

Goodman on Digitality

I. Preliminaries

A. Review

1. Overall, we are looking for the answers to three questions:

> **Q1** What are digital (discrete) systems good for? What are continuous systems good for? What are the constitutive properties of each?
>
> **Q2** What are the consequences of (reasons for? reasons against?) implementing on a digital substrate?
>
> **Q3** What kinds of fixity—and what kinds of fluidity—does digitality confer?

2. Last week, we looked at Haugeland's characterisation of digitality
   a. His basic position is that digitality is a kind of "**absolute perfection (in an intrinsically) messy world**"
   b. Our bottom-line characterisation is that Haugeland's analysis is a:
      i. Good analysis of *what digitality is for*; but a (✔)
      ii. Bad analysis of *what digitality is* (✘)
   c. Moreover, we noted that, even if one were disposed to agree with Haugeland's analysis, several questions would remain:

> **Q4** What is digitality, such that perfection, in our world, requires it?
>
> **Q5** What is the world like, such that digitality is required, to achieve perfection?

B. Plan (for the next couple of sessions): three things

1. Haugeland (I):
   a. First, I want to conclude our analysis and critique of Haugeland's object-level account of digitality (the account we have been looking at so far).
   b. In particular, we will
      i. Summarise where we got to, vis-à-vis the (very interesting) discussion about what is possible in a Newton/Maxwell world. In particular, I want to focus on the *epistemological* formulation of "perfection" that we arrived at, at the end of class.
      ii. See whether we can extract what is right about that insight from its epistemic formulation, so as to give us more of an *ontic* condition on perfection.
2. Goodman
   a. Second, we will look at chapter 4 ("The Theory of Notation") of Nelson Goodman's *Languages of Art*

b. Semantics
   i. As we noted last time, H's analysis is not of (necessarily) *semantic* or *interpreted* systems. It applies equally to uninterpreted systems—such as Lincoln Logs.
   ii. In contrast, Goodman's analysis does (necessarily) apply to interpreted entities, such as symbols, notations, descriptions, models, etc.
   iii. As such, it will dovetail into the intuitions people expressed at the beginning of this section of the course, having to do with the reals, rationals, decimal notation, etc.

c. It is also (in my view) just about the best analysis there is of the fundamental question that Haugeland doesn't answer: of what, ontically, it actually *is* to be digital (or discrete)[1]

3. Haugeland (II)
   a. Third, either on Thursday, or perhaps next week (i.e., when we are done with Goodman), we will go back to Haugeland.
   b. This time, we will shift up one level: away from his object-level account, to look at his notion of **"higher-order" digitality**.
   c. The idea, here, will not so much be to understand what digitality is, as to explore the consequences of the fact that, in most scientific work, the *concepts* we use are (in a certain sense, to be explained) discrete.
   d. This higher–order notion will be extremely important, to the overall theme of the course (particular, with the focus on *formality*).

C. To prepare for all these things, you should read Haugeland's "Analog & Analog"[2] (as well, of course, as reading Goodman and Haugeland—and perhaps Lewis—on the first-order or object-level notions of digitality that we are looking at first).

II. Haugeland (conclusion)

A. Review

1. Last Thursday, we focused on the implicit assumption that seems to underlie Haugeland's characterisation (of digitality in terms of positive and reliable "read/write" procedures).
   a. In particular, we said that his characterisation in terms of perfection didn't convey any sense, really at all, of what it is to *be* digital. So it answers the first of the three questions in **Q1** , but not the other two.
   b. Rather, it seems that his characterisation is (or may be) *extensionally correct* (i.e., may hold of just those systems that are digital) because of a background assumption:

> **D1** The only way to be "perfect"—positive and reliable, in Haugeland's sense—at least in this world, is to be a *digital system*.
>
> — I.e., *perfect* ⇒ *digital*

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[1]Though that doesn't mean that it is adequate! As we will see, it suffers from many of the same infelicities (and circular assumptions) that plague Haugeland.

[2]Haugeland, John, "Analog and Analog," *Philosophical Topics* (Spring 1981); reprinted in J. I. Biro & Robert W. Shahan, (eds), *Mind, Brain, and Function: Essays in the Philosophy of Mind*, Norman, Oklahoma: Univeristy of Oklahoma Press (1982), pp. 213–225. This paper is in the class reader.

