

COMPUTATIONALISM AND CLASSICAL LOGIC *DRAFT* AN ARGUABLE INCOMPATIBILITY

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ABSTRACT

Semantical paradoxes permit to derive propositionalism (as defined in the text) from classical logic. Propositionalism seems *prima facie* at odds with computationalism (as defined in the text) because usual computations may be completely described as mechanical processes dealing only with sentences (syntactical objects), not with propositions (semantical objects). As Searle (1984) pointed out, semantics seems to require intentional states, which computational devices need not have.

However, this approach is insufficient to reveal any logical incompatibility between propositionalism and computationalism. Physically implemented computational devices could well have intentional states even if they need not have them. We could only conclude such incompatibility if we were able to show that intentionality is sometimes functional for cognitive behavior or that its presence makes a logical difference.

We propose a sentence and argue that, according to classical logic, it could fail to express a proposition but that it should always express a proposition if computationalism held. The key of the argument is that a computational state of affairs is always equivalent to some well defined arithmetical state of affairs, so that no sentence about it can fail to express a proposition. We show that the presence of intentionality is decisive for this difference.

Key words: classical logic, computationalism, intentionality, proposition, propositionalism, sentence.

1. ARGUMENT

1. 2. DEFINITION 1

Classical logic (CL) is the claim that any proposition has exactly one truth value, namely one of the following two: *true*, *false*.

This argument will proceed within CL.

1. 3. DEFINITION 2

Propositionalism (PR) will be understood here as the conjunction of the following claims:

- a) Propositions, as semantical objects, and not sentences, which are purely syntactical objects, are the truth value bearers and, consequently, the objects of assertion, deduction, proof, knowledge and belief.
- b) There are some unambiguous sentences or sentence tokens that cannot be used to make statements i.e. that fail to express propositions.

Any unambiguous sentence or sentence-token that fails to express a proposition will be called 'non propositional'.

1. 4. PROPOSITION 1

CL \rightarrow PR

1. 4. 1. JUSTIFICATION

CL, as defined, implies 1. 3. a). Only 1. 3. b) needs justification.

Consider the sentence and accept that our linguistic code includes hereafter what the reference of 'L' is:

$L =_{\text{def}}$ 'L expresses no true proposition'

L is an unambiguous sentence able to describe a state of affairs (namely, that there is no true proposition expressed by L). But, if we assume that L expresses a proposition P, then P cannot be consistently assigned a truth value. So, if CL holds, L is not propositional and there are unambiguous sentences that express no proposition.

Even though we have stipulated that the reference of 'L' is a sentence-type, a tokenistic approach (where we take that only some of the tokens of L express no proposition) seems possible. It is possible if we accept that 'L', within a token of L, can only refer to previously present tokens of L. In a first token 'L1' of L, 'L' would refer to nothing at all and L1 would therefore express no true proposition; this could be stated by means of a new token L2, where 'L' would refer to L1 but not to L2. In that approach we can no longer say that L1 unambiguously describes a state of affairs; we must say rather that L1 would unambiguously describe a state of affairs if 'L' in L1 had a reference.

This (especially radical) tokenistic approach cannot be derived from classical logic and we will not assume it. Anyway, the whole argument can be easily modified to fit this tokenistic standpoint. We briefly comment on this in 1. 12. 2. (Remark 5).

1. 4. 1. 1. REMARK 1

L is able to describe the state of affairs that there is no true proposition expressed by L (though it cannot assert it is the case) or at least it is clear what L would describe if the usual descriptive conventions were in force in L. Otherwise we would have never come to know that L has no truth value. As suggested above, we will assume that unambiguous paradoxical sentences are able to describe a state of affairs but not to assert it as being the case. When a sentence S is not only able to unambiguously describe a state of affairs T_S (in a certain linguistic code LC) but can also be used (according to LC) to assert that T_S is the case, we will say that S asserts T_S (according to LC).

Note as well that a state of affairs, as we use the term here, is not necessarily a fact; it is only a fact when it is the case.

1. 5. DEFINITION 3

Computationalism (CP) is the claim that every cognitive behavior is a Turing machine computation.

