Structural Alignment Method of Conceptual Categories of Ontology and Formalized Domain

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Abstract

The problem of the structural method of ontology alignment and the more formally represented structured domain is considered. The applied area of research belongs to the field of ethical AI. The ontology developed on the basis of the ISO / IEC TR 24028 standard - Overview of trustworthiness in Artificial Intelligence, and the formalized research based on the corpus of gray literature which represents global landscape is investigated. Presented a structured alignment method used for manual alignment. The method is part of a general system of alignment and is based on building relationships about the study entity on the domain of ontology and finding the appropriate structure on the structured domain. The method is based on the semantic structures of concepts and relationships between them. More formally, the emphasis is on semantic relationships and the search for appropriate semantic structures to determine alignment at the level of the structure of relationships.

The aim of the study is to detect the compliance of the trustworthiness ontology with the current global state of the problem and the existing global trend in the field of AI ethics. The structural method has shown that semantic relationships with the domain of research are an important element and stage of alignment. Semantic relationships play an important role because they can be used to detect the alignments of concepts, despite the fact that the corpus has been documented in different languages and with a different lexical notation of concepts. The results of the research showed that the ontology based on the ISO / IEC TR 24028 standard adequately corresponds to the global view on the issue of AI ethics.

Keywords

alignment ontology, structural alignment, data integration, trustworthiness, ethic AI.

1. Introduction

Artificial Intelligence (AI) is expanding the scope of its practical application. It allows performing tasks that are difficult to describe formally. This is one of the most promising computer technologies, which corresponds to modern trends and the practicality of its application should be highly valued. AI has been studied for a long time in view of the speed of development of computer technologies, but recently in the areas of machine learning and deep learning has gained accelerating development. This is due to the prospects of application in a variety of applications of a wide range of human activities. Methods are developing visual analytics to use human intellectual capabilities in machine learning [1]–[3], methods based on ensembles of models are used [4]–[7], methods used to reduce the dimensionality of features in classification, and clustering [8]–[11] and other areas. The scope of application is quite wide in information security [12], [13], telecommunication [14], [15], medicine

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[16], and so on. Due to the rapid development and intensive spread of AI, the impact on society as a whole and the individual, in particular, is manifested in a variety of ethical, law, and social challenges. These challenges can significantly reduce the value and benefits of AI implementation if these challenges are not properly addressed. In addition, there is the prospect of negative impacts on human life, which sometimes have critical, threatening, and dangerous consequences. The risks of widespread AI implementation are already becoming apparent in the early stages.

Risks range from violating an individual's confidentiality, discriminating against him on a set of features, to the global consequences of the economic crisis from managing e-commerce, managing mass security systems, and malicious manufacturing, and so on.

In order to prevent the creation of negative consequences from the introduction of AI, prevention of risks and dangers, as well as preserving the benefits and positive effects of AI on human life and society on a global scale at the present stage of human development are considered AI. As part of this concept, the EU Commission's High-Level Expert Group on AI (AI HLEG) European AI Alliance in the "Ethics Guidelines for Trustworthy AI" [17], [18] proposed the Trustworthy AI concept. Within the framework of ethical AI, this concept is responsible for defining the boundaries of trust and the necessary sets of factors for the use of AI in terms of safety, risk minimization, especially in critical, important for human life areas.

For example, the use of AI when driving a car. The driver must trust the AI decision, only then he'll agree to implement and use it. In the field of health care, the physician who uses AI in the diagnosis and as a recommendation system should trust AI, as well as understand why AI gives such a recommendation. If AI in some areas from the modern point of view cannot fully replace a person, it can significantly increase the efficiency of his work and bring to a qualitatively new level the likelihood of correct decisions that people make if they trust AI. There are also industries such as electronic markets that make extensive use of computer technology. The introduction of AI in this area can significantly affect these markets. However, this impact can have global negative consequences, and therefore to prevent it, one must be sure that the introduction of AI will not lead to this. AI trust in this case also plays a key and decisive role in implementation.

