

Toward an Ontological Representation for Corporate Financial Documents and Their Components: An Investigation on Balance Sheets and Their Accounts

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Abstract

Some documents record information as a literature book, for example, the *Odyssey* by Homer. There are other documents capable of creating social entities, for example, a financial document, which one, enforced by law (also a document), can transform one person or corporation into a debtor or a creditor. In the present paper, we start to investigate the ontological aspects of financial documents, particularly the balance sheet, as part of an ongoing project for an accounting and corporative ontology. To reach our goals, we first contextualize financial documents and explain what a balance sheet is. Then, we advance a meaning for money and its value in the ontological sense, thus suggesting a place for it within Basic Formal Ontology (BFO) framework. Then, we also address issues concerning parts of documents to explain what the accounts in a balance sheet represent in reality. Finally, we provide a first attempt of an axiomatization in OWL for the issues discussed so far. We hope that the initiative can contribute so that studies in social ontology increasingly acquire a realistic character.

Keywords¹

Social ontology, financial documents, document acts, BFO

1. Introduction

Any person or modern corporation needs to create, manipulate and keep several kinds of financial documents during their life span. In the case of corporations, such a need arises from the commitment with partners and shareholders in controlling business for for-profit purposes. Also, from obligations to pay taxes to government agencies like the Federal Revenue Service.

Within the various financial documents of this kind that one can number, the *balance sheet* is a vital one. By using a balance sheet, accountants can answer questions about whether or not a business is thriving. In addition, it is a mandatory document for the majority of corporations in order to meet obligations regarding taxes.

As a whole, the balance sheet has the primary purpose of revealing the corporation's financial situation, a sort of picture of it on a specific date. The balance sheet comprises main blocks: *assets*, *liabilities*, and *stockholders' equity* (Figure 1). The *assets block* (Figure 1, left side) represents the rights of a corporation, in different degrees of liquidity, the most liquid on the top. The *liabilities block* (Figure 1, right side) represents obligations according to demand degrees; in other words, what should be paid first comes on the top.

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Example Corporation Balance Sheet December 31, 2020			
ASSETS		LIABILITIES	
Current assets		Current liabilities	
Cash and cash equivalents	\$ 2,200	Short-term loans payable	\$ 5,000
Short-term investments	10,000	Current portion of long-term debt	15,000
Accounts receivable - net	39,500	Accounts payable	20,900
Other receivables	1,000	Accrued compensation and benefits	8,500
Inventory	31,000	Income taxes payable	6,100
Supplies	3,800	Other accrued liabilities	4,000
Prepaid expenses	1,500	Deferred revenues	1,500
Total current assets	<u>89,000</u>	Total current liabilities	<u>61,000</u>
Investments	<u>36,000</u>	Long-term liabilities	
Property, plant & equipment - net		Notes payable	20,000
Land	5,500	Bonds payable	375,000
Land improvements	6,500	Deferred income taxes	25,000
Buildings	180,000	Total long-term liabilities	<u>420,000</u>
Equipment	201,000	Total liabilities	<u>481,000</u>
Less: accumulated depreciation	(56,000)	Commitments and contingencies (see notes)	
Property, plant & equipment - net	<u>337,000</u>		
Intangible assets		STOCKHOLDERS' EQUITY	
Goodwill	105,000	Common stock	110,000
Other intangible assets	200,000	Retained earnings	220,000
Total intangible assets	<u>305,000</u>	Accum other comprehensive income	9,000
Other assets	<u>3,000</u>	Less: Treasury stock	(50,000)
Total assets	<u>\$ 770,000</u>	Total stockholders' equity	<u>289,000</u>
		Total liabilities & stockholders' equity	<u>\$ 770,000</u>

The accompanying notes are an integral part of this statement.

Figure 1: A template for a balance sheet [1].

Many of these accounts – *regarding assets or liabilities* – represent the monetary values of entities in the real world that compose a corporation. However, what does it mean to say that something has a monetary value? In this paper, we investigate an alternative answer for this question in approaching the balance sheet. Taking the balance sheet as a normative document, we focus on how its "parts" – the accounts themselves – can also represent entities other than those provided by the whole document. The remaining paper is organized as follows: Section 2 introduces basic notions about the meaning of money. Section 3 approaches documents and their parts, while Section 4 examines what kind of financial document a "balance sheet" is. Finally, Section 5 presents a preliminary axiomatization of the investigations developed in prior sections.

