Reconsidering the Second Argument on the Veridicality Thesis, "Semantic Argument"

Abstract

Philosophy of Information is a discipline that has been systematized by Floridi and other theorists since the late 1990s, but even before that, qualitative and quantitative aspects of the concept of information have been considered in philosophy and related fields. Contemporary philosophers of information have presented several arguments on the “Veridicality Thesis” (VT), which is a qualitative issue, and which remains an influential topic in the philosophy of information and is important for considering both the quantitative and qualitative aspects. In this paper, I will focus on the "Semantic Argument” (SA) of the argument for VT proposed by Floridi. By pointing out that the nuclear and structural ideas of SA are "the distinction between domains of discussion" and "the interpretation of the informative content H", I will reformulate SA in a different way than in the previous studies and re-evaluate SA as suggesting quantitative issues. As a result, the idea of "negativity of information" (which is not commonly assumed) could be derived from SA.

1 Introduction: Why should we discuss VT now?

According to Floridi (Floridi 2002; 2011), the main task in the new discipline called "Philosophy of Information" is the analysis of the concept of information. This analysis can be approached from both quantitative and qualitative aspects. For example, a partial example of an analysis from the quantitative aspect is the study of the informativeness of semantic information[1], which is one of the many types of notions of information (Floridi 2004b; D'Alfonso 2011). In the other analysis from the qualitative aspect, it is considered how the multiplicity of notions of information is categorized and which of them have what truth value (Floridi 2010; Scarantino and Piccinini 2010). These two aspects are not independent, and the position taken on one side can influence the considerations on the other.

The aforementioned discipline of "philosophy of information" has been systematized since the late 1990s by theorists such as Floridi and Adriaans (Floridi 2011; Adriaans and van Benthem 2008). On the other

1 The way the concept of information is organized differs from theorist to theorist, but among them, Floridi's "a map of information concepts" is the most famous (Floridi 2010). Information accompanied by meaningful content is called both "semantic content" and "semantic information," and Floridi distinguishes between "semantic content" as that which is alethically neutral and "semantic information" as that which is true. However, there is a persistent position that all information that is accompanied by meaningful content, regardless of whether it is true or not, should be treated as "semantic information" (e.g., Scarantino and Piccinini 2010).

hand, even before their attempts at systematization, however, the concept of information continued to be a frequently raised issue in philosophy and other related fields. In quantitative terms, there were discussions by Bar-Hillel and Carnap shortly after the rise of information theory, and in the context of Popper's falsifiability, the amount of information contained in a hypothesis was debated (Bar-Hillel and Carnap 1952; Popper 1959). Similarly, on the qualitative side, various theorists have argued about the truth value of information. While disciplines such as library and information science and informatics tended not to require truthfulness, philosophical fields such as epistemology often insisted on truthfulness (Dretske 1981; Grice 1989).

Especially since the 2000s, contemporary philosophers of information, led by Floridi, have presented several arguments concerning the Veridicality Thesis (hereafter referred to as "VT"), which requires that semantic information must be true. However, the controversy has only a new name and is practically a continuation of the above mentioned tradition. Therefore, it can be said that the individual controversies surrounding VT are partly outdated, but VT itself is still an influential topic in the philosophy of information for the following reasons. First, since the consideration of quantitative and qualitative aspects are interrelated, the position one takes with respect to VT will strongly affect one's approach to the quantitative aspect. Second, although Floridi groups together arguments that demand the truthfulness of information as "VT," there are different approaches to VT, including arguments that defend it by intuition, by imposing certain constraints on it, and by argumentation, which are not monolithic (this is discussed in more detail in Section 2). Third, for any argument about VT, it can only become clear that it is endowed with significant properties other than truth value by interpreting it in a way that complements the assumptions it implicitly makes.

Thus, in this paper, of the two famous arguments presented by Floridi, the "Splitting Test" and the "Semantic Argument" ((hereafter referred to as "SA"), the latter will be the focus of this discussion. This is because SA itself has multiple flaws, and its problems have already been pointed out by several theorists (cf. Scarantino and Piccinini 2010; Demir 2014; Lundgren 2019), but it has a special structure in terms of some issues not mentioned in the previous studies (discussed in more detail in Section 3). Therefore, after noting that the unique issues of SA lie in the two points mentioned in Section 3, this paper attempts to reassess SA not only in terms of an argument for deriving VT, but also as a simultaneous reflection of Floridi's particular view of informativeness.

In discussing the above, this paper is structured as follows. First, in section 2, I clarify the premise of SA, its peculiarities, and the structure of argumentation through a comparison with Dretske, who argues for VT similarly to Floridi. Then, in section 3, I point out that the core ideas of SA are the "distinction between domains of discussion" and the "interpretation of the informative content H". Based on these considerations, in section 4, I reconstruct SA in a consistent manner using these two core ideas as clues, and in section 5, I point out that " negativity of information" is derived as a consequence of this reconstruction.

2 Overview of SA via Dretske

Dretske and Floridi tend to be seen as one and the same in their defense of VT. However, as noted above, several types of arguments in defense of VT can be recognized. In the first half of this section (2-1), it will be noted that Dretske adopts an argument by imposing certain constraints, while Floridi's SA adopts one by argumentation (in addition, the 'Splitting Test', also by Floridi, is classified as one by (linguistic) intuition). In this sense, the second half of this section (2-2) gives as much as possible an overview of Floridi's SA in its original form; a consistent reinterpretation of SA will be presented again in section 4, but this section is also important for understanding which parts of Floridi's original description are problematic.

2.1 Difference between Dretske and Floridi

Contemporary philosophers of information see Dretske as arguing for VT with the following statement from Dretske (Dretske 1981, p. 45).

> false information and mis-information are not kinds of information——any more than decoy ducks and rubber ducks are kinds of ducks.

That is, if the semantic content of a proposition is false, whether intentionally or unintentionally, then the proposition is not called "information" and is at best pseudo-information. Since this is a typical claim for VT, contemporary theorists in favor of VT, including Floridi, often rely on this statement.