Research on AI trust covers research areas of ethical AI, human-machine interaction, machine learning and the use of information technology by society, management methods using information technology, and the role of trust in these areas based on the experience of different levels of AI use. The level of importance and interest in this direction is indicated by high-level guidelines and recommendations of gray literature and soft-law documents at the world level. Thus, the issue of AI trust went beyond study and reached a level of broad discussion in order to develop a general, global approach to AI trust.

2. Related works

In general, trustworthy AI is an interdisciplinary and sphere of research, and a necessary set of knowledge on technical and non-technical aspects extends to a wide field of disciplines and manifested in diverse studies. This circumstance makes it difficult to conduct objective studies that have fully taken into account all aspects and identified its implementation.

In this study, we aim to determine the structure of trustworthy AI and promote this important direction. Since the research field is quite wide and known different directions and interpretations of the semantic structure of trustworthiness. It is also necessary to determine the development of trustworthy AI at the global level, taking into account the diversity of directions and approaches in the understanding of this concept. To do this, we use the study of Jobin A. et. al [19], which based on the created document corps, summarizes world experience for developing ethical AI and ontology of trustworthy AI [20]. The features of the created corps are determined by the fact that it consists of soft-law levels and are gray literature from different countries and are presented in a variety of languages. Accordingly, these documents are trying to highlight public opinion on issues of importance and significance of ethical AI. They are also used to develop wording, semantic meaning, informative content, etc., to create a basis for further development of the widespread introduction of AI in society. In addition, the advantage of using these studies is that the corps documents already contain a certain level of generalization and represent the opinion, and quite often a wide range of

people, also at the level of state institutions, professional unions, world corporations, and more. The analysis of corps documents will give an objective knowledge of the trustworthy AI development at the world level. In order to become a degree of alignment with world trends, use ontology based on ISO / IEC TR 24028 [21]. In addition, the alignment also pursues the purpose of determining the importance and significance of structural components of the trustworthy AI concept.

With the development of AI and in accordance with recent trends, numerous new directions and branches of AI have been formed. For example, research in such areas as beneficial AI [22], [23], responsible AI [24]–[27], ethical AI [15], [28]–[30], fairness AI [31]–[34] and others. Despite the diversity of the presented concepts and areas of research in general, the content can be attributed to the same goals. These goals can be summarized as promoting the development of AI so that the benefits of its use are maximized, but the risks and dangers have to be eliminated. In order to unify the wording, recommendations on ethical AI have been developed, and AI standards are being introduced, for example, ISO / IEC TR 24028: 2020, ISO / IEC DIS 22989, ISO / IEC TR 24030: 2021 and others.

The heterogeneity of semantic structures in the subject information field is largely due to the modeling of the same conceptual categories of reality by different approaches. This is due to the fact that the rapid development of AI occurs simultaneously and globally. And to date, no stable formulations and named designations have been developed. Syntactic constructions are used in different formats and content. Subject concepts need to be formalized in order to establish correspondence and harmonize lexical structures. It should be noted that the role of humans in the processes of analysis is sometimes significant and decisive [35]. One of the most convenient methods of formalizing knowledge is the development of subject areas ontologies. Ontologies contain a conceptual description of data as formalized knowledge in the concepts form of their properties and the relationships between these structures. At the same time, in the context of the study, the ontology should show world experience and meet current trends. The presentation of concepts should be objective in semantic terms.

Alignment ontology - a technique that is widely used and based on establishing the correspondence of individual concepts [36], based on the structure, i.e. taking into account the structure of the organization of several concepts [37], the use of meta heuristics, data related to ontological concepts [38].

The most well-known method and one that has been continued in many works is OWL (Web Ontology Language) [39]. The method contains better semantic informativeness than the methods on the knowledge graphs. It can be used for complex alignment of axioms using logical constructors and entities from the target to the source ontology. These axioms form an alignment of ontologies. Matching in OWL is determined by the logic of relationships in the domains of alignment ontologies.