2. The Meaning of Money and its Value

Among the social acts that compose reality, a relevant kind is the act of promising [2]. If I promise to pay you 20 dollars because you lent me this amount of money, I have an obligation (to pay), and you have a right (to receive). Situations like this are studied within the scope of a discipline called *Social Ontology* [3]. In this simple case, everything can be arranged verbally by "doing things with words" [4].

The importance of such a simple situation is made clear by the proposal of the so-called speech acts [4], [5], which can explain many everyday situations regarding rights and obligations. However, one can no longer rely only on memories, for example, to pay debts and receive rights, insofar as social relations expand every day. Within larger societies, those obligations extend beyond the local realm and become networks of duties, impossible to retrieve without the help of records. Smith [6], in his theory of document acts, calls these records *documentary economic objects*. One prominent entity like this is *money*, although it is a complex and hard to define entity.

Ancient human societies had no resources like money. Negotiations were made in terms of exchange. For example, if John had a cow and Mary had apples, they could negotiate their items in an exchange process in which John provided some milk and received apples in return. One issue here is to

identify how many units of milk correspond to how many apples. Another issue is that both John and Mary could desire other products and not always they would be able to find someone that possessed the desirable item while also interested in milk or apples. The solution was creating an exchange mechanism to trade products corresponding to a unique and widely accepted entity. Using a mechanism like this, John and Mary would have more options to obtain other desirable things, still offering milk and apples.

The mechanism, nowadays evident to us, consists in the use of *money* for trade. In this introductory essay, we define money as something that someone receives in return for providing an item, which can also be used to acquire other different and desirable items. In basic terms, any specific item can be assessed – cheap or expensive – according to its usefulness within a community. An item like this acquires a *value*, in other words, a combination of debt discharging and purchasing power [7]. In addition, such value is associated with either material or immaterial objects and a measurement system. The notion of value evolved historically, producing different kinds [7]:

- *Use value* is the value assigned to something desired, relevant for a community;
- *Payment value* is something that a community ranks as a means of discharging debts of any species (not only monetary ones);
- *An exchange value* is a value that supports receiving a numerical value in a meaningful way.

Applying the exchange value to the current monetary system, one can delineate a debit and credit relation between a *debtor* and a *creditor*. The importance of understanding properties and relations like these resides in their contribution to the functioning of money. It is also important to stress that what supports money is not physical entities like in chemistry or biology. Ultimately, what support money and other social entities are people who have powers and functions assigned by society, both by verbal orders and through documents [6].

3. Documents and Parts of Documents

Money and its value are entities recorded when one writes their economic qualities that are useful for society. When focusing our attention on a record like this – for example, a title of a house and not on the house itself – we are entering the realm of the social ontology where money lives [6].

The record that governs all economic assets in a corporation is the *balance sheet*; a document used to control and pay taxes. As we have already mentioned (Section 1), this document has two main blocks representing the *rights* and *obligations* of a corporation. These main blocks, in turn, are divided into other small blocks; for example, the *assets block* is divided into the following sub-blocks: i) *current assets*, ii) *investments, plant & equipment*; iii) *intangible assets*; iv) *other assets*. In dividing each of these sub-blocks, again and again, one reaches the minor portion of information within a balance sheet: *the account*. For example, the first account of *current assets block* for rights is called *cash and cash equivalents*, the second is called *short-term investments*, and so forth (Figure 1). The same happens with the *liabilities block*, using different accounts for obligations, divided into small parts.

The accounts contained in balance sheets record the value of different rights and obligations held by the corporation. One can think about accounts like "components" of the balance sheet: an account is a component of a balance sheet in the social world in the same way that a hand is part of the human body in the natural world. To adequately address wholes and their parts, one generally takes advantage of the theories of *mereology* [8]. However, to work well, mereology has to be applied to concrete and spatiotemporal objects, which allow the mereological sums found in extensional systems. This is not the case when one is dividing the content of documents like balance sheets.

Another approach to understanding a document and its components is to consider them as kinds of *human artifacts* [9]. There is a multitude of objects considered artifacts: in terms of variety, they range, for example, from a bulb to a fork; in terms of granularity, they are found in many sorts, some small, some seen from space; in terms of complexity, they have distinct levels of complexity, ranging from domestic stoves to spaceships; in terms of time, some are built-in minutes and others, like old cathedrals that took hundreds of years. This variety transforms the project from achieving a general approach to artifacts into an ambitious undertaking, even more so for documents and their components [10].