However, when Dretske argues for VT, he imposes certain constraints on his argument. In other words, by imposing certain constraints, he offers an argument in defense of VT. Dretske thought that when a signal conveys informational content to the receiver side, the "conclusion" must stand as a consequence of something that satisfies all of the following three "requirements" (Dretske 1981, pp.63-65).

requirement A	:	The signal carries as much information about *s* as would be generated by *s*'s being *F*.
requirement B	:	*s is F*.
requirement C	:	The quantity of information the signal carries about *s* is (or includes) that quantity generated by *s*'s being *F* (and not, say, by *s*'s being *G*).
conclusion	:	The conditional probability of *s*'s being *F*, given *r* (and *k*), is 1.

The validity of this inference is not the issue at hand. What is essential in Dretske's theory is not the conclusion of "conditional probability 1," but rather requirement A, which requires that the equivocation

between two points be zero[2]. Requirement A eliminates the possibility of information loss in the information chain between two points, and allows the receiver to decode what is happening at the source simply by looking at the signal delivered to the receiver. Because of this constraint, VT is valid within the theory developed by Dretske.

Let us review how Floridi organizes the approach to computing the informativeness of semantic information. Floridi calls the probability-based approach to the informativeness of semantic information as the Theory of Weakly Semantic Information (hereinafter referred to as 'TWSI'), and distinguishes it from the truth-value-based approach, the Theory of Strongly Semantic Information (hereinafter referred to as 'TSSI') (Floridi 2004; 2011). Although the fact that Dretske supports VT can easily lead to misunderstandings, Dretske is classified as TWSI because he takes a probability-based approach to informativeness. Similarly, Bar-Hillel and Carnap can also be classified as TWSI.[3]

On the other hand, although Floridi himself professes to have basically adopted TSSI, it can be said that as far as SA is concerned, it is a TWSI framework. This is because, when SA is formulated again, the claim is that "without assuming TSSI, VT can be formally derived by argumentation as long as the 'four principles' employed in TWSI and information theory and the 'semantic properties of information' explained in Section 3 are assumed as additional premises". Dretske imposed the constraint 'equivocation is 0' when justifying VT in the TWSI framework. In other words, he thought that VT could not be justified without imposing such a constraint. On the other hand, Floridi argued that it is possible to justify VT in the same TWSI framework by means of argumentation. This is one of the reasons why SA is unique when compared to other arguments.

2.2 How Floridi attempted to derive VT?

First, I will give an overview of Floridi's original argument in order to see what steps SA does. SA uses the following vocabulary under a two-values logic.

D	:	(possibly empty) domain of propositions；$\{p_1, \ldots, p_n\}$
φ, ψ	:	propositional variables ranging over D
S	:	(possibly empty) domain of instances of information；$\{i_1, \ldots, i_n\}$

2 Equivocation can be defined as the conditional entropy $H_r(s)$, which expresses 'the extent to which we do not know about the information source s when we receive the signal r'. Note that this point that requirement A is essential has also been raised by Schulz (Schulz 2016).

3 TWSI includes both those who adopt the self-information content ($I = -\log p$) used in information theory and those who adopt the semantic content ($(CONT) = 1 - p$) formulated by the Inverse Relation Principle, which will be explained in section 3. In this paper, we are only concerned with the perspective of how Floridi perceives TWSI, and we adopt Floridi's classification as it is (Floridi 2004a; 2004b; 2011, p.31). Note that the term 'probability' as used here varies from discussant to discussant, as it can be a frequency probability or calculated by state descriptions.

x, y	:	propositional variables ranging over S[4]
$t(\varphi)$	:	φ is contingently true
$f(\varphi)$	:	φ is contingently false
$t/f(\varphi)$	:	φ is contingently true or false
$T(\varphi)$	:	φ is a tautology
$C(\varphi)$	:	φ is a contradiction
$H(\varphi)$	:	primary informative content of φ
$P(\varphi)$	:	probability of φ [5]

Here, S is a subset of D, since all semantic information is assumed to be in the form of propositions. In addition, the following four principles are introduced as "standard assumptions" that are "uncontroversial" in information theory and philosophy of information based on TWSI (Floridi 2007, p.35; 2011, p.99).

P1 : $\forall x H(x) \geq 0$
(principle of the non-negative nature of information)

P2 : $\forall x \forall y((x \neq y) \rightarrow (H(x \cup y) = H(x) + H(y)))$
(additive principle)[6]

P3 : $\forall \varphi((P(\varphi) = 1) \rightarrow (H(\varphi) = 0))$
(inverse relationship principle)[7]

P4 : $\forall \varphi((H(\varphi) = 0) \rightarrow \neg(\varphi \in S)$

According to Floridi, we "should implement" these four principles in order to obtain "any satisfactory understanding of semantic information" (Floridi 2007, p.34; 2011, p.98).

Floridi begins his argument by equating S and D. That is, he assumes that all information takes the form of propositions and that all propositions are information. However, from P3 and P4, we can say the following.

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4 Although not mentioned in Floridi's original paper, these variables are used in P1 and P2 as variables on S, so I added them.

5 Although Floridi's original paper stated "$P(x)$" using variables on S, Floridi himself applied probability to variables on D; therefore, I modified it using variables on D.

6 The imprecision of P2 is discussed in section 5. The original additivity is said for "two independent" variables, but Floridi describes it as "two different" variables (Floridi 2007, p.34; 2011, p.98).

7 Although described by Floridi as the "Inverse Relationship Principle (IRP)", P3 is not the IRP itself, but an expression that takes only the case with probability 1 out of the IRP. The reason why IRP itself is not included among the four principles is probably because "informative content H" is not considered as a quantity that is calculated simply according to IRP alone, as will be discussed in section 3.2.