1. 6. DEFINITION 4

$G =_{\text{def}}$ ‘the first time H appraises G after t H does not infer G expresses a true proposition’

where ‘H’ denotes a human and ‘t’ denotes a clearly defined date, e.g. the year 2000 AD. Henceforth, for short, we will write ‘at t’ instead of ‘the first time H appraises G after t’.

1. 6. 1. REMARK 2

G must be interpreted in a linguistic code that includes that ‘G’ is a name for the sentence we have called so. We will call ‘LC’ that linguistic code. LC establishes what ‘G’ denotes and is common English for the rest. The existence of LC is empirically but not logically evident; consequently, our results must be taken as conditional on the existence of LC.

1. 7. PROPOSITION 2

$CL \rightarrow \sim \Box PG$

where ‘ \sim ’ is the negation symbol, ‘PG’ means ‘G is propositional’ and ‘ \Box ’ is the modal necessity operator.

That is, according to CL there are some logically possible conditions under which G, as interpreted in LC, is not propositional.

1. 7. 1. JUSTIFICATION

1. 7. 1. 1. INFORMAL ARGUMENT

Assume CL and hence PR.

H is clearly not entitled to infer at t that G expresses a true proposition, because if he inferred it, G would express a false proposition and H would have inferred a falsity.

Assume H understands G.

Assume H knows he is H when he proceeds to evaluate G at t. Assume H knows it is the first time he is going to evaluate G after t, which is perfectly possible if t is sufficiently well defined and H proceeds immediately after t, for instance if t is the year 2000 and H proceeds at 00’01 on 1/1/2001.

Assume H knows at t that if H at t inferred that G expresses a true proposition, G would express no true proposition, so that H at t knows that H at t does not infer that G expresses a true proposition.

Those are the conditions we require from H.

If G is propositional, then it says that H at t does not infer that G expresses a true proposition. H knows at t that H at t does not infer G expresses a true proposition. So, if G is propositional, then H is entitled at t to infer that G expresses a true proposition. Since H is not entitled at t to do it, G expresses no proposition.

The logical possibility of the existence of a human fulfilling the conditions we require from H is empirically evident: whoever is able to follow our reasoning above could be H. But to offer logical evidence we need to specify what those conditions are and show that they are consistent.

Reasoning from paradoxes seems often suspect of exploiting ‘ex contradictione quodlibet’. This advises again to formalize our reasoning so as to specify the assumptions it relies on. We will do it by presenting a set of axioms and inference rules and we will show that the axioms are consistent. Consequently, the logical possibility of the existence of a human satisfying the conditions required from H should become logically evident. We have weakened our axioms by employing a weak concept of entitlement.

1. 7. 1. 2. NOTATION AND LANGUAGE

‘ φ ’, ‘ ψ ’ serve as variables over well formed formulas (wff) as such formulas are defined below.

$\sim =_{\text{def}}$ logical negation.

$\& =_{\text{def}}$ logical conjunction.

$\vee =_{\text{def}}$ logical disjunction.

$\rightarrow =_{\text{def}}$ logical (material) implication.

$F\varphi =_{\text{def}}$ H at t infers that φ expresses a true proposition.

$K\varphi =_{\text{def}}$ H at t knows that φ expresses a true proposition.

$P\varphi =_{\text{def}}$ φ expresses a proposition.

$T\varphi =_{\text{def}}$ φ expresses a true proposition.

‘ $*\varphi$ ’ denotes the proposition which φ expresses, if φ expresses any; otherwise it denotes nothing.

$S(\varphi, *\psi) =_{\text{def}}$ φ expresses $*\psi$.

$R\varphi =_{\text{def}}$ H at t is entitled to infer at t that φ expresses a true proposition. This symbol must be understood in accordance with the definition of entitlement in 1. 7. 1. 3.

$\&I =_{\text{def}}$ Conjunction Introduction.

$MP =_{\text{def}}$ Modus Ponens.

$MT =_{\text{def}}$ Modus Tollens.

$RD =_{\text{def}}$ Reductio ad Absurdum.

Note that ‘ $\sim FG$ ’ \neq G. We have changed the place of ‘at t’ in the translation of ‘ $F\varphi$ ’ in order to get a new sentence. This must be so to represent the fact that H can know that the state of affairs G describes is the case without inferring that G expresses a true proposition.