Efforts to understand documents can be found in Information Artifact Ontology (IAO)² and in Document Acts Ontology (D-Acts)³, the ontologies of the OBO Foundry⁴ specialized in documents. IAO has a class called *document*, a sibling of *document part*, both subclasses of *information content entity*. Examples of *document part* – for example, *abstract*, *sections*, *authors list*, and *result*, to mention a few – reveal that IAO privileges scientific papers as documents. These subclasses for document parts – although relevant for IAO in the scope of Biomedical research – represent only informal parts related to scientific content. There is no way to represent financial accounts and their values, as in the case of the balance sheet.

D-acts ontology reuses IAO maintaining the same document "parts" and providing other classes that can be useful to address a balance sheet and its accounts. We approach the alternatives provided by IAO and D-acts when investigating the place of balance sheets in an ontology (Section 3).

Finally, another option to be used is *Granular Partitions Theory* (GPT) based on partitions, which are defined as cognitive mechanisms employed by people to label, classify, and catalog other people's activities [11]. GPT encompasses several types of partitions, namely, objects that can be recognized as a partition unit. These objects can be *bona-fide*, that is, objects that exist independently of human demarcation activities, for example, the coast of the state of Rio de Janeiro on the Atlantic Ocean. It can also be *fiat-objects*, which exist precisely because of demarcation activities, for example, the border between the state of Rio de Janeiro and the state of Minas Gerais. GPT is a formal theory consolidated in two sub-theories: i) *Theory A* reflects the notion that units of a partition can recognize fiat objects through human cognition; and, *Theory B* explains how fiat-objects are created by projecting partitions onto reality.

According to Theory A, the partitions created by people divide reality into *units and sub-units* (or *cells and sub-cells*). If two units of a partition overlap, then one is a subunit of another. A unit is defined by its position within the partition and by the relationships it maintains with other units. Units can further be nested within one another as constituent subunits. On the other hand, Theory B connects partitions to reality, for example, the relationship between the "partition fruit" and fruit in reality. In other words, Theory B has two directions: it *projects* partitions onto reality and *locates* real objects in the partition. Projection is a successful relationship if the object on which a unit is projected is also located in that unit. For example, the architectural design of a building is first produced by the architect's mind, and then, reality will match the design through the construction of the building.

balance sheet = maxim cell

"assets" is a subcell of the balance sheet

"liabilities" is a subcell of balance sheet

Example Corporation Balance Sheet December 31, 2020																																											
<p>ASSETS</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Current assets</td> <td style="text-align: right;">Text</td> </tr> <tr> <td>Cash and cash equivalents</td> <td style="text-align: right;">\$ 2,200</td> </tr> <tr> <td>Short-term investments</td> <td style="text-align: right;">10,000</td> </tr> <tr> <td>Accounts receivable - net</td> <td style="text-align: right;">39,500</td> </tr> <tr> <td>Other receivables</td> <td style="text-align: right;">1,000</td> </tr> <tr> <td>Inventory</td> <td style="text-align: right;">31,000</td> </tr> <tr> <td>Supplies</td> <td style="text-align: right;">3,800</td> </tr> <tr> <td>Prepaid expenses</td> <td style="text-align: right;">1,500</td> </tr> <tr> <td>Total current assets</td> <td style="text-align: right; border-top: 1px solid black;">89,000</td> </tr> <tr> <td>Investments</td> <td style="text-align: right;">36,000</td> </tr> </table>	Current assets	Text	Cash and cash equivalents	\$ 2,200	Short-term investments	10,000	Accounts receivable - net	39,500	Other receivables	1,000	Inventory	31,000	Supplies	3,800	Prepaid expenses	1,500	Total current assets	89,000	Investments	36,000	<p>LIABILITIES</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Current liabilities</td> <td></td> </tr> <tr> <td>Short-term loans payable</td> <td style="text-align: right;">\$ 5,000</td> </tr> <tr> <td>Current portion of long-term debt</td> <td style="text-align: right;">15,000</td> </tr> <tr> <td>Accounts payable</td> <td style="text-align: right;">20,900</td> </tr> <tr> <td>Accrued compensation and benefits</td> <td style="text-align: right;">8,500</td> </tr> <tr> <td>Income taxes payable</td> <td style="text-align: right;">6,100</td> </tr> <tr> <td>Other accrued liabilities</td> <td style="text-align: right;">4,000</td> </tr> <tr> <td>Deferred revenues</td> <td style="text-align: right;">1,500</td> </tr> <tr> <td>Total current liabilities</td> <td style="text-align: right; border-top: 1px solid black;">61,000</td> </tr> <tr> <td>Long-term liabilities</td> <td></td> </tr> <tr> <td>Notes payable</td> <td style="text-align: right;">20,000</td> </tr> </table>	Current liabilities		Short-term loans payable	\$ 5,000	Current portion of long-term debt	15,000	Accounts payable	20,900	Accrued compensation and benefits	8,500	Income taxes payable	6,100	Other accrued liabilities	4,000	Deferred revenues	1,500	Total current liabilities	61,000	Long-term liabilities		Notes payable	20,000
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Figure 2: Blocks of a balance sheet seen as cells and subcells

