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# **REPRESENTATION AND ANALYSIS OF A CORPUS OF LEIBNIZ-CLARKE LETTERS**

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**Abstract.** The paper presents an XML annotation structure for corpora of letters, and a series of processings for complex visualizations, obtained with XSLT transformations and with the RederBench environment. The underlying idea is the usage of the polyphonic model of discourse, which is very well suited for capturing the weaving of threads of discussions involving debates. As a case study was taken the correspondence between Leibniz and Clarke.

**Keywords:** annotated corpora, natural language processing, polyhponic model, discourse analysis, Republic of letters

#### 1. Introduction

In Europe of the 16-18 centuries, many philosophical and scientific debates have taken place by exchanging letters in what was called the "Republic of letters" ("Respublica literaria").

In recent years, the interest in analyzing these debates has increased. For example, at least two major projects have this subject, at Stanford University in the US (http://republicofletters.stanford.edu/) and in a COST action in the EU (http: www.republicofletters.net/).

A powerful tool for the investigations on the Republic of letters is information technology and, particularly, Natural Language Processing (NLP). In this direction, this paper presents a framework for the analysis of the correspondence-debate of ideas, and its implementation using NLP, based on the polyphonic model [1], inspired from Mikhail Bakhtin's ideas [2].

As a case study, the correspondence between Leibniz and Clarke [3] is used. These debates of ideas are very important and interesting because they implicitly involve Isaac Newton, whose disciple is Clarke, the discussions therefore being directly related to Newton's ideas.

Consequently, the correspondence reflects the confrontation of the ideas of two titans of science and philosophy, including topics such as God, space, time, soul, miracles, nature, etc. [3].

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Fig. 1. A volume containing the exchanged letters between Leibniz and Clarke [4].

## 2. The corpus

The corpus of correspondence contains eight letters, four authored by Leibniz, who starts the correspondence, and four written by Clarke. After the first letter, each of them has direct references to the previous one. Even if he did not authored any of the letters, Isaac Newton is a participant at the debate implicitly, through the ideas attributed to him and advocated by Clarke.

The corpus has been annotated in two phases. The text of the corpus was firstly semi-manually annotated according to the Document Type Definition (DTD) used for conversations [5], which included only annotations for turns (in our case, letters) and utterances (according to the paragraphs of the text). The references made in text were coded as the explicit references in the case of chats.

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As source for the text was considered the version at 
http://www.earlymoderntexts.com/assets/pdfs/leibniz1715_1.pdf, last accessed at 22 October 2017.
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In a second phase, new annotations were introduced in order to code the main subjects of the discussion and the indirect utterances ("iutt"), that means utterances that are emitted by a person, but attributed to another. This latter element has an attribute for polarity (positive or negative).

An example of using these new elements of annotation is the following, where Leibniz writes what Newton said:

<Turn nickname="Leibniz" nr="1">Leibniz's first paper (November 1715)

<Utterance genid="1" ref="-1"> 1 Natural religion seems to be greatly on the decline -in England-, where many people hold that human <subject>soul</subject>s are made of <subject>matter</subject>, and others contend that <subject>God</subject> himself is a corporeal being, -i.e. a body-. </Utterance>

<Utterance genid="3" ref="-1">3 <iutt pol="positive">Newton says that <subject>space</subject> is an organ-like a sense-organ- by which <subject>God</subject> senses things. <c w="disj">But</c> if <subject>God</subject> needs an organ to sense things by, it follows that they don't depend entirely on him and weren't produced by him.</iutt>