The formulas of the language are interpreted as propositions except when they are under a semantic, epistemic or doxastic operator: P, T, S, *, K, R, F; in this case they are interpreted as sentences. This ambiguity could easily be avoided by marking the formulas in some uniform way whenever they are under such operators; for simplicity we will do without such marking.

The set of well formed formulas of the language employed is the smallest set resulting from the following rules:

R1: 'G' and 'S(G,* ~FG)' are wff.

R2: if 'φ' is a wff, so are 'Pφ', 'Tφ', 'Fφ', 'Kφ', 'Rφ', '¬φ'.

R3: if 'φ' and 'ψ' are wff, so are 'φ → ψ', 'φ & ψ', 'φ ∨ ψ'

1. 7. 1. 3. AXIOMS AND INFERENCE RULES

The first axiom contains the interpretation of G in LC:

AXIOM 1: $PG \rightarrow S(G,* \sim FG)$

That is, if G expresses a proposition, then G says that H at t does not infer that G expresses a true proposition.

The second axiom is intuitively justified by the interpretation of G:

AXIOM 2: $FG \rightarrow \sim TG$

That is, if H infers at t that G expresses a true proposition, then G does not express a true proposition. Axiom 2 is not ultimately independent from axiom 1. We permit that dependence for simplicity.

The third axiom partially represents H's correct understanding of G at t:

AXIOM 3: $KFG \rightarrow K\sim TG$

This says that if H at t knows that H at t infers that G expresses a true proposition, then H at t knows that G expresses no true proposition. We only need a partial representation of H's understanding of G because we choose in axiom 7 a weak version of the concept of entitlement.

The fourth axiom represents H's correctness with respect to G at t:

AXIOM 4: $K\sim TG \rightarrow \sim FG$

This says that if H at t knows that G expresses no true proposition, then H at t does not infer that G expresses a true proposition.

The fifth and sixth axioms establish a certain self-awareness of H regarding H's inference with respect to G at t:

AXIOM 5: $FG \rightarrow KFG$

AXIOM 6: $\sim FG \rightarrow K\sim FG$

These axioms say respectively, that if H at t infers that G expresses a true proposition, then H at t knows that H does so, and that if at t H does not infer it, then H at t knows that H does not.

We establish by definition that one is entitled to infer that a sentence expresses a true proposition if and only if that sentence expresses a proposition and one knows that proposition (even if one ignores that the sentence expresses a proposition one knows true; this is a 'weak entitlement'). In our context this yields:

$$RG \leftrightarrow S(G, * \sim FG) \& K \sim FG$$

This entails the following axioms:

$$\text{AXIOM 7: } S(G, * \sim FG) \& K \sim FG \rightarrow RG$$

$$\text{AXIOM 8: } (FG \rightarrow \sim TG) \rightarrow \sim RG$$

Axiom 7 affirms that if G says that at t H does not infer that G expresses a true proposition and H at t knows that H at t does not infer that G expresses a true proposition, then H is entitled at t to infer that G expresses a true proposition.

Axiom 8 says that if the fact that H at t infers that G expresses a true proposition implies that G expresses no true proposition, then H is not entitled at t to infer that G expresses a true proposition.

We will use only the inference rules we have already mentioned in 1. 7. 1. 2., which are: Conjunction Introduction, Modus Ponens, Modus Tollens, Reductio ad Absurdum.

1. 7. 1. 4. FORMAL DEDUCTION

1.	$PG \rightarrow S(G, * \sim FG)$	AX 1
2.	$FG \rightarrow \sim TG$	AX 2
3.	$KFG \rightarrow K \sim TG$	AX 3
4.	$K \sim TG \rightarrow \sim FG$	AX 4
5.	$FG \rightarrow KFG$	AX 5
6.	$\sim FG \rightarrow K \sim FG$	AX 6
7.	$S(G, * \sim FG) \& K \sim FG \rightarrow RG$	AX 7
8.	$(FG \rightarrow \sim TG) \rightarrow \sim RG$	AX 8
9.	$\sim RG$	MP 2, 8
10.	FG	ASSUMPTION
11.	KFG	MP 5, 10
12.	$K \sim TG$	MP 3, 11
13.	$\sim FG$	MP 4, 12
14.	$FG \& \sim FG$	&I 10, 13
15.	$\sim FG$	RD 10-14
16.	$K \sim FG$	MP 6, 15
17.	PG	ASSUMPTION
18.	$S(G, * \sim FG)$	MP 1, 17
19.	$S(G, * \sim FG) \& K \sim FG$	&I 16, 18
20.	RG	MP 7, 19

21. RG & ~RG

&I 9, 20

22. ~PG

RD 17-21

Note that ‘~FG’ is derivable but G is not.