(1)	$T(\varphi) \rightarrow (P(\varphi) = 1)$	(from the probability axiom)
(2)	$(P(\varphi) = 1) \rightarrow \neg(\varphi \in S)$	(from P3 and P4)
(3)	$T(\varphi) \rightarrow \neg(\varphi \in S)$	

Despite the assumption that S and D are the same set, the assumed principles lead to the conclusion that the tautology is not an element of S. This means that the first assumption that S and D are the same set is false. Therefore, it is reasonable to assume that S is a subset of D that does not contain tautologies.

The current model of S makes the following inference reasonable.

(1)	$(P(\varphi) = 0) \rightarrow (P(\varphi) < 1)$	
(2)	$(P(\varphi) < 1) \rightarrow (\varphi \in S)$	(from the current assumption[8])
(3)	$C(\varphi) \rightarrow (P(\varphi) = 0)$	(from the probability axiom)
(4)	$C(\varphi) \rightarrow (\varphi \in S)$	

In TWSI, which calculates information content based on probabilities, the less likely propositions are, the greater the information content; therefore, the contradiction becomes the most informative proposition. This is what Floridi calls the "Bar-Hillel & Carnap Paradox" (cf. Bar-Hillel and Carnap 1952) and is unavoidable as long as TWSI is employed. How one deals with this counterintuitive result that "contradiction is the most informative" depends on the position one adopts, but if one follows Floridi's policy of eliminating contradictions, the model of S should be modified as follows.[9]

$$\forall\varphi\left(\left(T(\varphi) \vee C(\varphi)\right) \rightarrow \neg(\varphi \in S)\right)$$

The current model of S is a set of contingencies. In this model, we can say the following from P1 and P2.

8 The first explicit assumption is that D and S are the same set, and the hidden assumptions are that all elements in D have probability and that we now consider only propositions as having probabilities. That is, if something has probability, it is an element of D or S. However, at this step, the set of D minus the tautology is the same set as S. Therefore, having a probability less than 1 means the same thing as being an element of the current S.

9 How to handle the information content of contradictions and inconsistencies varies from theorist to theorist, but there are three main strategies that can be considered. (1) assigning zero information value, (2) assigning infinite information value, and (3) eliminating all inconsistent cases from consideration. In SA, it reads as if (3) is adopted, but even if (1) is adopted, the contradictions are excluded from S by P4, and the result remains the same.

$$\forall\varphi\forall\psi((\varphi \neq \psi \wedge t/f(\varphi) \wedge t/f(\psi) \rightarrow (0 < H(\varphi) < H(\varphi \cup \psi) > H(\psi) > 0))$$ [10]

Alternatively, it could be paraphrased as follows[11].

$$H(\cup_1^n \varphi) \leq H(\cup_1^{n+1} \varphi)$$

Since information is non-negative (P1) and additive (P2), the informative content H in the repository should increase monotonically without decreasing as contingencies are added to the information repository one after another.

In the current model of S, the informative content in the repository cannot be reduced unless it is physically damaged. However, Floridi lists the following R1 and R2 as requirements that we should "try to satisfy […] if possible" (Floridi 2007, p.34; 2011, p.98).

R1 : Informative contents can decrease syntactically, without necessarily being damaged or erased physically.

R2 : An information repository is unlikely to be increased by adding any contingent proposition.

For example, after "p" is submitted to the repository, consider the operation of submitting "$\neg p$", which is inconsistent with the immediately preceding proposition. Then, "p" and "$\neg p$" have their own informative content, but when the two mutually inconsistent propositions are combined in the repository, "$p \vee \neg p$", that is, a tautology is formed[12]. However, as noted above, tautologies must be eliminated from the elements of S. Hence,

$$\diamond(H(\cup_1^n \varphi) > H(\cup_1^{n+1} \varphi))$$

must be syntactically established[13]. Thus, tautologies, contradictions, and inconsistencies have been removed from S.

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10 In section 4 of this paper, I will adopt Enomoto's interpretation and consider that the variables are erroneously described by variables on D when they should have been described by variables on S (Enomoto 2020). In section 2, however, I have deliberately kept the notation as it was in Floridi's original paper, partly because I want to survey Floridi's argument in its original form as much as possible.

11 Floridi describes it this way, but it should be described as I modified it in section 4. Note that although this expression "$H(\cup_1^n \varphi)$" is used without explanation, it means that by repeatedly applying P3, the informative content is calculated by connecting the 1st through n-th variables submitted to the information repository with disjunction.

12 In his explanation, it is difficult to understand the mechanism by which the informative content of the entire repository is reduced when a proposition that is inconsistent with the previous one is added to the repository. It seems that "$p \vee \neg p$" would not be formed in the repository if one only added "p" at one stage in the repository and then added "$\neg p$" at some subsequent stage. We will return to this point in section 4.

13 The operator "$\diamond$" is used here to denote possibility, not in the sense strictly defined by possible worlds and accessibility relation, but simply in the everyday sense of "is possible" or "could be."

However, Floridi argues that even in the current model, the phenomenon of what might be called "semantic loss of information" has not yet been realized. For example, we have the intuition that when a true proposition is rewritten (or negated using the operator "¬"[14]) as a false proposition, the semantic informative content of the original true proposition is lost. Therefore, the third requirement R3 must be satisfied.

R3 : Informative content can be lost both physically, syntactically, and semantically.

That is,

$$\Diamond(H(\cup_1^n \varphi) > H(\cup_1^{n+1} \varphi))$$

must be semantically established. This motivates the elimination of false contingencies and leads to the following conclusions.

$$\forall\varphi((\varphi \in S) \rightarrow t(\varphi))$$

The last remaining model of S is a set of true contingencies, which is nothing more than the claim of the "Veridicality Thesis" that semantic information must be true. This is an overview of SA.

3 Preparations for discussion

In section 2, we reviewed how Floridi attempted to derive the VT. However, as Enomoto points out, the original SA seems to contain some typographical errors and explanatory omissions that do not make sense in this form (Enomoto 2020). Furthermore, the assumption about the domain of discussion for variables is not used in the argumentation, and there remains ambiguity as to how to interpret the informative content H. Therefore, as preparations for the discussion to reconstruct SA to make sense, section 3 shall clarify the issues by focusing on the "distinction between domains of discussion" and "interpretation of informative content H."