2. It might be that **D1** is right. And if so, that is an enormously important result to have on the table (even if it doesn't explain what digitality is).
3. *If* **D1** is right, then of course it remains to explain *why* it is right. More seriously, though, we wondered whether **D1** actually *is* right. On reflection—and in spite of its evident superficial appeal—it wasn't so clear whether it was as obviously right as initial intuition might suggest.
   a. We considered systems in a Newton/Maxwell (continuous & deterministic) world.
   b. More specifically, what we imagined were (intuitively) continuous, non–digital systems, and procedures defined in terms of them, that nevertheless honored **D1**.
   c. If such procedures are indeed possible (and we didn't find a non-circular way of excluding them), then it would seem that **D1** may not hold in a Newton/Maxwell world.

B. Epistemology
1. These considerations led us to a different suggestion, which we can call **D2**, which talks
   a. Not about perfection as an ontic (ontological) condition,
   b. But rather about epistemic perfection: perfect *predictability*

> **D2** The only way to be **perfectly known** (i.e., positively and reliably known, which is to say, correctly thought to be perfect or reliable, in a something like an informationally-complete way), at least in this world, is to be a *digital system*.
>
> — I.e., *perfectly knowable* ⇒ *digital*

2. If **D2** is true, then that would seem to relate digitality intrinsically to epistemology. It also raises the very demanding question of *why* **D2** is true, if it is. Two possible answers are:
   a. Because of considerations due to *quantum mechanics* (because of an intrinsic uncertainty or vagueness or indeterminacy in a quantum mechanical world); or
   b. Because of considerations of *computational complexity* (in the sense we talked about in Part III of the course: i.e., that, *because of the limits of causal effectiveness*, only by understanding systems under a digital abstraction can one get a grip on them that is finite and "calculable" in a way that allows perfect prediction in finite time[3]).
3. It looks—if **D2** is right—that "being digital" is a (perhaps nevertheless genuine way) of being, in the world, so as to honour an *epistemic demand.*
4. Maybe that is so. Maybe, that is:[4]

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[3]For example, it might be that one cannot understand the world in a non-abstracted way because the world is running the optimal algorithm.

[4]Note: this (**D3)** *may* be a stronger thesis than that *everything* is (in part) epistemic, in the way in which social constructivist (such as me) might think. On the other hand, it may *not* be stronger; it depends on details about the constructivist metaphysical view. Unfortunately, though this is an extremely interesting issue, we don't have time to pursue it here.

This ⇒ may not be true

> **D3** The notion of digitality has intrinsically (essentially) to do with knowledge, predictability, and abstraction—all of which are essentially epistemic notions—implying that the "theory of digitality" will intrinsically and inevitably be a subject matter in epistemology, not in (straight) ontology.
>
> — I.e., *digitality is essentially epistemic*

C. Status
   1. If **D3** is true, it might be because of the character of the (counterfactual supporting?) correlation that constitute the sorts of relationship that underlie semantics and knowledge.
   2. But there is another possibility.
      a. It might be that **D2** is true, but that even though it is true, the reason why it is true is not intrinsically epistemic. It might be, that is, that **D2** *does not imply* **D3**.
      b. In particular, maybe epistemic states exemplify a property—call it property **P**—which
         i. Is not itself an intrinsically epistemological property, but
         ii. Is the reason for the truth of **D2**.
      c. If *that* were true, then **D2** might be true, without **D3**'s being true.
   3. If that were so, then pursuing this whole line of inquiry might lead us to a non-epistemic characterisation of **P**.
   4. I am sympathetic to this approach.[5] But we are not going to pursue it here, directly.
   5. Instead, we will turn to Goodman's analysis. For my sense is that if we go through Goodman's analysis (on which, in part, Haugeland based his own), we will gather enough material that we might be able (next week) to take a stab at formulating a possible **P**.

D. So turn to Goodman: in particular, to chap. 4 ("The Theory of Notation") of his *Languages of Art*

III. Prefatory Comments (on Goodman)

A. Goodman
   1. Goodman is a *nominalist*
      a. He doesn't believe in abstract objects, essences, etc.
      b. So he won't talk about *types and their instances*
      c. Don't be distracted by that, in reading him
      d. Here, I will translate him into more familiar language
         i. In particular, when we might say 'type', Goodman is more likely to say 'character'
         ii. Where we would say 'token', Goodman would say 'mark'.
         iii. And when we would say "token are an instance of a type", Goodman would instead say that "marks belong to the character."
      e. I am not claiming that this is all there it to nominalism! But for our purposes, this much of a "translation manual" will suffice.
   2. Goodman's project
      a. To provide an analysis of representation in the arts

[5] Which is not to say I think it is right. See the lecture notes for next week.