▼ <dialog team="1"></dialog>
▼ <participants></participants>
<person nickname="Leibniz"></person>
<person nickname="Clarke"></person>
Leibniz-Clarke papers G. W. Leibniz and Samuel Clarke Clarke 1: (26.xi.1715)
▼ <body></body>
▼ <turn nickname="Leibniz" nr="1"></turn>
Leibniz's first paper (November 1715)
▼ <utterance genid="1" ref="-1"></utterance>
1 Natural religion seems to be greatly on the decline -in England-, where many people hold that human <subject>soul</subject>
s are made of
<subject>matter</subject>
, and others contend that
<subject>God</subject>
himself is a corporeal being, -i.e. a body
▼ <utterance genid="2" ref="-1"></utterance>
2 Locke and his followers aren't sure whether the
<subject>soul</subject>
is material and naturally perishable.
▼ <utterance genid="3" ref="-1"></utterance>
3
▼ <iutt pol="pos"></iutt>
Newton says that
<subject>space</subject>
is an organ-like a sense-organ- by which
<subject>God</subject>
senses things.
<c w="disj">But</c>
if
<subject>God</subject>
needs an organ to sense things by, it follows that they don't depend entirely on him and weren't produced by him.
▼ </td
Clarke translates Leibniz as speaking of how <subject>God</subject> 'perceives' things; <c w="disj">but</c>
>
▼ <utterance genid="4" ref="-1"></utterance>
4 Newton and his followers also have a very odd opinion regarding
<subject>God</subject>
's workmanship. According to them,
<subject>God</subject>
's watch -the universe- would stop working if he didn't re-wind it from
<subject>time</subject>
to

Fig. 2. An example of annotation.

The full DTD used in annotation is:

<!ELEMENT Dialog ( #PCDATA | Participants | Turn )\* > <!ATTLIST Dialog team NMTOKEN #REQUIRED > <!ELEMENT Participants ( Person+ ) > <!ELEMENT Person EMPTY > <!ATTLIST Person nickname NMTOKEN #REQUIRED > <!ELEMENT Turn ( #PCDATA | Utterance )\* > <!ATTLIST Turn author NMTOKEN #IMPLIED > <!ATTLIST Turn nickname NMTOKEN #IMPLIED > <!ATTLIST Turn nickname NMTOKEN #IMPLIED > <!ATTLIST Turn nr NMTOKEN #REQUIRED > <!ELEMENT Utterance ( #PCDATA | c | iutt | page | ref | subject )\* > <!ATTLIST Utterance genid NMTOKEN #REQUIRED >

<!ATTLIST Utterance ref NMTOKEN #REQUIRED >

```
<!ELEMENT c ( #PCDATA ) >
<!ATTLIST c w NMTOKEN #FIXED "disj" >
<!ELEMENT iutt ( #PCDATA | c | ref | subject )* >
<!ATTLIST iutt pol ( neg | pos ) #REQUIRED >
<!ELEMENT subject ( #PCDATA ) >
<!ATTLIST subject attr CDATA #IMPLIED >
```

An example of the full annotation is presented in the Figure 2.

## 3. Analysis of the corpus

## 3.1 The polyphonic model

The correspondence between members of the Republic of letters includes debates on complex subjects related to philosophy, science, and religion as in the case of the letters exchanged by Leibniz and Clarke. Moreover, discussions usually include many times ideas of other people (for example, Newton in the previously mentioned case) or influential mentalities. Therefore, a deep analysis of the discourse is needed and, as, in our opinion, classical discourse analysis in NLP is not offering suitable tools; we considered that the advanced polyphonic model of discourse [1, 6, 7] is needed.

The polyphonic model is based on the theories of the Russian philosopher Mikhail Bakhtin [2]. He considers that dialog is omnipresent in our lives, that multiple voices are present in any text, even in a word, that the ventriloquism phenomenon occurs (one person speaks with the voice of another), and that sometimes voices weave in a polyphonic way. In our extension of the ideas of Bakhtin,

"we consider a voice in a general sense, not reduced to the physical, acoustical dimension. We rather consider it as a distinct, differential position with persistence and interference with other voices. We consider that, for example, an utterance, that means a word, especially if it is repeated ..., an idea, a reply, a book or even a non-verbal act ... may become a distinct voice through its echoes and influences in the subsequent utterances. Of course that we consider as voices also the participants to a conversation or even groups of persons (for example, minorities), because they represent distinct positions, with persistence and that interfere with other voices, be the other persons, groups or voices in a general sense (for example, ideas or replies that influences them)." [1].