Thus, relationships of *projection* and *localization* and GTP as a theory are helpful resources for the present essay. They are applied here to explain the relationships between accounts within a balance sheet and between accounts and reality. Using Theory A, we consider the balance sheet as the maximum

² Available on the internet on: <<http://purl.obolibrary.org/obo/iao.owl>>. Access: June 07, 2021.

³ Available on the internet on: <<http://purl.obolibrary.org/obo/iao/d-acts.owl>>. Access: June 07, 2021.

⁴ Available on the internet on: <<http://www.obofoundry.org/>>. Access: June 07, 2021.

unit, having "assets" and "liabilities" as sub-units (Figure 2). Besides, the sub-units just mentioned having by themselves balance sheet accounts as sub-units. For example, on the left side (Figure 3), the accounts named *cash and cash equivalent* and *short term investments* are sub-units of *assets*, in addition to be minimum units as well. On the right side (Figure 2), *short-term loans payable* and the *current portion of long-term debt* are sub-units of *liabilities*. There are examples of minimum units.

Theory A provides a connection among accounts and blocks and accounts, which matters for future papers. Theory B is relevant for this essay since it can connect entities in the world to accounts in a balance sheet. Nevertheless, using theory B, one can say that any account – *short-term investments* and *inventory* – is a minimum unit. Items like this *project onto* the entity we called *exchange value* (see Section 2). While the *short-term investments* account projects partitions onto cash values, the *inventory* account projects partition onto the value of material assets in the real world, for example, machines and industrial plants. On the other hand, these very same values of cash and inventory are *located in* accounts, which are themselves partitions.

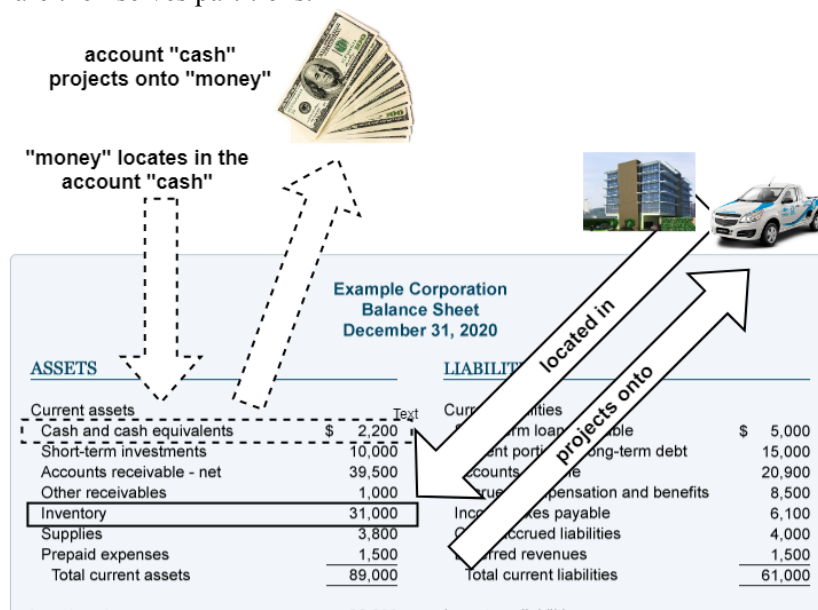


Figure 3: accounts of a balance sheet projected onto reality and located in the document

4. The Place of Balance Sheet in Ontologies

To find room for balance sheets within the BFO framework, we examine two ontologies mentioned above specialized in documents. We also employ another mechanism, the *illocutionary logic*, a theory that analyses English verbs and their effects within the scope of the speech acts theory [12]. Among the *illocutionary verbs* – namely, *assertives*, *comissives*, *expressives*, *declaratives*, and *directives* – we are interested in directives. We do not intend to mix linguistic and ontological resources in thinking about verbs as candidates to relationships. The inspiration comes from the translation between speech acts and document acts carried out by Smith [6].