1. 7. 1. 5. CONSISTENCY

Although our axioms are intuitively sound, and though we have offered an empirical model for them in 1. 7. 1. 1., we will prove that they are consistent under the inference rules of propositional logic and under the relevant semantic and epistemic inference rules. We will do this by means of a suitable valuation function V.

Let W be the set of the well formed formulas; we define $V: W - \{G\} \rightarrow \{0, 1\}$ where ‘1’ means ‘true’ and ‘0’ means ‘false’, so that V behaves according to the usual truth tables for the propositional connectives, and according to the following semantic and epistemic inference rules.

1. 7. 1. 5. 1. RULES FOR THE OPERATORS P, T, K, R, S

The entailment relations among operators and between operators and sentential variables define the lattice L_A in figure 1. The partial order in L_A entails the following rules, which are the sole applicable to the formulas in our axioms:

R'1: $Kx \vdash x$

R'2: $Rx \vdash x$

R'3: $x \vdash Tx$

R'4: $Tx \vdash Px$

R'5: $S(G, *~FG) \vdash PG$

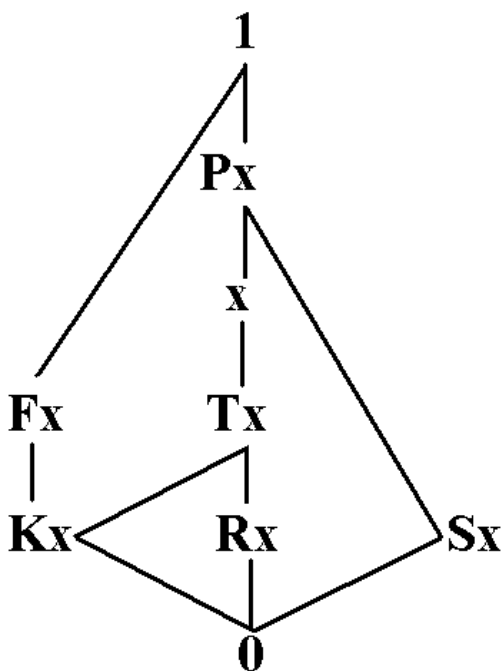


Figure 1: lattice L_A

Figure 1 permits to easily check the completeness of our rules.

1. 7. 1. 5. 2. VALUATION V

R'1-R'5 imply:

$$\begin{aligned}
 V(S(G,* \sim FG)) &\leq V(PG) && \text{from R'5} \\
 V(RG) &\leq V(TG) && \text{from R'2 and R'3} \\
 V(TG) &\leq V(PG) && \text{from R'4} \\
 V(KFG) &\leq V(FG) && \text{from R'1} \\
 V(K\sim TG) &\leq V(\sim TG) && \text{from R'1} \\
 V(K\sim FG) &\leq V(\sim FG) && \text{from R'1} \\
 V(KFG) \cdot V(K\sim FG) &= 0 && \text{from R'1}
 \end{aligned}$$

In the construction of V we will take as well into account our conclusions above, namely that G is not propositional, that H at t knows it, etc. So V assigns no truth value to G, and consequently it assigns 0 to 'PG', 'S(G,* ~FG)', 'TG' and 'RG'. V assigns 0 to 'FG' as well. This is all simultaneously satisfied by the relevant part of V:

$$\begin{aligned}
 V(PG) &= 0 \\
 V(S(G,* \sim FG)) &= 0 \\
 V(FG) &= 0 \\
 V(TG) &= 0 \\
 V(KFG) &= 0 \\
 V(K\sim TG) &= 1 \\
 V(K\sim FG) &= 1 \\
 V(RG) &= 0
 \end{aligned}$$

For the rest V obeys the classical truth tables for the propositional connectives.

V is a model of the axioms and complies with R'1-R'5 and thus with the partial order in L_A . As a consequence, the axioms are consistent and there are some possible conditions under which G, as interpreted in LC, is not propositional.