Therefore, in addition to the obvious voices of the participants (explicit or implicit, for example, Newton in our case), we identify voices also starting from the topics discussed in the correspondence. For this purpose and for analyzing the inter-animation of voices, we use and XSLT transformations (https://www.w3.org/Style/XSL/) and the NLP tools developed under the ReaderBench platform [8] of the corpus represented in XML.

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An example of using XSLT transformations for the visualization of the distribution of the main concepts in the correspondence of Leibniz and Clarke is shown below.

===Leibniz Letter nr. 1 1 - -1 - soul, matter, God, 2 - -1 - soul, 3 - -1 - space, God, God, 4 - -1 - God, God, time, time, time, ... God, God, , God, ===Clarke Letter nr. 1 5 - 1 - mathematical, , God, mathematical, matter, 6 - 2 - soul, mathematical, 7 - 3 - space, God, God, God, space, God, God, God, God, space, , 8 - 4 - , God, , God, God, , God, , God, God, ===Leibniz Letter nr. 2 9 - 5 - mathematical, mathematical, mathematicians, , mathematics, time, mathematical, mathematics, mathematics, God, , , 10 - 5 - matter, space, matter, matter, space, matter, matter, God, space, 11 - 7 - **space**, **God**, 12 - 7 - soul, space, soul, soul, soul, 13 - 7 - God, soul, 14 - 8 - God, , , God, God, God, God, , , God, , God, 15 - 8 - God, God, 16 - 8 - God, God, , God, 17 - 8 - , God, God, , God, 18 - 8 - **God**, soul, 19 - 8 - **God**, 20 - 8 - , , time, time, God, , soul, ===Clarke Letter nr. 2 21 - 9 - mathematical, , matter, mathematical, mathematical, mathematical. ... God. God. 22 - 10 - matter, mathematics, matter, , matter, matter, God, matter, matter, God, 23 - 11 - **space**, **God**, **space**, 24 - 12 - soul, soul, , soul, , , space, space, 25 - 13 - God, soul, God, 26 - 14 -27 - 14 - God, God, , , God, , 28 - 16 - God, time, God, God, , God, 29 - 17 - , , **God**, , **God**, 30 - 18 - God, 31 - 19 - God, God, ,

32 - 20 - God, God, God, God, God, soul, soul, God, soul, God, God, soul, God, God, God,

===Leibniz Letter nr. 3 33 - 21 - mathematical, mathematics, 34 - 21 - space, 35 - 21 - space, space, space, God, space, God,, 36 - 21 - time, space, time, space, , space, , 37 - 21 - , space, space, , space, space, , space, God, , , space, space, God, 38 - 21 - time, God, , time, time, time, time, time, time, 39 - 21 - God, space, God, God, 40 - 21 - God, God, God, 41 - 22 - matter, God, space, matter, God, matter, space, matter, matter, space, God. 42 - 23 -43 - 24 - soul, 44 - 25 - God, soul, soul, soul, 45 - 27 - , God, , God, 46 - 28 - God, God, 47 - 30 - God, God, 48 - 31 - God, God, God, 49 - 32 - God, God, , , ===Clarke Letter nr. 3 50 - 33 - mathematical, mathematical, 51 - 34 - , God, matter, space, space, space, space, space, , space, space, space, 52 - 35 - , space, God, space, God, , space, , time, space, space, space, time, , time, 53 - 36 - space, God, , God, , space, time, 54 - 37 -55 - 38 - , , **God**, 56 - 39 -57 - 40 - . God. God. 58 - 41 - matter, , matter, , God, 59 - 42 -60 - 43 - soul, soul, soul, 61 - 44 - God, soul, God, God, 62 - 45 -63 - 46 - , , , 64 - 47 - God, 65 - 48 - God, God, God, God, space, 66 - 49 - **God**, **God**, , ,