As we have already mentioned, D-acts reuse IAO's kinds of documents. Thus, in both ontologies, one can find only one class able to subsume a balance sheet, namely, the IAO's *directive information entity* (DIE). A DIE is defined as "*an information content entity whose concretizations indicate to their bearer how to realize them in a process.*"⁵ The definition for directives in Searle's view is not so different from the IAO's DIE, namely: "*the primitive for the directive is 'direct,' a verb that means an attempt to get the hearer to do something as specified, with the alternative of refusal*" [11].

Looking for a place for a balance sheet in IAO, we examined the definitions under IAO's DIE⁶: *Action specification*, *Conditional specification*, *Objective specification*, *Plan specification*. The verb used in IAO's definition of DIE is "to indicate": "*An information content entity whose concretizations indicate to their bearer how to realize them in a process*" (IAO, 2021). This is not one of the

⁵ Available on the internet on: <<http://purl.obolibrary.org/obo/iao.owl>>. Access: June 07, 2021.

⁶ Available on the internet on: <<http://purl.obolibrary.org/obo/iao.owl>>. Access: June 07, 2021.

illocutionary verbs listed by Searle's account, which are ordered according to what is called *point*⁷, in *direct, request, ask, urge, tell, require, demand, command, order, forbid, prohibit, enjoin, permit, suggest, insist, warn, advise, recommend, beg, supplicate, entreat, beseech, implore, pray* [12].