3.1 On the distinction between domains of discussion

Floridi distinguishes the following domains of discussion for the vocabulary and four principles used in the SA (Floridi 2007, p.35; 2011, p.99).

P1 and P2 concern S and the cumulative nature of informative contents. P3 and P4 concern D and

14 Floridi lists four things that cause "semantic loss": "falsification," "negation," "making propositions satisfiable by all possible worlds," and "making propositions inconsistent" (Floridi 2007, p. 40). However, since the latter two correspond to the elimination of tautologies, contradictions and inconsistencies described in the previous step, only the former two will be considered in this paper.

the relation between information and probability.

Yet, this distinction is not used at all in the actual argument (see section 2). This is the first point that seems puzzling about SA.

As mentioned earlier, D is the set of propositions and S is the set of information. Since it is assumed here that all information is in the form of propositions, S is a subset of D. In other words, since the elements of S are also the elements of D, the properties given to D can be applied to the elements of S. For example, since P3 and P4 are described using variables on D, these principles are applicable to the entire domain of **Fig.1**, including S. However, the properties given to S are not applicable to the elements of $D \cap \bar{S}$. For example, since P1 and P2 are described by variables on S, these principles can be applied to the polka-dot portion of **Fig.1** (S), but not to the shaded pattern ($D \cap \bar{S}$).

In summary, all principles from P1 to P4 can be applied to the polka-dot patterned area in **Fig.1**, that is, the domain of discussion of S. In contrast, only two principles, P3 and P4, can be applied to the shaded area in **Fig.1**, that is, the domain of discussion of D, excluding S ($D \cap \bar{S}$). This distinction between domains of discussion is crucial for the reconstruction of SA to be done in section 4, but this point has been overlooked in previous studies.

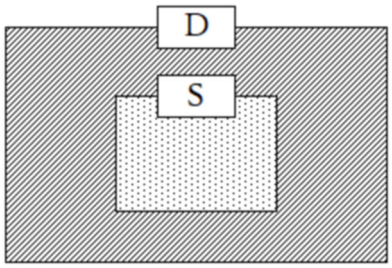

Fig.1 the distinction between domains of discussion

3.2 On the interpretation of the informative content H

The second point that seems puzzling about SA is that it does not specify on what calculation the "informative content H" is based. In TWSI, the definition of information content is fundamentally based on the idea of Inverse Relationship Principle (hereafter, "IRP"). As noted in section 1, TWSI includes both those who adopt the self-information content ($I = -\log p$) used in information theory and those who adopt the semantic content ($(CONT) = 1 - p$). Although their calculation methods are slightly different, the mechanism is the same: the lower the probability, the higher the information content, and conversely, the

higher the probability, the lower the information content[15]. This is IRP, as long as SA is considered in the context of TWSI, IRP is likely to be relevant to informative content H.

Furthermore, Floridi himself makes statements in several places that allow the informative content H to follow probabilities. For example, P3 is not itself an IRP, as noted in Note 7, but only extracts the case of probability 1 from the IRP, but the step of eliminating contradictions can be read as directly explaining the use of IRP.

> Since contradictions are most unlikely, to the point of having zero probability, they are very informative. […] Counterintuitively, you may be receiving an increasing amount of information about the outcome of an event by receiving an increasingly unlikely message but, strictly speaking, the most unlikely message is a contradictory one. (Floridi 2007, p.36; 2011, p.100)

From this, we can also expect that IRP is related to informative content H.

On the other hand, it is also suggested that when R3 is introduced, the informative content H does not simply follow probability alone, but is given semantic properties.

> However, according to [9][16], no loss of informative content would occur […]. Quantitatively, this may be true, but semantically it seems unacceptable. (Floridi 2007, p.39; 2011, p.103)

This statement is suggestive because it says that no loss of "informative content" would occur, even though it is possible to have quantitative loss of information. That is, informative content cannot be described only quantitatively.

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15 The definition of information content such that satisfies additivity is uniquely determined by the self-information content using logarithms. Perhaps this is why Demir and Lundgren, when questioning the validity of P2, implicitly assume that the informative content H in SA is "self-information content" in the sense of information theory, and then criticize Floridi for misinterpreting P2 (Demir 2014, pp. 128-129; Lundgren 2019, pp. 2894-2895). On the other hand, Demir also describes it as follows.

> It is perhaps worthwhile to state that I could have formulated my criticism by using the inverse relationship between the probability of a proposition and its informative content. I shunned away from doing that, because Floridi's alethic theory of semantic information is based on the criticism of a seemingly paradoxical implication of the probability-based theories of information. […] Therefore, it would have been unfair if I had formulated my criticism in terms of the inverse relationship between probabilities and informative content. (Demir 2014, p.133)

However, it still seems that Demir is criticizing with an interpretation based solely on mere "quantity", which Floridi avoids. Note that since SA is a claim that VT can be derived from TWSI and information theory plus more, it can be considered separately from the idea of informative content in TSSI (Floridi's alethic theory of semantic information), which is Demir's concern. Note that, technically speaking, the semantic content ($(CONT) = 1 - p$) can also be converted to self-information content ($I = -\log p$) if the appropriate procedure is followed (Bar-Hillel and Carnap 1952).

16 "[9]" refers to a set S whose elements have only contingencies that are not mutually inconsistent with each other, such that R1 and R2 are satisfied but R3 is not. Floridi says that at this stage, it is only possible to have physical or syntactic loss of information, and it is not possible to have semantic loss of information.

However, this statement alone does not establish which of the following two meanings of "informative content" Floridi uses.

（1） Although it is also possible to view it semantically from another perspective, it is essentially a quantitative "informative content" that is consistently calculated based on probability alone.