===Leibniz Letter nr. 4 67 - 51 -68 - 51 - God, 69 - 51 - God, God, 70 - 51 - matter, space, 71 - 51 -72 - 51 -73 - 51 - space, , space, space, 74 - 52 - , space, space, space, 75 - 52 - space, space, space, space, 76 - 52 - space, God, God, 77 - 52 - space, space, space, space, 78 - 52 - space, 79 - 53 - God, God, 80 - 53 - **space**, 81 - 53 - God, , time, time, 82 - 55 - space, time, space, time, 83 - 55 -84 - 57 - space, God, God, 85 - 57 - God, 86 - 57 - God, 87 - 58 - matter, 88 - 58 - matter, matter, matter, 89 - 58 - matter, God, matter, matter, 90 - 59 -91 - 59 -91 - 59 -92 - 59 - God, God, , 93 - 59 -94 - 61 - , , God, God, space, space, God, soul, , soul, 95 - 61 - God, soul, , , God, 96 - 61 - soul, soul, God, 97 - 61 - soul, , God, , God, soul, soul, God. 98 - 61 - God, , , soul, 99 - 61 - soul, God, God, , 100 - 61 - soul, soul, soul, God, 101 - 61 - soul, 102 - 61 - soul, 103 - 63 - , , , 104 - 63 - , 105 - 63 - , **God**, , , , 106 - 65 - , space, time, time, time, space, time, God, 107 - 66 -108 - 66 - . 109 - 66 - God, 110 - 66 - ,

111 - 66 - , , time, , God, space, , God, space, time, God, God, space, God, matter, matter, space, space, space, matter, space, space, matter, space, matter, matter, space, space, space, space, matter, , space, ===Clarke Letter nr. 4 112 - 67 - time, time, , God, 113 - 69 - God, matter, matter, matter, God, God, matter, 114 - 71 - time, space, time, time, God, , God, matter, , God, matter, matter, 115 - 73 - space, space, matter, space, matter, matter, time, matter, matter, 116 - 74 - space, matter, , , space, 117 - 75 - space, space, space, space, space, God, matter, 118 - 76 - , , God, space, God, 119 - 77 - space, space, space, God, space, , space, space, , matter, 120 - 79 - God, , space, mathematical, 121 - 80 - space, space, time, 122 - 81 - God, matter, space, space, God, God, matter, God, time, 123 - 82 - , time, 124 - 84 - , God, God, God, matter, God, 125 - 85 - God, matter, , 126 - 86 -127 - 87 - , matter, matter, God, 128 - 88 - God, , 129 - 90 -130 - 94 - , God, soul, God, soul, , soul, 131 - 95 - soul, God, 132 - 96 - soul, soul, 133 - 97 - soul, matter, God, soul, 134 - 98 - , , , **God**, , , 135 - 99 - God, soul, 136 - 101 -137 - 102 - soul, 138 - 103 - , mathematical, 139 - 104 - , , **matter**, 140 - 105 - God, , 141 - 106 - space, time, time, space, God, 142 - 107 -143 - 108 -144 - 109 -145 - 110 -146 - 111 - , , mathematical, matter, matter, matter, matter, matter, matter, matter,

#### **3.2 Processing with ReaderBench**

A first set of processings of the Leibniz-Clarke correspondence corpus were done using the ReaderBench platform, a multipurpose framework, which uses NLP for performing tasks ranging from concept extraction, computing semantic distances between concepts and documents, identification of voices (in the extended sense of the polyphonic model presented in the previous section) and their interinfluence (personal and social knowledge building, inter-animation, etc.). The set of the most frequent concepts were identified and displayed (Figure 3, and a detail of it in Figure 4) and as a network (Figure 5). A classical NLP approach was used: counting the resulted stems after stop-words elimination and stemming. Part of speech tagging was also performed for the separation between nouns and verbs.