The method POMI (Pattern mining for Ontology Matching-based Instances) [40] allows to obtain the necessary knowledge based on the correlation of the basic ontology and the resulting using approaches to clustering and modeling patterns. Clustering is performed using the k-means algorithm. The peculiarity of the method is that it groups the instances of each ontology, and then alignment the two ontologies based on a comparison of clusters and the corresponding instances within the clusters.

Another method uses a system of mapping agents to compare ontologies [41]. Agents establish semantic bridges between concepts in the source and resulting ontologies. Mismatches in alignment are processed using the confidence values for each semantic bridge and the complexity of processing the mismatch.

The SFA (Similarity Flooding Algorithm) method [42]-[44] is used to alignment structural ontologies called models. Models are represented by data schemes that are converted into a directed graph. The algorithm is based on the position that the concepts are similar, if the adjacent concepts on the graph are similar. The algorithm begins work on obtaining the initial relations between the concepts on two graphs using the correspondence function corresponding to the initial state of comparison [45]-[48]. After obtaining the initial data values [49]-[51], the algorithm continues to matching based on the fact that the concepts are more likely to be similar the more likely they are to be related to other concepts. When achieving a stable distribution of probabilities between concepts, he degree of correspondence between the concepts of ontologies is determined [52].

3. Model of structural alignment ontology and structured domain

To make the structural comparison given by the function $structure(\ )$, we take as a basis for research [45]–[52]. The structural relations of entities within domains Ent_O and Ent_{Ds} we are denoted by sets $Link_O$ and $Link_{Ds}$. Correspondence for structural alignment is defined as follows

$$structure(ent, ent') = \begin{cases} \dfrac{|A|+|B|}{2|\pi_{ent}(Link_O)|}; \\ A = \sigma_{link_{Ds(ent',y)}:\exists link_{O,Ds,filter(x,y)} \wedge \exists link_{O(ent,x)} \wedge (\forall x \in Ent_O) \wedge (\forall y \in Ent_{Ds})} (\pi_{ent'}(Link_{Ds})); \\ B = \sigma_{link_{O,Ds,filter(x,y)}:\exists link_{O(ent,x)} \wedge (\forall y \in Ent_{Ds}) \wedge (\forall z \in Ent_O)} (Link_{O,Ds,filter}), \end{cases} \quad (1)$$

$$s.t.\ \ structure(ent, ent') \neq structure(ent', ent), structure(ent, ent') \in [0,...,1],$$
$$\exists link_{O,Ds,filter(ent,ent')}, ent \in Ent_O, ent' \in Ent_{Ds}, \exists! link = \sigma_{\max_w}(Link), w \in [0,...,1].$$