（2） It is a hybrid "informative content" that has not only simple quantitative properties determined solely by probability, but also semantic properties that are at the same time influenced by factors other than probability.

If we adopt the interpretation in (1), it would be closer to the meaning of "information content" as used in TWSI and information theory, and would seem to fit well with the four principles that are "standard assumptions". In fact, the criticism of P2 by Demir and Lundgren may be based on the interpretation of (1). In this case, however, although the same term "informative content" is used in two different senses in the steps of eliminating inconsistencies and eliminating false contingencies, the exact same principle is applied to the argument. Can the four principles be applied in such an ambiguous way? Furthermore, the sudden change of the vocabulary term "informative content H" in the middle of an argument is unnatural.

Therefore, I will argue that a vocabulary in SA should be assigned a consistent meaning, and I will adopt interpretation (2) in this paper. Under this interpretation, the informative content that a true contingency would have had is lost by being rewritten (or negated using the operator "¬") into a false contingency, as well as being calculated roughly according to probability. For example, for propositions with the same probability, the informative content in the true case will be greater than in the false case. Furthermore, if the probabilities are very different, the informative content in the false case could be greater than in the true case.

In adopting the interpretation of (2), the idea of "epistemic-value" by Scarantino & Piccinini is useful for understanding (Scarantino and Piccinini 2010).[17] According to this idea, when probabilities are equal, false contingencies are epistemologically inferior to true contingencies and have lower informative content. In other words, it is the epistemic-value of information that is the informative content H in SA, which basically changes in quantity according to the information-probability relation as described in the IRP, but which is not simply determined by probability alone and is greater when it is true. This seems to be consistent with the use of the unfamiliar notation "informative content" instead of the more common "information content" for self-information content, and with the fact that IRP itself is not adopted as one of the four

17 Scarantino & Piccinini consider three cases of Floridi's information loss phenomenon: quantitative, qualitative, and epistemic-value loss. The quantitative loss of information is the loss that occurs when the relevant information instance is removed from the information repository if the interpretation in (1) is adopted. Also, there is a qualitative loss of information in the sense that, for example, when one propositional content is rewritten into another, it is no longer the same propositional content.

principles.[18]

4 Reconstructing SA

The reconstruction of SA can be done by considering the two ideas organized in section 3 as the core of SA. Although there are still some problems in the reconstructed arguments below, as will be discussed in section 5, this section aims to restore the arguments that Floridi would have originally wanted to make and to compensate for his typographical errors and omissions in the explanations. First, there is no problem up to the step of eliminating tautologies and contradictions. In other words, the information model S_1 at this point is as shown in **Fig.2**. At this point, in the domain of discussion of S, the following holds.

$$\forall x \forall y((x \neq y) \rightarrow (0 < H(x) < H(x \cup y) > H(y) > 0)) * [19]$$

Alternatively, it could be paraphrased as follows (note that this differs from the notation in Section 2).

$$\forall x \forall y((x \neq y) \rightarrow (H(\cup_1^n x_i) \leq H(\cup_1^{n+1} x_i)))$$

where the index "i" is an integer greater than or equal to 1. Floridi's original argument uses the variables "φ" and "ψ" on D. As Enomoto points out, this is a misprint for the variables "x" and "y" on S (Enomoto 2020, p.51). As discussed in section 3, P1 and P2 are assumed to be principles that can only be applied to S. Therefore, a monotonic increase in informative content will occur in S_1.

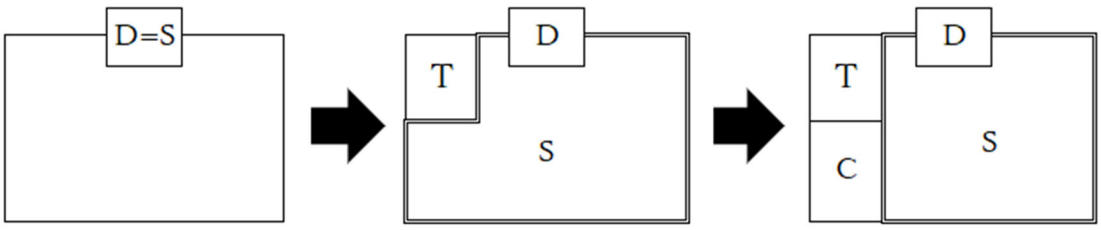

Fig.2 information model S_1 eliminating tautologies and contradictions from D

18 If the IRP is adopted as is as a principle, the informative content H would be determined only by probability; therefore, it can be interpreted that the principle dares to take out and adopt only the case with probability 1.

19 When we reviewed Floridi's argument in section 2, the expression was used to specify that the two variables are contingencies. However, by rewriting it using variables on S, "x" and "y" cannot be tautologies or contradictions at this point. Therefore, the expression specifying that "x" and "y" are contingencies is redundant.

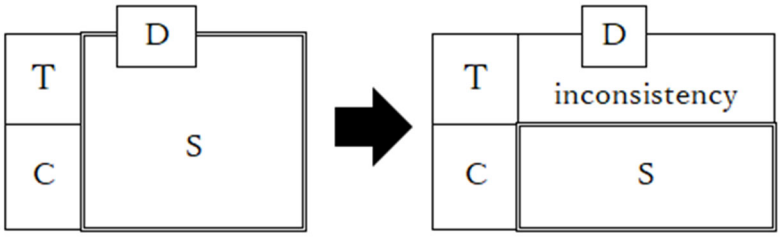

Fig.3 information model S_2 eliminating inconsistencies from S_1

Here, Suppose the operation of submitting "p" to the n-th and "$\neg p$" to the n+1-th of the information repository. In this case, as noted in Note 12, the tautology "$p \vee \neg p$" is not immediately generated as Floridi states, so we must interpret it as follows. From P2, if "x" and "y" are different variables on S, then $H(x \cup y) = H(x) + H(y)$. the two currently considered variables "p" and "$\neg p$" are on S and different ones, the total informative content of $H(p)$ and $H(\neg p)$, computed independently of each other, should be equal to $H(p \cup \neg p)$. However, since "$p \vee \neg p$" is a tautology, $H(p \cup \neg p)$ will be zero, and not only the informative content of the n+1-th input "$\neg p$", but even the informative content of the n-th input "p" will be lost. The result would be that the total informative content up to the n+1-th would be less than the total informative content up to the n-th, just as Floridi said! In other words, there is a case in S_1 in which the following is true (abbreviated for simplicity).