1. 8. AUXILIARY DEFINITIONS AND NOTATION

We will use the verb 'to determine' and its derivatives in the sense of 'making something be somehow', 'being a factor of', not in the sense of ascertaining how things are or of making up one's mind. So, determination and indetermination must be understood as *objective ontological determination* and as *objective ontological indetermination*.

The *reality value* of a state of affairs is its being or not being the case. According to the law of excluded middle, each state of affairs has only one of the following two reality values: *is the case*, *is not the case*.

If T is a state of affairs, VT is the reality value of T.

If T is a state of affairs and p is a proposition, ' $\forall T \heartsuit p$ ' means that there is no *logically possible* way of computing $\forall T$ other than computing it from the fact that p ; or, equivalently, that $\forall T$ is indeterminate whenever p is not true.

If S is a sentence, ' PS ' means ' S is propositional'.

If S is an unambiguous sentence, T_S is the state of affairs S describes.

1. 9. PROPOSITION 3

$$\forall S \sim \text{PS} \rightarrow \forall T_S \heartsuit \sim \text{PS}$$

1. 9. 1. JUSTIFICATION

Obviously, if $\forall T_S$ were determinate even if PS , S would be propositional.

1. 10. PROPOSITION 4

$$\forall T_S \text{ AT}_S \rightarrow \Box \text{PS}$$

where ' AT_S ' means that T_S is logically equivalent to some arithmetical state of affairs T_A in the sense that $\Box \forall T_S = \forall T_A$.

1. 10. 1. JUSTIFICATION

By definition all arithmetical facts can in principle be computed from the structure of the natural numbers (i.e. from Dedekind's axioms) and in principle need not be computed from the propositional status of any sentence. The reality value of any state of affairs equivalent to an arithmetical one can in principle be computed from the reality value of the later.

This and proposition 3 imply proposition 4.

1. 10. 2. REMARK 3

The situation established by proposition 4 is sometimes formulated by means of the concept of groundedness: any sentence unambiguously describing a state of affairs equivalent to an arithmetical one is grounded.

1. 11. PROPOSITION 5

$$\text{CP} \rightarrow \Box \text{PG}$$

1. 11. 1. JUSTIFICATION

Assume CP .

H is at t a Turing machine implemented in a physical device (perhaps H 's brain and a part of the content of its light cones at t) whose computational processing can be reproduced by a mechanical device M . Then H 's inference regarding G (as interpreted

in LC) at t is a well defined physical and mechanical state of affairs T_M . T_M reduces to whether M , taking G as input, yields a particular output or it does not. Moreover, through Gödelization T_M is logically equivalent to an arithmetical state of affairs T_A , again in the sense that $\Box VT_M = VT_A$.

Thus G describes a state of affairs logically equivalent to an arithmetical state of affairs T_A . Proposition 4 entails that G is necessarily propositional.

1. 11. 2. REMARK 4

Let's try to define a Turing machine M with the abilities of H at t by means of the following direct translation.

If φ is a formula, $\lceil \varphi \rceil$ is the code of φ which M accepts. ' $\Pi \lceil \varphi \rceil$ ' means ' M outputs the code of φ ' and translates the operator F . ' $\Pi^K \lceil \varphi \rceil$ ' means ' M correctly outputs the code of φ ' and translates the operator K . Finally $G^M =_{\text{def}} \lceil \sim \Pi \lceil G^M \rceil \rceil$, so that $\lceil G^M \rceil = \lceil \sim \Pi \lceil G^M \rceil \rceil$. Note that this definition is in contrast with the fact that $G \neq \sim FG$.

When M takes $\lceil G^M \rceil$ as input, the instructions of M make these conditionals hold:

$\Pi^K \lceil \Pi \lceil G^M \rceil \rceil \rightarrow \Pi^K \lceil \sim TG^M \rceil$	translation of axiom 3
$\Pi^K \lceil \sim TG^M \rceil \rightarrow \sim \Pi \lceil G^M \rceil$	translation of axiom 4
$\Pi \lceil G^M \rceil \rightarrow \Pi^K \lceil \Pi \lceil G^M \rceil \rceil$	translation of axiom 5
$\sim \Pi \lceil G^M \rceil \rightarrow \Pi^K \lceil \sim \Pi \lceil G^M \rceil \rceil$	translation of axiom 6

From this follows that M does not output $\lceil G^M \rceil$ but does output $\lceil \sim \Pi \lceil G^M \rceil \rceil$, which is impossible since $\lceil G^M \rceil = \lceil \sim \Pi \lceil G^M \rceil \rceil$.