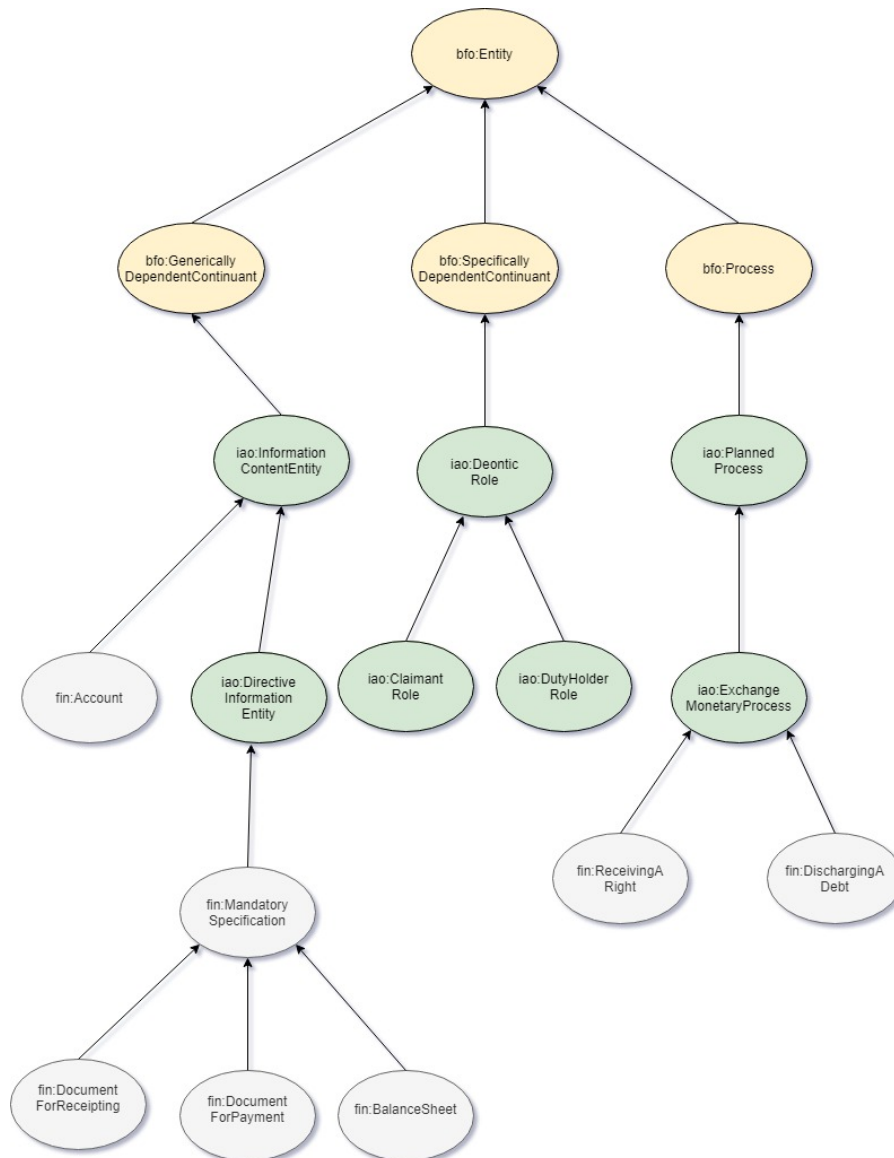


Figure 4: A visual scheme of the ontology

Informally comparing, the verb "indicate" in the IAO's definition might correspond to the verbs "advise" or "recommend" in Searle's list. We believe that IAO's subclasses of a DIE lack the deontic aspect required if one considers a balance sheet as a mandatory document capable of generating obligations in the form of taxes. Thus, D-acts ontology is required here since it contains a family of "roles" under the deontic role class, which might fulfill the need for rights and obligations.

The impossibility of some distinctions between deontic concepts to clarify philosophical concepts is well-known [13]. The distinctions provided are made in a non-classic logic, which is not suitable for modern ontologies. Nevertheless, the theoretical insights obtained help define the relations between money, value, and financial documents that we have been conducting for practical purposes.

So, we created another class under IAO's DIE – we called *mandatory specification* – to accommodate the balance sheet and other standard financial documents that one might need to represent. In general lines, the taxonomy can be as bellow.

⁷ Point means what the speaker intends to do when he performs an act, see Searle and Vanderveken [12].

1. **iao:information content entity** *is-a* **bfo:generically dependent continuant**
2. **iao:directive information entity** *is-a* **iao:information content entity**
3. **fin:mandatory specification** *is-a* **iao:directive information entity**
4. **fin:balance sheet** *is-a* **fin: mandatory specification**

A draft of the schema proposed is presented in Figure 4. More details are provided in the next section on the axiomatization (Section 5). From here, we adopt as a notation that classes are written in bold, properties in italics, and both follow the W3C's camel-case style.

5. Axiomatizing the Accounts of a Balance Sheet

So far, we have provided an informal account of a representation for financial documents and their parts. In this section, we formulate the first axiomatization of such representations using OWL constructs in a notation based on Manchester Syntax plus natural language definitions. At this point, we combine the notions presented for *money*, *value*, and *exchange value*, and others (Section 2) to reach the formal account. For the sake of clarity, we rename the *exchange value* used before (Section 3 and 4) for *exchange monetary value*. To identify the origin of the reused entities, we use the correspondent namespaces and the fictitious "fin:" to entities created here. Finally, the majority of relations used comes from Relations Ontology (RO)⁸.

Class – **fin:Account**

Superclass	iao:InformationContentEntity
Definition	An account is an information content entity that denotes an exchange monetary process and projects onto some entity in the real world.
Equivalent class	iao:InformationContentEntity <i>fin:projectsOnto</i> some bfo:Entity and <i>iao:denotes</i> some (fin:ExchangingMonetaryProcess)
Example of use	The <i>short-term loans payable</i> account (of a balance sheet) denotes a monetary exchange process of discharging debts that refer to some asset; the <i>short-term investments</i> account (of a balance sheet) denotes a monetary exchange process of receiving rights that refer to some asset
Observation	The "denotes" relationship is a sub-property of "is about" (in IAO), which has an information content entity as domain and no range.

Class – **fin:ExchangeMonetaryProcess**

Superclass	iao:PlannedProcess
Definition	A monetary exchange process is the planned process that realizes the role of the debtor or creditor.
Equivalent class	iao:PlannedProcess and <i>bfo:realizes</i> some (iao:ClaimantRole or iao:DutyHolderRole)
Example of use	GM sold cars to US public administration in a process where the corporation is the creditor, and the public administration is the debtor.