	lerBench - Chat Visualization		- 0	Х
liscuss	ion Topic: z.xml			
Content	8			Topic
0	Lebniz 1 Natural religion seems to be greatly on the decline-in England-, where many people hold that human souls are made of matter, and others contend that God himsefils a corporeal being. Le a body: [21:547]	Category:	Entire discussio	
1	Leboiz 21 cocle and his followers aren's use whether the soul is material and naturally perishable. [5 141]	• •	Entre discussio	
2	Lebbriz: 3) lewton says that space is an organ-like a sense-organ- by which God senses timings. Bull God needs an organ is sense timings by, it follows that they don't depend entirely on him and werent produced by him. [25,727]	Filter only:		
3	Lebbic: 4 Newton and liss followers also have a very odd opinion regarding God's workmanship. According to them, God's work-the universe, would stop working if he ddn't ne wind if from time to time! He ddn't have encough foresight to give it perpetual motion. This machine that he has made is so imperfect that from time to time! He ddn't have encough foresight to give it perpetual motion. This machine that he has made is so imperfect that from time to time! He ddn't have encough foresight to give it perpetual motion. This machine and may view, the workt always contains the same amount of. Force and energy, which changes only by passing from one material timig to another in accordance with the laws of nature and the beautiful order: that God has: pre-established. And Thod that when God works	Verbs	0 25 50	
	miracles, he does it not to meet the needs of nature but to meet the needs of grace. Anyone who thinks differently must have a very mean notion of the wisdom and power of God. [75:374]	Topics thing	Relevanc	3.461
4	Carlet Carlos repetie Expland (and in their counties) registratianal and point or get 1 all wrough that is were too, and much to be interested But. This is larged due to the blace philosophy of the materialistica philosophy of the	reason Way		3.319 3.166
5	Curke 21.cole dd write some things implying that we want sure whether the -turnar- soul was immaterial or not, but the only people who have followed him in this are some materialists, who are enemies to the materializal principles of philosophy, and who accept the or nothing in the local energy of the loc	part matt fime		3.104 2.984 2.749
6	An inclusion in the second sec	place world order sense nature fact idea		2.489 2.289 2.282 2.252 2.252 2.245 2.077
7	Clarker 4 Among humans, the maker of a machine is rightly regarded as skill on ip proportion to how long a machine that he has made will work properly without any further inhering by him. Why? It's because he exercises his skill on ip in constructing, adjusting, or putting together certain moving parts such as weights and sprongs-shakeness source of motion is a set of forces that are entring independent of him; he arranges them in various ways, but he didn't market hem. But hum for part to Go, the case is significant detected is such as assessmilling things into structures, he is himself the withor and continual preserver of their basic forces or powers of motion. So the lack chart horing happens without himself hum contained and working it is a "togethy or join is workinamable and in detected form. The lease that the work is a particular head together without heme motion (busk) calle accidence and particular head together (G). But is a set of the source that are entring have that the activity is a source of the source of the source (G) and the source of the source (G) and the source of the source (G) and the sour	idea point god work word		2.05 2.005 2.005 1.934 1.788
8	Lebuiz To Clarie's 111 agree that the principies of the materialists contribute greatly to the spread of impiel; Buil see no reason to add that the mathematical principies of philosophy are-opposale to hose of the materialists. Really they are-the same, with just this difference. The materialists who follow Democritus; Epicous and Hobbes contine themselies allogather to mathematical principies (24.177)	question power principle		1.783 1.78 1.763
9	Lebble 2 Clarke goes on to sig that according to Newton's physics mater is the most inconsiderable part of the universe 2 That is because Newton admits empty space as well as mater, and holds that mater files up only a very small part of space. But Demonstrase and Epicours matatameter be same thing except that the most inconsiderable part of the universe 2 That is because Newton as predevate to its, because Newton and power. And that is gather of exerting most that have thoring the most inconsiderable part of space as up and in the same time and the transmit most or holds that mater the same time and the transmit most or holds that in the same time and the same time and the transmit most or holds that in the same time and that is and the same time and the sa	difference mind space		1.745 1.697 1.656
