Big/ \min_{f} \{ d(\mathcal{T} \cdot f_{\text{projection}}, \mathbf{\Psi}_{OBS.}) \}$$

- Which can have a unique solution.

3.2 The limits of observation - Observational limits

1. A **Finite Number of Details** related to the object can be found.
2. Such number **depends on the surface bounding** the object.
3. The **volumetric distribution** of an object **cannot be known** only based on its manifestations on the environment.
4. The description of the object that can be achieved corresponds to a **projection of the inner inhomogeneities** over $\mathcal{S}$.

- **Fundamental limits** to the observation problem, not related to sense structure, but to the **differences that can be found**
- Related to the **maximal** *a posteriori* **knowledge**
- Complexity$_{\text{Object}}$ can be > Complexity$_{\text{its Manifestation}}$

  Unknown *Given*

- Holographic principle (universe) –J.D. Bekenstein-

3.3 The nature of perception

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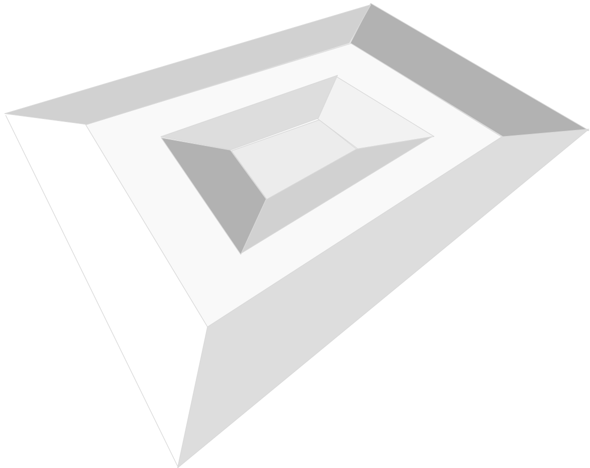
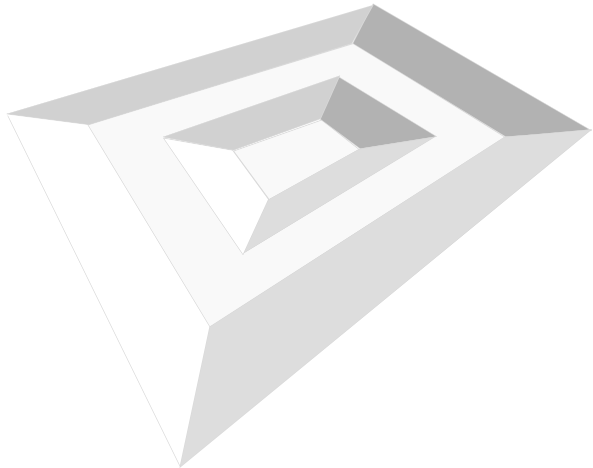
- *Further limits* on the amount of differences that a perceiving subject can acknowledge about the object.
- The more complex its sensitive organs are, the closer it can reach the stated limits.
- The differences encountered in sensation points to a *radical incompleteness* in relation to the reality being felt ~ ambiguity of illusory images.
- Despite of a relative **autonomy** in perception with respect to the whole act of apprehending reality, this seems to be a **unitary act** in which different sensitive structures take part (synchronic or diachronically) together with an intellective moment.