$$H(\cup_1^n x_i) > H(\cup_1^{n+1} x_i)$$

However, this contradicts the principle of monotonic increase in S_1. This is because "$H(\cup_1^n x_i) > H(\cup_1^{n+1} x_i)$" cannot be simultaneously true in S_1, where the principle is "$H(\cup_1^n x_i) \leq H(\cup_1^{n+1} x_i)$". The fact that there is a contradiction means that the assumption that S is identical to S_1 was wrong. Thus, an information model S_2 is obtained that eliminates the inconsistencies that cause such discrepancies in S_1 (**Fig.3**).

In the current model S_2, the informative content continues to increase monotonically from P1 and P2 ($H(\cup_1^n x_i) \leq H(\cup_1^{n+1} x_i)$ holds). The informative content in SA is more informative (epistemologically valuable) when it is true than when it is false. In this case, if we take the operation of rewriting a true contingency into a false contingency (or negating it using the operator "¬"), we will have a semantic loss as shown in **Fig.4**. In other words, the following holds in S_2.

$$H(\cup_1^n x_i) > H(\cup_1^{n+1} x_i)$$

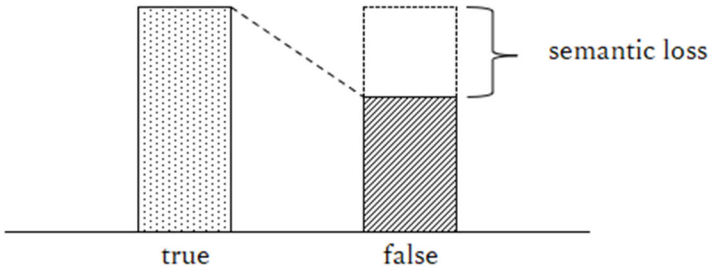

Fig.4 semantic loss of information

However, this contradicts the principle of monotonic increase in S_2. This is because "$H(\cup_1^n x_i) > H(\cup_1^{n+1} x_i)$" cannot simultaneously be true in S_2, where the principle is "$H(\cup_1^n x_i) \leq H(\cup_1^{n+1} x_i)$". The fact that there is a contradiction means that the assumption that S is identical to S_2 was wrong. Thus, an information model S_3 is obtained that eliminates the false contingencies that are the cause of such discrepancies in S_2 (**Fig.5**). The information model S_3 thus obtained is the set of true contingencies ($t(\varphi)$), which is nothing but VT.

Reconstructing SA with the compensation of Floridi's misprints and omission of explanations, we can see above that the distinction between the domains of discussion and the interpretation of informative content H is important in SA.[20] This argument would not be possible without relying on the fact that the domains of discussion of P1 and P2 are restricted to S alone and cannot be applied to any other domain (D ∩ $\bar{S}$). Moreover, semantic loss can only be explained by a conception of informative content with epistemic-value, based on Floridi's own interpretation, rather than a mere quantitative interpretation as understood in previous studies.

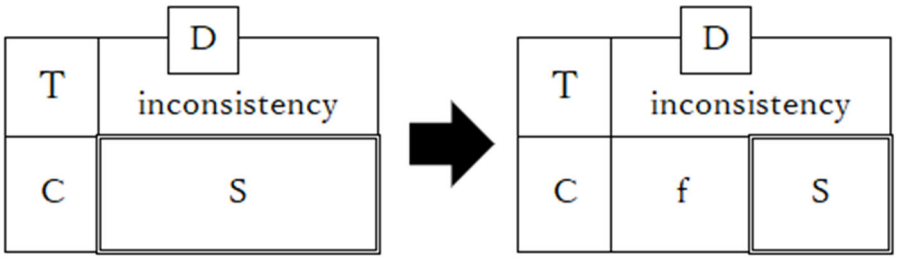

Fig.5 information model S_3 eliminating false contingencies (f) from S_2

20 Note that Lundgren interprets P4 as the core of SA (Lundgren 2019).

5 Consequences of SA

In section 4, I have reconstructed SA as Floridi would have originally wanted it, by correcting typographical errors and explanatory omissions in the original argument, and by considering the two ideas of "distinction between domains of discussion" and "interpretation of informative content H" as the core of SA. However, as pointed out in the first half of this section (5-1), it turns out that VT derived by the revised SA is based on the negativity of informative content. Since the quantity of information is generally non-negative, SA based on negativity is even more peculiar. Yet, this consequence only holds if one assumes that all four principles are true. If the negativity cannot be interpreted consistently with Floridi's other theories, it is necessary to consider the possibility that the four principles may be in error and to revise SA appropriately accordingly (5-2).

5.1 Negativity of information

I have reconstructed SA in section 4, but there are still some parts that are not fully explained. Do we really get the information model S_3, which is mentioned at the end of SA, in a self-evident way? In the following, I will examine in more detail how the last step is accomplished.

In this paper, I take the same position as Demir in that there is no up to the point of eliminating inconsistencies (Demir 2014). In subsequent steps, however, Demir considers the informative content H in SA as a simple quantity and criticizes it as follows. In this respect, the positions of this paper and Demir differ.

> However, it is absurd to expect a loss of information in this case [(when negating a proposition)], because both R and not-R are assumed to have the same amount of informative content. […] Do we expect a loss of information in the repository if "the outcome of flipping a coin at time t_1 is heads" was just replaced with "the outcome of flipping a coin at time t_1 is tails"? The answer seems to be clear NO, because both the original statement and its negation have the same amount of informative content. (Demir 2014, p.131, quoter in parentheses)

However, as I pointed out in section 3, Floridi can be interpreted as giving the informative content H the property that it has greater amount when it is true. Thus, if R is true, its negation ¬R has smaller informative content than R, even if the probability of occurrence of R and ¬R is the same. In other words, there would be a loss of information. Thanks to this interpretation of informative content H, Floridi can escape Demir's criticism.