10	Leibniz: 3 In the Appendix to his Optics I find Newton saying explicitly that space is the sensorium of God, and "sensorium' has always signified the organ of sensation. If he and his friends now see fit to mean something different by it, I shan 1 object. (20 1075)	situation body		1.655
11	Lebmiz + Clarke supposes that the -mere-presence of the soul is sufficient to make It aware of what happens in the brain. [15:23]	oody		1.63/
12	Lebbits 7 The reason why Gold is aware of everything is not just hits-presence bud also hits-activity he presence things by an action that continually produces whatever is good and perfect in them, and of course he is aware of what he is doing. But the correspondence between soul and body cart he-even pady-explained by her being presents bad on the Leasaure neither of them has any immediate influence over the other. To Clark's 4 (2) 4 20)			
13	Lebric & When we commend a machine, that is primarily because of what 1 does, not because of what this reflects in the designer of the machine is this skill, not his -power. So the reason Clarke gives for praising Gof % Achaely, he says that 'mathematical principies' have that consequence, but 's really leavon's system that he is tabling about. Mithematical principies, syncept 's -callek, have noting to say about the make's retirely, without thinging an any materials from outside shart pool enough. How does Gos surpass every other machine maker? Well, Carlar's part of the surpcire of a principies, syncept 's -callek, have noting to say about the principies, syncept 's -callek, have noting to say about the principies, syncept 's -callek, have noting to say about the principies, and the substant fragment and the start's have the designer of the machine start's power. But God's accellence also has another source, namely its wishon, which shares in its machine's lasting paper. But God's accellence also has another sasemble the not have have and have need the neutrop esciptific theore. The workman had a God give ability coreate the mather that the wheels are made of, what you as the buyer of the watch will want to how is whether he had a Gifferent God -give ability, namely the print dissembling the parts that make a witch that property filling have noticing the reasons to be pleased with God's work will want a better reason than the one that Clarle has produced. His supposed reason is a called part of the start's distance also have store that the store has buy have the regularity that is to kell (port, ]146 5091			
14	Lebbitz 7 Gods skill has to be infinitely superior to hal of a human-workman. The mee facts about what he produces do show Gods power, but dont adequalely convey his wisdom. Those who think otherwise-achnowledging the power but not propely admitting the wisdom of the source of things-will fail no exactly the same error as the materialists and Spinza, though they to leep them at ama? length. (29 4/7)			
15	Lebbitz 81'm not saging that the material world is a machine (a walch, sag) that runs without God's intervening, and I have predi storogly insisted that the things he has created need his continual influence. Bud do say that the material world is a walch that runs without needing to be mended by God otherwise we would have the say that God charges his mind-I hade. God has present and for a ophing that might go wrong the has provided a remedy in advance. There is in his works a harmony, a pre-stabilished beauth, [50, 422]			
16	Lebble 3 This sphion fresh exclude God's prividence in his greemment of the winkt, on the contrary, it makes (perfect. A true dainer prividence requires perfect transight and also prividen in advance for any remedies that will turn out to be needed. Otherwise God must be locating either in the winkt on the contrary (2007) and any contrary is advance for any remedies that will turn out to be needed. Otherwise God must be locating either in the God the God must be locating (2007).			
	Labele 11 devine configuration and the first initiation and an and a second sec	Ge	nerate network of	concepts
Parti	apart evolution Cotlaboration - Voice Destapping Display voice inter-animation		View correlated	