3.3 The nature of perception

a) regular hole or irregular coloured protuberance



b) irregular protuberance or regular coloured hole



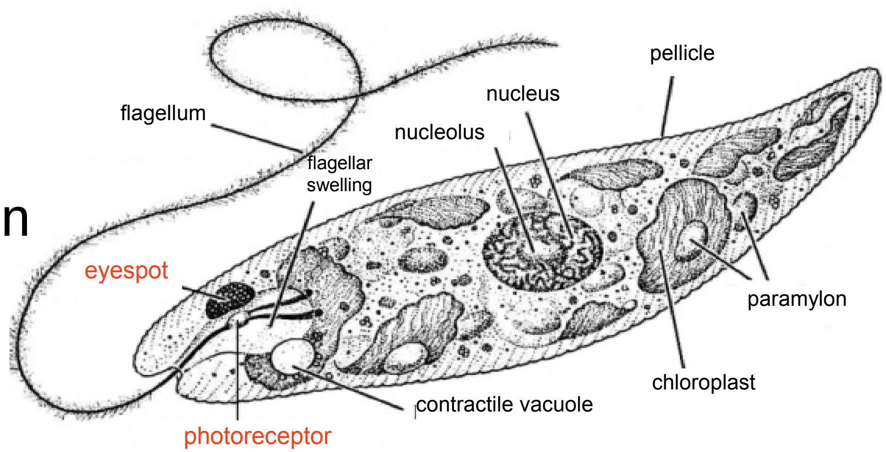
- The preferred perceptions tend to be those corresponding to the simplest configurations (Ockam's razor)

3.3 The nature of perception

- The more **complex** the sensitive structure, the greater the **ambiguity** of its perception and the more **accurate** the determination of the object.
- The **cell** has several means to sense the environment and to adapt to those variations which are relevant for its survival
- Protovision of the *Euglena viridis*:

  brightness (high/low), direction
- Animal vision:

  accuracy↑ and ambiguity↑



4. Limits of Dretske’s approach & foundations of cognition

4.1 Information, “objective commodity” vs “process”

4.2 Certitude, fallibility and channel conditions

4.3 Foundations of cognition

4.4 Digital vs fuzzy fundaments of semantics

4.5 A fuzzy-digital formality of perception

4.1 Information, “objective commodity” vs “process”

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- Dretske´s understanding of information can rather be interpreted as a **process**:
  - Digitalization of the world

- Signals do not convey information:
  - Unless they bring about to the “synchronic receiver” the certitude that something is the case

4.2 Certitude, fallibility & channel conditions

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- **p = 1** is essential to Dretske's vision (Knowledge vs Belief) ← "informational relationship"
- **Circularity** of *-idealism* vs *–information*
  Can we be sure on the object itself?
  Or the subject itself?
  Or rather on the interaction...
- Dretske's **channel correctness** vs MTC model and the 3th Thermodynamic principle.

4.3 Towards a more coherent foundations of cognition

- Previous analysis of observation $\rightarrow$ Dretske's certitude can not be supported $\Vdash$ beyond the "digital form" of "perceiving" "informational relations"
- Information- vs Semantic- Support

Reality itself + Complex Structure of perception and intellection

unitary act: *sensing reality*

$\supset$ *transcendence* (openness)

4.4 Digital vs fuzzy fundaments of semantics

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- Shannon's noiseless channel $\propto$ {limitation to **syntax**} vs {the **pragmatic** and **semantic** aspects of defining the elements of the **digital** mode}
- From Dretske's sureness {*s* is *F*} $\rightarrow$
  - *s* is noted as otherness $\rightarrow$
  - more notes and **fuzzy** constellations of notes are grasped $\rightarrow$
  - some reality is **fuzzily** sensed in an intelective moment… (e.g. patience fever) as it does its openness.

4.5 A fuzzy-digital formality of perception

- We need to deal with our world → we feel the environment fuzzily rather than digitally (e.g. *Euglena*: fuzzy control)
- What we are seeing, is an apple (~D's digital form)... Is it? → We need further notes... But better than being sure we may rather prefer a fresh apple)

nomic regularities (*de re* perception) → **conventional** regularities (*de dicto* perception)

s is F — *s* is F with a *confidence* degree

- We must be ready to accept that what we are feeling is something else that what we believed...
- There is a real relation among reality & its manifestation, but it is surjective
- The complex structure of our intellective sensation: truthful appreh.

Thank you for your attention

Cordially thankful to the organisers

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