Here, I consider again what kind of operation Floridi performs in the last step. Floridi describes semantic loss as follows.

> Suppose this [(statement)] is true. This informative content could be lost […] but also if some false statement is added or if the meaning is changed. (Floridi 2007, p.39; 2011, p.103, quoter in parentheses)

The relationship between “statement" and "proposition" is difficult to read, but here it reads as if Floridi thinks that a proposition is formed by the accumulation of one or more statements. According to this explanation, we do not add new propositions to the repository, but rather we operate by adding false statements to a given true proposition and rewriting it into a false proposition, or by rewriting the original proposition so that its meaning changes.

Now, the current information model is S_2, which eliminates up to inconsistencies. In this model, if the k-th true proposition is t_k and the proposition that rewrites it as false (or negates it using the operator “¬”) is f_k, then using P1 and the interpretation of informative content H, we can say

$$0 \leq H(f_k) < H(t_k)$$

Note that since S_2 is now a candidate for S and a set of all contingencies regardless of their truth value, P1 can of course be applied to false propositions.

Looking back at what Floridi has done in the previous steps, when eliminating inconsistencies, the input of the n+1-th proposition reduces the total informative content to less than the total up to the n-th. However, what Floridi does in the last step is to rewrite the n+1-th true proposition as a false one (or to negate it using the operator “¬”), and we look at the change in informative content between the n+1-th proposition and n+1*-th one (**Fig.6**).

Indeed, if we compare the n+1-th to the n+1*-th, the truer t_{n+1} is, the smaller the informative content of f_{n+1}, which is rewritten as false (or negated using the operator “¬”), and a loss of information is allowed ($H(f_{n+1}) < H(t_{n+1})$). However, when compared to the informative content $H(\cup_1^n x_i)$ up to the n-th, the informative content $H(\cup_1^{n+1} x_i)$ up to the n+1-th is still larger (when $H(f_{n+1}) > 0$), or at least the same amount (when $H(f_{n+1}) = 0$), as shown in **Fig.6**. In other words, a semantic loss between n+1-th and n+1*-th does not imply a semantic loss from n-th.

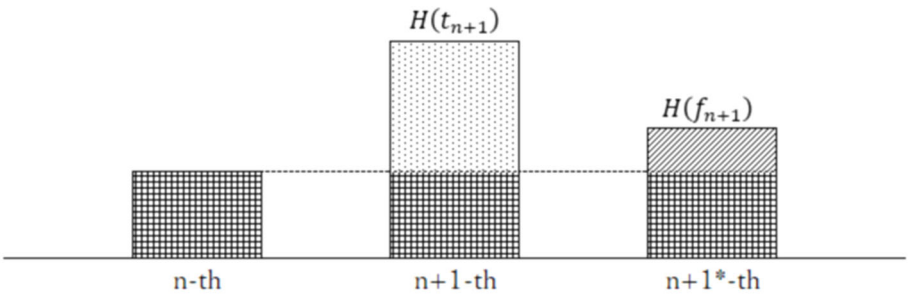

Fig.6 comparison of informative content between n+1-th and n+1*-th

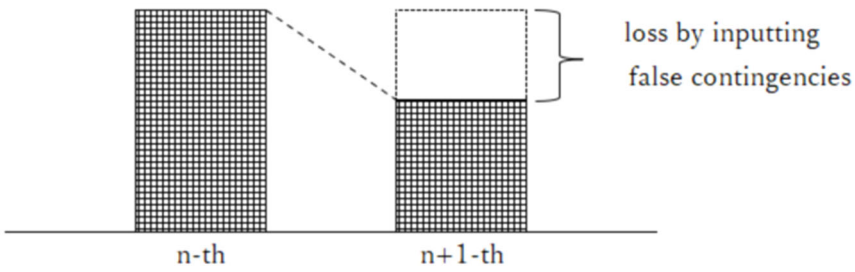

Fig.7 when the informative content of the false contingency is negative

The above facts mean that false contingencies cannot be uniformly eliminated. If one wants to eliminate false contingencies uniformly, then when the n+1-th false contingency is submitted to the repository, the loss of information must be allowed, as shown in **Fig.7**. However, for such a loss of information to occur due to the single input of a false contingency, the false contingency must have some negative informative content. In other words, we must assume the existence of a false contingency such that $H(\varphi) < 0$ in the domain of discussion of D.

This consequence of the need to recognize the negativity of information has not been previously clarified in previous studies, nor has it been explicitly stated by Floridi himself. This newly discovered view of information probably leads to the following remarkable idea. That is, if the total informative content is reduced by putting a false contingency into the repository, then false contingencies, in general, have the power to erode the informative content of other contingencies.

As mentioned earlier, SA that is based on negativity is quite heterogeneous, since the quantity of information is generally assumed to be non-negative. It can be said to be a good example of how qualitative considerations about the notion of information do influence quantitative considerations. This paper has suggested the possibility of taking the negativity of information into account in quantitative considerations of semantic information.

5.2 When not accepting the negativity of information

The consequence of the negativity of information itself is open to consideration. Nevertheless, it is also true that the negativity of information does not fit with our intuition about the nature of information. So, another way is to reconfigure SA in a direction in which we do not accept the negativity of information.

Again, according to Floridi, the four principles to be implemented are "standard" and "uncontroversial" in information theory and philosophy of information (TWSI). In particular, Floridi states that he uses the assumptions employed in Bar-Hillel and Carnap (1952), Dretske (1981), Barwise and Seligman (1997), and van der Lubbe (1997) (Floridi 2007, p.35; 2011, p.99).