Obviously the contradiction is a consequence of the definition of G^M , which in turn is a consequence of the fact that we face here no non propositional sentence G to be differentiated from the proposition asserting exactly the state of affairs G describes and cannot assert. Such a distinction makes no sense for Turing machine outputs and, as a consequence, we are entitled to define G^M the way we have done.

H at t is able to know that H at t does not infer that G expresses a true proposition but this does not imply that H infers G at t ; H infers at t that the state of affairs G describes is the case but H does not infer G at t . This is only possible if H is capable of propositional attitudes different from mere symbol manipulation. Such a performance cannot be asked of purely syntactical devices.

This remark is intended to highlight that the possession of intentionality by H makes a logical difference since it is necessary for the non propositionality of G .

1. 12. PROPOSITION 6

$CL \rightarrow \sim CP$

1. 12. 1. JUSTIFICATION

From propositions 2 and 5.

1. 12. 2. REMARK 5

A tokenistic version of the whole argument would be:

1. The same reasoning which proves that G is not propositional goes through when referred to the token of G that H considers at t; thus CL implies that at least one token of G that is not propositional; call it 'G₁'.
2. If CP holds, the state of affairs G₁ would describe, if it described any, is a purely syntactical one; then G₁ cannot fail to describe it, because reference to the mere syntactic features of a sentence is never problematic; consider: S =_{def} 'S has nineteen letters'. That state of affairs would again be equivalent to some arithmetic state of affairs, so that G₁ cannot fail to assert it. Hence, if CP holds, G₁ is propositional.
3. Consequently, CL and CP are incompatible.

2. DISCUSSION

2. 1. SENTENCES WITHOUT PROPOSITIONS

We have shown that according to classical (consistent bivalent) logic there are grammatical and unambiguous sentences that express no proposition even if they are able to describe well defined states of affairs.

So it appears that, for classical logic, the availability of states of affairs, in order to be asserted, cannot be absolute but relative to the 'observer', so to say. A. N. Prior in *Epimenides The Cretan* (1958, p. 256) rather audaciously proposed:

"Thus what can be or not be the case, is not necessarily assertible by a given person or a person in a given situation".

More recently Laurence Goldstein (2006. p. 878) wrote:

"We have said that token sentences are the vehicles for statements; that we typically use token sentences to make statements, and that it is the statements so made that have content and truth-value. But there are occasions when, though we go through the motions of making a statement, no statement results (...)".

These claims seem logically related. Some states of affairs, that are well defined in an objective sense, are not so for some 'observers', so that they cannot be asserted by such 'observers'. As a consequence, the utterances of those 'observers' may fail to make statements. Some states of affairs are not available for some 'observers' in order to be asserted by them as being or not being the case. Why?

Goldstein (Goldstein 2000, p.71) suggests in an earlier paper that the failure of a sentence to make a statement is parallel to the failure of a thinker to think a thought:

"Infinite queues of speakers (or thinkers) provide vivid illustrations of another way in which attempts to make a statement (or to think a thought) can fail".

There is an obvious way in which the impossibility to think a thought is related to the impossibility of a sentence to express a proposition. Nobody can have circular thoughts like:

‘what I’m currently thinking is not true’

which would correspond to our sentence L. Or:

‘I do not infer that the inference I’m currently carrying out is correct’

This would correspond to G.

Adopting some terms from Phenomenology, we can say that those impossible acts of thought would require the existence of *intentional acts* having themselves as *intentional objects*. Since such acts would imply vicious circularity, it seems likely that *no intentional act can be its own intentional object*. This can be thought of as an *eidetic* feature of intentional acts. This impossibility can easily be shown as follows.

Let ‘ $\psi(x)$ ’ denote an intentional act whose intentional object is x .