b. E.g., to analyse notions of (musical) *scores*, *paintings*, etc.
   i. For example, the locus of identity of a painting is the concrete instance
   ii. But the score (a more "abstract" thing, one might thing) is the locus of identity of a piece of music
c. We need to keep those interests in mind (partly because they are interesting, but also—and for present purposes more importantly—because they affect his analysis)
d. Overall, though, we need to keep our eye on a notion of digitality that we can use to analyse *computation* (which *is* an interpreted or intentional phenomenon)

3. Semantics
   a. Because of his interest in scores, languages, etc., Goodman does what Haugeland does not do: analyse digitality *in the context of representation*
   b. So he will talk about both *syntactic* and *semantic* aspects of digitality.
   c. More specifically, we will spell out the six requirements that Goodman specifies on what it is to be (what he calls) a "**notational system**"
4. Assessment
   a. I will have criticisms of Goodman's view
   b. But as I say, I think it is the best characterisation of digitality that there is.

B. Digitality
   1. Remember our basic intuition: that digitality is reminiscent of a square wave (cf. figure 1)

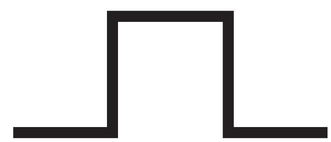

Figure 1 — Digitality

   2. Three characteristic properties
      a. **Flat top:** everything inside it is *identical* (for the relevant purposes)
      b. **Vertical sides:** the boundaries of a digital notion are *sharp*
      c. **Flat external space:** digital values are *separated*
   3. We should keep an eye on all three properties, in Goodman's analysis

C. Semantics
   1. When we began Part IV of the course, people raised a number of examples of digital systems (notational schemes for the rationals, etc.). All of these examples, as we noted at the time, were intentional: they involved one set of structures denoting or naming or signifying another.
   2. As mentioned, one virtue of Goodman's account is that it deals with such cases. So we can use it, somewhat in passing, take a look at those examples people had.
   3. Strictly speaking, they don't have to do (at least not in any simple or obvious way) with what it is to be discrete, per se. But it is still useful to be able to characterise those intuitive cases.

IV. Syntactic properties

A. Goodman identifies three criterial properties that a (syntactic) digital system must have:
   1. **SYN·I: Character indifference**
      a. Note that Goodman states, but does not "number," this requirement
      b. Basic idea: any token (instance) of syntactic type is (semantically) equivalent to any other
         i. Note that this is defined wrt semantics (i.e., wrt a given purpose or function)

ii. This is one of the places where one might want to argue that digitality is fundamentally an intentional notion (which, as I've mentioned, many people seem to think)

c. This corresponds (in my analogy) to the "flat top" of the square wave

2. **SYN·2: (Syntactic) Disjointness**
   a. No two syntactic types have overlapping extensions (members in common)
   b. This corresponds to a requirement of his notational interests: he wants to have *uniqueness* for a certain class of digital entities (for example, that for any given piece of music there will be a unique score).
   c. Cf. letters (in an alphabet): you can see why you would want not to have any overlap. But this doesn't seem as if it is intrinsic to being digital or discrete; it seems to be a property more designed for other parts of his project (the analysis of notation).
3. **SYN·3: (Syntactic) Finite Differentiation**
   a. For any token (or instance), there must *no more than one type such that one cannot* **tell** *whether the token is of that type.*
      i. Ruled out: marks of length <1", marks of length ≥1". They could be too close
      ii. Okay: marks of length <1", marks of length >2".
   b. This negative formulation is very clever—it ducks various questions:
      i. How one decides whether a token is of a type
      ii. What to do about (inevitable) boundary cases (as in a.ii, above)

B. Remarks
1. Finite differentiation is not the same as finite number of types
   a. +finite differentiation, –finite types: arabic numeral fractions
   b. –finite differentiation, +finite types: marks of length ≤1", marks of >1"
2. Disjointness is not the same as finite differentiation
   a. +disjoint, –finite differentiation: marks of length ≤1", marks of >1"
   b. –disjoint, +finite differentiation: union of (written) English and French

C. Goodman defines some additional notions
1. **Density:** if a scheme is ordered, then it is *dense* if, for any two types, there is a third type between them
2. He also distinguishes **atomic** and **compound** types

D. Criticism (cf. Haugeland)
1. The characterisation of finite differentiation (at least as Goodman formulates it) makes reference to whether one can *tell* something. "Telling" is an epistemic notion. So it looks as if we are back to many of the same worries that permeated our analysis of Haugeland.
2. Does this pack in a digitality assumption (of "determining" whether it is of a type or not)? It seems to.
3. Again: in a perfect Newton-Maxwell world, why wouldn't marks of ≤1", marks of >1" satisfy finite-differentiation?
4. Are we no further ahead than we were with Haugeland? Maybe not …

V. Semantic properties

A. Intro

1. There are also three criterial semantic properties (for Goodman's notion)
2. Notation: Take '$\mapsto$' to mean *represent*, for both types and tokens. So:
    a. **s**: $\sigma \mapsto$ **t**: τ means that **s** of type σ represents or denotes **t** of type τ.
    b. $\sigma \mapsto \tau$ means that for any $\mathbf{s}_i$ of type σ, $\mathbf{s}_i$ denotes some $\mathbf{t}_i$ of type τ.