However, there have been several criticisms of these principles themselves. For example, Demir and Lundgren point out that Floridi's P2 is based on an incorrect interpretation.

> The reasoning here is based on a specification of the additive principle that is incomplete. In other words, P2 is not the correct formulation of the additive principle. […] This formulation […] clearly implies that additive principle does not apply to mutually inconsistent propositions, because mutually inconsistent propositions are not independent of each other. (Demir 2014, pp.128-129)

> There are three problems. First, it is not clear how we should interpret "different instances of information"; clearly, it does not follow from the formalism. Second, if we have two different instances of information with a great overlap then their informative content is obviously not equal to the sum of their individual informative content. […] Third, the principles are, in fact, incompatible even with GDI[21] (Lundgren 2019, pp.2894-2895, footnote 15)

Moreover, Lundgren addresses and criticizes P4, namely the principle that anything lacking informative content is not information. In addition, even if the literature mentioned above (Bar-Hillel and Carnap 1952; Dretske 1981; Barwise and Seligman 1997; van der Lubbe 1997) supports Floridi's claim, it has been criticized as merely *argument ad populum* (Lundgren 2019, pp.2894-2895).

All of the above criticisms seem reasonable under certain conditions. However, it would be possible to avoid the above criticisms by interpreting Floridi's argument in the following favorable way: As we have seen in section 3, since Floridi assigns unusual properties to the informative content H, the additivity established under such an unusual interpretation is not exactly the additivity we are familiar with, but an unusual special additivity. (but this is no longer "standard" or " uncontroversial"...)

What this paper is concerned with, then, is not the validity of each principle per se, but rather the way in which the domains of discussion identified in section 3 are set up. Even if the formulas of these principles set up by Floridi are found to be legitimate and exempt from all the above criticisms, the way in which the domains of discussion are set up may be "non-standard" and "controversial."

For example, according to P1, non-negativity of information is only valid in S. In other words, it is suggested that non-negativity may not hold in $\mathrm{D} \cap \bar{S}$. Indeed, if P1 holds only in S, then it is reasonable that the domain of discussion of P2 is also limited to S. This is because if the informative content of a proposition can be negative in $\mathrm{D} \cap \bar{S}$, then the domain of discussion of P2 must be limited to S, since additivity cannot hold to the extent that P1 does not apply. However, if we honestly follow our intuition and academic traditions, the informative content of a proposition cannot be negative; hence, P1 is a principle on D, and accordingly, P2 is also a principle on D. Therefore, the four principles should be modified using variables on D as follows.

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21 GDI is semantic information in the sense Floridi claims, defined as "well-informed, meaningful, and veridical data".

P1' : $\forall\varphi H(\varphi) \geq 0$

P2' : $\forall\varphi\forall\psi((\varphi \neq \psi) \rightarrow (H(\varphi \cup \psi) = H(\varphi) + H(\psi))$

P3' : $\forall\varphi((P(\varphi) = 1) \rightarrow (H(\varphi) = 0))$

P4' : $\forall\varphi((H(\varphi) = 0) \rightarrow \neg(\varphi \in S)$

The domain of discussion for all four principles is D. The latter part of SA, that is, the part after the step of eliminating inconsistencies, depends on the setting of the domains of discussion. Therefore, if the setting of the domains of discussion becomes invalid, then although it is a valid argument up to the step of eliminating tautologies and contradictions, all subsequent arguments are no longer valid.

Note, however, that since mutually inconsistent propositions generate "$p \vee \neg p$" (tautology) or "$p \wedge \neg p$" (contradiction) in the repository, it is not a serious problem if they are excluded from S regardless of the setting of the domains of discussion, as Demir also points out (Demir 2014, p.129). In other words, in this case, SA can only lead up to the elimination of inconsistencies, and what is accepted as "information" by this model is a set of mutually consistent, alethically-neutral contingencies.

6 Conclusion

Finally, I shall reiterate the implications derived from this paper. In the philosophy of information, the analysis of the concept of information is carried out in both quantitative and qualitative aspects. The debate on VT can be said to be approached from the qualitative aspect, and as a classical subject, it has been debated in various forms. SA developed by Floridi is one such example. SA has many problems as an argument in defense of VT, and indeed it has been criticized by other debaters. However, when we reinterpret SA based on the view that its core lies in the distinction between the domains of discussion and the interpretation of the informative content H, there was a hidden and important assumption: the negativity of information. By not only reformulating SA more clearly as a qualitative approach, but also re-evaluating it as a quantitative approach, new light was shed on Floridi's view of the quantity of information. Whether or not one ultimately accepts the negativity of information, this result is highly suggestive for examining the quantity of semantic information. Normally, it is an implicit assumption that the quantity of information is greater than or equal to zero, i.e., non-negative. However, if we extend the scope of consideration from semantic information to propositions, is there a case in which the quantity of information is negative? This is an issue that needs to be addressed in the future.

Furthermore, the significance of the findings is not only the negativity of information. Even if the negativity of information were not a very acceptable premise, it would have revealed that the problem with SA as a qualitative approach lies in the previously unidentified negativity of information. If the argument is accepted in the direction indicated in 5-2, we can say the following. That is, the performance of SA leaves us

with the set of contingencies (information model S_2), that excludes tautologies, contradictions, and inconsistencies from D. In this case, although the derivation of VT has failed, the current information model S_2 is by no means useless. For example, Bar-Hillel & Carnap Paradox is said about contradictions, but the current information model S_2 avoids this paradox because it already eliminates contradictions and inconsistencies. Moreover, by interpreting the informative content H in the manner organized in section 3, differences arise between true and false contingencies in terms of epistemic-value, and an epistemic advantage can be granted to the true contingencies. In this respect, even the current information model S_2 can yield fruitful results.[22]

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22 The point that even alethically-neutral information models can (or do) build fruitful theories has been made by numerous commentators, especially in the empirical sciences (e.g., Dodig-Crnkovic 2005; Scarantino and Piccinini 2010).

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