That no intentional act can be its own intentional object is written thus:

$$\square \sim \exists x \psi(x) = x$$

Suppose:

$$(1) \quad x = \psi(x)$$

Then by substitution:

$$(2) \quad x = \psi(\psi(x))$$

$$(3) \quad x = \psi(\psi(\psi(x)))$$

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The intentional object would be circularly defined: the variable T could never be instantiated because it is defined in terms of itself. So, the intentional object would be indeterminate; since no actual object can be indeterminate, (1) is impossible.

Unambiguous non propositional sentences could well be exactly those that are not expression of any possible intentional act of thought.

The point is that some states of affairs are not available to be asserted by means of some unambiguous sentences that describe them, because the intentional act one is performing is not available as a state of affairs to be asserted while one is performing it, and it is not so because it is not a possible object for itself. There is a sense in which computational devices such as Turing machines or formal systems are universally objectified for any intentional act whatsoever and this is why no non propositional

sentence about them exists. Any computational behavior is universally objectified while no intentional act is objectified for itself.

Intentionality seems functional to explain why an unambiguous sentence expresses no proposition and has no truth value. As we have seen, the possession of intentionality by an individual can also determine the non propositionality of a sentence.

2. 2. INTENTIONALITY MAKES A DIFFERENCE

John Searle (1984) famously argued that the difference between minds and machines are that minds have intentional states while machines can be completely described without any reference to such states. He abridges his conclusion in the well known formula: *syntax is not enough for semantics*.

As an argument against computationalism this has the following loophole: that machines can be completely described without reference to intentional states does not entail that machines lack intentional states, it only implies that intentionality *makes no difference* in the following sense:

1st. No sentence about a machine's behavior will change its logical value according to whether the machine possesses intentional states or not, once the directly intentional terms (like 'knows', 'infers', etc.) have been suitably translated into some neutral vocabulary; i.e. that intentionality *makes no logical difference*.

2nd. No eventual possession of intentional states and semantical dimension would change anything in the possible behavior of a machine i.e. intentionality *is not functional*.

Only if we show that intentionality makes some logical difference or that it is functional, we can conclude against computationalism.

Our argument shows that the capacity of an individual to distinguish propositions from sentences makes a logical difference in the sense that it can make a sentence referring to that individual be non propositional.

Consider the following analogy. If human inferences were equivalent to Turing machine outputs and to formal system theorems, we could establish the following (rather rough) parallelism between attempts at diagonalizing:

1. As input for a Universal Turing machine U that only outputs 1 on true sentences and 0 on false ones, consider a suitable version of a sentence of the sort:

$G_U =_{\text{def}} \text{'M does not output 1 on } G_U\text{'}$

M would loop on G_U .

2. For a sound formal system P consider a Gödelian sentence of the sort of:

$G_P =_{\text{def}} \text{'}\not\vdash_P G_P\text{'}$

S would fail to prove the true sentence G_P .

3. For the human H consider the sentence G*:

$G^* =_{\text{def}}$ 'H does not infer at t that G* expresses a true proposition'

The human, if endowed with some plausible intellectual capabilities, will not loop on G*. If CL holds, H will sooner or later correctly conclude that G* makes no sense, expresses no proposition. So H will not fail to prove any true sentence G*. *H cannot be outgoedeled by means of G**.

Thus the argument also shows that possessing intentionality and semantics can render a human capable of discarding a sentence as non propositional after a finite period of time, instead of looping on it. The difference between human inference, as an intentional act, and any Turing computation is sometimes relevant for a sentence like G* to be or not to be propositional and for a human H to loop or not to loop on G*.

Once we have distinguished between sentences and propositions, we can consider the possibility that not all tokens of a same unambiguous sentence are logically equivalent. The following is a weaker tokenistic approach than the one we described in 1. 4. 1. Let's call 'A' the following sentence-token:

'A expresses no true proposition'

The usual 'reductio' shows there is a fact we can assert by means of sentence-token B:

'A expresses no true proposition'

B expresses a true proposition. The fact that A expresses no true proposition can be asserted by means of B but not by means of A. There is no phenomenologically possible act of thought that A could express, while B expresses a correct thought. The relevant fact is, however, that two syntactically identical tokens of an unambiguous sentence are logically different. No purely syntactical device could perceive a logical difference between syntactically identical tokens. And there are reasons to believe there is no way to avoid the need for that perception. So semantics seems again logically functional.

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