Class – **fin:ReceivingARight**

Superclass	fin:ExchangeMonetaryProcess
Definition	Receiving a right is a monetary exchange process that realizes the role of the creditor.
Equivalent class	fin:ExchangeMonetaryProcess and <i>bfo:realizes</i> some iao:ClaimantRole
Example of use	GM is receiving rights from the US administration in a monetary exchange process of selling cars as expected.

⁸ Available on the internet on: < <http://www.obofoundry.org/ontology/ro.html>>. Access: June 07, 2021.

Class – **fin:DischargingADebt**

Superclass	fin: monetary exchange process
Definition	Discharging debt is a monetary exchange process that realizes the role of the debtor.
Equivalent class	fin:ExchangeMonetaryProcess and <i>bfo:realizes</i> some iao:DutyHolderRole
Example of use	Netflix is paying debts regarding federal taxes to the US administration in the process specified by Federal Revenue Service.

Class – **iao:ClaimantRole**

Superclass	iao:DeonticRole
Definition	A deontic role that inheres in an agent A, that mutually depends on the existence of a duty holder role borne by agent B, and that specifies B is doing or abstaining from C or providing or surrendering C to A.
Equivalent class	fin:MandatorySpecification and <i>bfo:concretizes</i> some (fin:DocumentForPayment)
Example of use	Claimant roles can be discharged by one act of fulfilling a duty (e.g., when I pay back \$5 owed to a friend), or they can remain intact and require ongoing adhering to a duty.
Observations	The fields "Definition" and "Example of use" came from IAO ⁹ .

Class – **iao:DutyHolderRole**

Superclass	iao:DeonticRole
Definition	A deontic role that inheres in an agent A, that mutually depends on the existence of a claimant role borne by agent B, and that specifies A doing or abstaining from some action C, or providing or surrendering C to B.
Equivalent class	fin:MandatorySpecification and <i>bfo:concretizes</i> some (fin:DocumentForReceipting)
Example of use	-
Observations	The fields "Definition" and "Example of use" came from IAO ¹⁰ .

Class – **fin:DocumentForPayment**

Superclass	fin:MandatorySpecification
Definition	Document for payment is a mandatory specification that has a currency, a value, and involves a duty holder role.
Equivalent class	fin:MandatorySpecification and <i>fin:hasCurrency</i> some iao:Symbol and <i>fin:hasExchangeValue</i> exactly "x" <i>xsd:decimal</i>
Example of use	GM has an invoice to receive values referred to cars sold to Google.

Class – **fin:DocumentForReceipting**

Superclass	fin:MandatorySpecification
Definition	Document for payment is a mandatory specification with a currency, a value and involves claimant role.
Equivalent class	fin:MandatorySpecification and <i>fin:hasCurrency</i> some iao:Symbol and <i>fin:hasExchangeValue</i> exactly "x" <i>xsd:decimal</i>
Example of use	Google has an invoice to pay values referred to cars bought from GM.

⁹ Available on the internet on: <http://purl.obolibrary.org/obo/IAO_0021013>. Access July 7 2021

¹⁰ Available on the internet on: <http://purl.obolibrary.org/obo/IAO_0021016>. Access July 7 2021

Observations	The "document for payment" and "document for receipting" are equivalent classes. We could call it "invoice": on the claimant's side, it works as a way of receiving and on the side of the duty holder as a way of paying.
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Class – **fin:MandatorySpecification**

Superclass	iao:DirectiveInformationEntity
Definition	A mandatory specification is a directive information entity that specifies what must happen when a monetary exchange process occurs.
Equivalent class	iao:DirectiveInformationEntity and <i>denotes</i> some fin:ExchangeMonetaryProcess
Example of use	John has an invoice in his hands specifying what he must pay because of the exchange monetary processes hold with eBay.

Class – **fin:BalanceSheet**

Superclass	fin:MandatorySpecification
Definition	A balance sheet is a mandatory specification that has accounts and records the exchange processes that occurred in a corporation.
Equivalent class	fin:MandatorySpecification and <i>fin:hasComponent</i> fin:Accounts and <i>fin:records</i> some fin:ExchangeMonetaryProcess and <i>obi:isSpecifiedInputOf</i> iao:DeonticDocumentAct
Example of use	The balance sheet of Ford Motor Company specifies that the corporation must pay some value to shareholders.
Observations	The deontic document act of which the balance sheet is the input can be an exchange process regarding a tax, a tribute, or a fee.