**Fig. 3.** The basic analysis performed by ReaderBench: The list of utterances and the most frequent concepts.

Topics	Relevance	
thing	3.461	٠
reason	3.319	
way	3.166	
part	3.104	
matt	2.984	
time	2.749	
place	2.489	
world	2.289	
order	2.282	
sense	2.252	
nature	2.245	
fact	2.077	
idea	2.05	
point	2.006	
god	2.005	
work	1.934	
word	1.788	
question	1.783	
power	1.78	
principle	1.763	
difference	1.745	
mind	1.697	
space	1.656	
situation	1.655	
body	1.637	
cause	1.635	Ŧ

Fig. 4. A detail from Figure 3.

The semantic distance between concepts was computed in ReaderBench using Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA) and distances on the implicit network of sysnests of WordNet [8]. In Figure 5 the semantic distances between concepts are depicted in the network as physical (Euclidian) distances. The size of the words for concepts reflects the frequence of their apparition in texts.



Fig. 5. The semantic distances between concepts.

There were numerous references made by Leibniz and Clarke between the letters, as shown in Table 1. Figure 6 shows their sequence in time as they were displayed by the ReaderBench platform. The length of the rectangles is proportional with the length of the letters, and the relative position of the links correspond to the positioning of the references in text.

Table 1. The number o	f references
-----------------------	--------------

References	Letter number				
iterenees	1	2	3	4	
Clarke	4	12	17	35	
Leibniz	-	12	17	46	

ReaderBench uses the LDA method [9] for identifying voices in texts. LDA detects topics, that means sets of semantically close words that are frequently appearing in text. For example, Figure 7 displays the voices identified in the correspondence between Leibniz and Clarke. User may select from the ReaderBench interface the voices that s/he wants to analyze.



Fig. 6. References between utterances.

For example, the following voices were selected and a statistic of them is displayed in Figure 8:

(god, thing, space)	(sensorium)
(matt) – matter	(word, intelligence, discussion)
(eternal, perfect, perpetual)	(mathematical)
(word, intelligence, discussion)	(sensorium)
(mathematical)	(philosophy, metaphysics)

erBench - Voices selection		- 0
	Voice	No. Concepts
(god,thing.space)		3207
(matt)		50
(present,confront)		41
(eternal.perfect.perpetual)		31
(absolutely,perfectly,little)		29 24
(natural.new)		22 24 22 21 19 17
(mere,simple,bare)		22
(newton)		21
(word,intelligence,discussion)		19
(mathematical)		17
(sufficient)		17
(sensorium)		17 17 18
(great hard, big)		IV IV
(empty)		16
(always,constantly)		15
(different)		15 15 14 13
(alike, similarly)		14
(organ,gland)		13
(wrong)		
(contrary,opposite)		12
(finite)		12 12 11 11
(philosophy,metaphysics)		11
(certain, sure, certainly)		
(impossible)		10
(usual,common)		9
(omnipresent)		9
(possible)		10 10 9 8 8 8
(constitution,formation)		8
(possibly)		8
(contradiction)		8
(quite instead)		1
(soon)		1
(indiscemible)		1 1 1 1
(supernatural)		7
(phrase)		1
(materialist)		1
(term)		1

Fig. 7. Selection of voices.

)		Voice	No. Words	Average uttera	Entropy Uttera	Average Recu	Stdev Recurre	Average senti	Stdev sentime.
	0	(god,thing,space)	3207	0.0	4.973	0.035	0.184	0.863	
	1	(matt)	50	0.0	3.974	5.727	8.018	0.34	
	2	(eternal,perfect,perpetual)	31	0.0	4.226	5.167	5.757	0.253	
	3	(word,intelligence,discussion)	19	0.0	4.039	7.706	6.745	0.205	
	4	(mathematical)	17	0.0	3.596	13.8	19.487	0.195	
	5	(sensorium)	17	0.0	3.619	9.571	11.005	0.19	
	6	(philosophy, metaphysics)	11	0.0	2.966	17.5	26.636	0.16	

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ReaderBench displays the inter-animation of voices in Figure 9.

The utterances that are constituted as a voice starting from one topic, are displayed on an horizontal line.

The colors (red and blue, in our case) correspond to the two authors (the "voices" of Leibniz, respectively Clarke).

Some other visualisations are provided for helping the investigation of the joint knowledge construction and the inter-influence of voices (see Figure 10).



Fig. 9. Voices' inter-animations.



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Fig. 10. Various visualizations of the knowledge construction and voice inter-influences.

## 4. Conclusions and future developments

Corpora of correspondence containing debates may be annotated, starting from the polyphonic model, in a complex way, which allows the extraction and visualization of various data, such as what are the most important discussed concepts and their semantic relationships, the evolution of the debate, and the inter-animation of the voices (in an extended sense, discussed in the paper).

The annotation structure will be extended for the inclusion of divergences and convergences [7] and for more details for the indirect utterances ("iutt"). Visualization means for these new elements are also under consideration.

One important goal is to enhance researchers to have a hermenophore attitude [10], that means for facilitating a hermeneutic analysis of the texts.

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