B. **SEM·1: Unambiguity**

1. *Type:* $\sigma \mapsto \tau_1$ and $\sigma \mapsto \tau_2$ implies that $\tau_1 = \tau_2$
2. *Token:* $\mathbf{s} \mapsto \mathbf{t}_1$ and $\mathbf{s} \mapsto \mathbf{t}_2$ implies that $\mathbf{t}_1 = \mathbf{t}_2$

C. **SEM·2: (Semantic) Disjointness**

1. No semantic types such that an element of semantic domain is an instance of both
2. I.e., **t**: τ_1 and **t**: τ_2 implies that $\tau_1 = \tau_2$
3. This is *very strong*
    a. For example, it disallows "cat" and "animal"—or any other subsumption relation
    b. The motivation: so that you can *recover* the syntax from the semantic item
    c. E.g., from musical performance, can write down the score (thereby identify the work)
4. It is unlikely that we will need this strong a notion for computing

D. **SEM·3: (Semantic) Finite differentiation**

1. For any token (instance) semantic object, there is no more than one syntactic type such that one cannot tell it is denoted by (a token of) that type.

E. Remarks

1. As before, *(semantic) disjointness* is not the same as *finite differentiation*
2. Again, he defines some other properties:
    a. If compound syntactic item σ designates a compound semantic item δ, such that δ is put together in the "ordinary" way out of the entities designated by the parts of σ, then σ is said to be **composite**; else, if δ exists, it is **prime**; else it is **vacant**.
    b. **Redundancy:** for one semantic type τ, there are two syntactic types σ_1 and σ_2 such that if $\sigma_1 \mapsto \tau$ and $\sigma_2 \mapsto \tau$ then $\sigma_1 = \sigma_2$ (plus the associated token version)
3. As said above, Goodman calls a system that meets all six conditions a **notational system**

VI. Remarks

A. Grain

1. What is good about Goodman's typology is that it opens up a space of possibilities
2. Rather than just "defining" (claiming) that this or that is what digitality or discreteness is, instead he offers a richer, more fine-grained way of understanding things
3. Even setting aside character indifference (which Goodman assumes, but doesn't single out as a numbered criterion), you are left with five binary distinctions, which generates a space of 32 (=2^5) possible types of system

B. Some examples from this space are given in figure 2, on the next page.

C. Analysis

1. It is absolutely common (e.g., in AI, in debates about visual representation) for people to make broad, coarse-grained distinctions about kinds of representation.

	Syntax		Semantics		
	Disjoint	*Fin. Diff.*	*Unambig*	*Disjoint*	*Fin. Diff.*
Integer numerals	✔	✔	✔	✔	✔
Rationals (arabic numeral fractions)	✔	✔	✔	✔	✘
Carpenter's scribe marks	✔	✘	✔	✔	✘
Written (ASCII) English (maybe?)	✘	✔	✘	✘	✘
Spoken English (maybe?)	✘	✘	✘	✘	✘
Macromedia Freehand (with "snap-to-grid")	✔	✔	✘	✔	✔
The differential calculus	✔	✔	✔	✘	✘

Figure 2 — Different kinds of digital system

2. For example, one of the most common is between "images" and "propositions"
3. Goodman's scheme, though far from perfect, is a better start at characterising representation systems than these traditional untutored distinctions.
4. Cf. Vinod Goel's *Sketches of Thought*. He argues that most computer drawing systems (CAD systems, illustration systems, etc.) are notational, and hence bad for *sketching* (e.g. of the sort that architects do, especially initially, in formulating designs)
5. The basic point is that, in many ways, the sorts of distinction that Goodman makes seem to cut deeper—to have more to do with what is really going on—than whether the system is "pictorial" or "sentential".

D. Critique
1. But let's get back to our main project: to understand digitality, in a way that will allow us to understand whether computing is digital.
2. What do we make of Goodman's characterisation—with respect to these demands? There are several things to say.
3. Turn to those on Thursday.

—— *end of file* ——