Datatype property – *fin:hasCurrency*

Super property	<i>iao:hasMeasurementValue</i>
Equivalent	-
Domain	fin:DocumentForPayment and fin:DocumentForReceipting
Range	<i>xsd:string</i>
Characteristics	-
Example of use	A "document for payment" or a "document for receipting" has a currency, for example, dollar, Deutsche mark, or franc.
Observations	There is no unit for monetary values in Units of Measurement Ontology (UO), the ontology responsible by units in the OBO scope.

Datatype property – *fin:hasExchangeValue*

Super property	<i>iao:hasMeasurementValue</i>
Equivalent	-
Domain	fin:DocumentForPayment and fin:DocumentForReceipting
Range	<i>xsd:decimal</i>
Characteristics	-
Example of use	An asset of the corporation has an exchange value of 10,000 dollars; a receipt has an exchange value of 1,000 dollars regarding a health service.

Object property – *ro:hasComponent*

Super property	<i>owl:topObjectProperty</i>
Equivalent	-
Domain	fin:BalanceSheet
Range	fin:Account
Characteristics	-

Example of use	A balance sheet has the "land account" and "equipment account" (Figure 1) as components.
Observations	We use this relationship from Relations Ontology (RO) since it has no range or domain. However, the natural language definition leads to believe that it is not suitable for the situation here: it is not possible to "disassemble" a balance sheet in accounts in the real world. See the original in RO ¹¹

Object property – *fin:projectsOnto*

Super property	<i>owl:topObjectProperty</i>
Equivalent	-
Domain	fin:Account
Range	bfo:Entity
Characteristics	inverse of <i>isProjectionOf</i>
Example of use	In an earthmoving company XYZ, the "equipment account" (Figure 1) projects onto a Caterpillar tractor in the real world.

Object property – *fin:isProjectionOf*

Super property	<i>owl:topObjectProperty</i>
Equivalent	-
Domain	bfo:Entity
Range	fin:Account
Characteristics	inverse of <i>fin:projectsOnto</i>
Example of use	In any company, the cash and cash equivalents kept in the vault are projected onto the "cash account" (Figure 1).
Observations	In GPT, the relations are "projection onto" and "located in," but we do not use the second term because it exists in RO with another sense.

6. Final remarks

In this article, we provided a preliminary effort to the financial documents for corporative domains. Indeed, this approach is not exactly a novelty since works exist on the theme – see, for example, an extensive reference by Sartor [14] or a reference using another ontological framework by Griffo, Almeida, and Guizzardi [15]. Within the BFO framework, the only approach that involves corporations is the Common Core Ontologies¹², which seems to be an ongoing endeavor.

We believe that more research is justified in the scope of financial documents and both documents and their components. This conviction relies on the fact that the investigated entities are pervasive, and parts of document alone, as accounts of a balance sheet, can represent material and social entities. It is worth mentioning that several different financial statements adopted by accounting can be used in the scheme proposed here.

As we mentioned, the approach is preliminary, and much still needs to be done. For example, one might say that the requirement to be considered money presented before is necessary but not sufficient. Indeed, several things that are not money could fit the description proposed, such as diamonds, gold, and cryptocurrencies. For the sake of conclusion, we list limitations observed in writing the paper, which is not well-defined yet, left to be dealt with in future works:

- In the scope of GPT, what are the relations between cell and sub-cell in a balance sheet?
- Some relationships employed here are not part of RO (the reference for relationships in BFO), for example, those used to represent GPT and those with the namespace "fin:";
- Deontic distinctions proposed by [12] can not be captured in OWL but can point directions;
- The "*denotes*" was used to say that financial documents represent a financial entity, but we could take advantage of more investigation;

¹¹ Available on the internet on: <http://purl.obolibrary.org/obo/IAO_0000033>. Access July 7 2021

¹² Available on the internet on: <<http://www.ontologyrepository.com/>>. Access: June 07, 2021.

- We believe that the *hasComponent* relationship should have a broader range and domain, but we limited it to our purposes here;
- We should add an instantiation of the ontology to explain modeling decisions better;
- Improvements in the literature review are required since there are many good references to be investigated, for example, theoretical [16] [17] or adopting other top-level ontologies [15] [18].

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