Structural alignment is formed using relations. The alignment of the entities $ent \in Ent_O$ with existing relations on the set Ent_O $Link_{O(ent,x)}$ where $x \in \{x \mid link_{O(ent,x)}\}$. That is, a set of connections of the comparison entity from the basic set of comparison of the trust ontology with other entities from the same set is obtained. That is, a set of relations of the alignment entity from the basic set of alignment of the trust ontology with other entities from the same set is obtained. The entity from Ent_O is similar to the entity or subset of entities from the set Ent_{Ds}. This is determined by the function of selecting relationships between sets Ent_O and Ent_{Ds} - $\sigma_{ent}(Link_{O,Ds,filter}) \neq \{\ \}$. If the set of existing entities $\sigma_{ent}(Link_{O,Ds,filter}) > 1$, explores all the similarities in the existing relationships with the entity ent on the set $Link_{O,Ds,filter}$. Relationships are sorted by weights $sort_w(\sigma_{ent}(Link_{O,Ds,filter})), w \in [0,...,1]$, and then removed from the sorted list. Then the function of alignment is calculated by (1) and a set of weight values of each of the available similarities is formed in relation to the essence of the study. This creates a sequence of definitions of relationships and entities from the base set as related to ent, relationships between entities on the set Ent_{Ds}, and relationships between sets Ent_O and Ent_{Ds}.Since the relationship is removed, the next relationship with the maximum weight is selected. This approach is used for all sets of relationship $(\forall link \in Link) : \exists! link = \sigma_{\max_w}(Link)$. The best case for structural alignment is the presence for each entity from Ent_O, which is related to the entity of alignment, a similar entity or a subset of entities on the set Ent_{Ds}, $\{x \mid \exists link_{O(ent,x)}, \exists link_{O,Ds,filter(x,y)}, \forall x \in Ent_O, \forall y \in Ent_{Ds}\}$. From this set, we can select sets of relationships: the set of relationships on Ent_O with the entity of the study ent - $\{link_{O(ent,x)} \mid ent, \forall x \in Ent_O\}$; the set of relationships between Ent_O and Ent_{Ds} with entities on Ent_O that have relationships with the entity of the study - $\{link_{O,Ds,filter(x,y)} \mid \exists link_{O(ent,x)}, \forall x \in Ent_O, \forall y \in Ent_{Ds},\}$. Since each entity from Ent_O, at best, that is related to the entity of the study should have a similar entity from Ent_{Ds}, and given

$(\forall link \in Link): \exists! link = \sigma_{\max_w}(Link)$, i.e. such a relationship at each stage of the study only one, can be written

$$\left|\left\{link_{O(ent,x)} \mid ent, \forall x \in Ent_O\right\}\right| = \left|\left\{link_{O,Ds,filter(x,y)} \mid \exists link_{O(ent,x)}, \forall x \in Ent_O, \forall y \in Ent_{Ds},\right\}\right| \quad (2)$$

That is, the powers of these sets will be equal. Accordingly, the best-considered case can be represented as a double value of the projection power entity ent on $Link_O$

$$2\left|\pi_{ent}(Link_O)\right| \quad (3)$$

When studying the relationship structure of the entity of the study, it is necessary to detect the presence of relationships of compatible entities Ent_O with similar entities on Ent_{Ds}. In real tasks, this may not correspond to the described best case. The existing relationships are determined by $Link_{O,Ds,filter}$, i.e., the set of the entity relations $\left\{link_{O,Ds,filter(x,y)} \mid \exists link_{O(ent,x)}, \forall x \in Ent_O, \forall y \in Ent_{Ds},\right\} \subset Link_{O,Ds,filter}$. We present this set of relations in the form of constraints of the selection function on $Link_{O,Ds,filter}$.

$$\sigma_{link_{O,Ds,filter(x,y)}: \exists link_{O(ent,x)} \wedge (\forall y \in Ent_{Ds}) \wedge (\forall z \in Ent_O)}\left(Link_{O,Ds,filter}\right) \quad (4)$$

On the set Ent_{Ds} defines all the relationships with relation ent' to such a relative entity ent. Associated entities with ent' on Ent_{Ds} must also have similar entities, i.e. relationships with entities on Ent_O. This determines the set of relationships $Link_{Ds}$ relative to ent' $\left\{link_{Ds(ent',y)} \mid \exists link_{O,Ds,filter(x,y)} \wedge \exists link_{O(ent,x)}, \forall x \in Ent_O, \forall y \in Ent_{Ds},\right\} \subset Link_{Ds}$. We present this set of relations in the form of constraints of the selection function on the projection on the entity ent' on $Link_{Ds}$

$$\sigma_{link_{Ds(ent',y)}: \exists link_{O,Ds,filter(x,y)} \wedge \exists link_{O(ent,x)} \wedge (\forall x \in Ent_O) \wedge (\forall y \in Ent_{Ds})}\left(\pi_{ent'}\left(Link_{Ds}\right)\right) \quad (5)$$

On a set of entities Ent_{Ds} in a structured domain Ds, the number of relationships ent' relative to other entities in the same set may exceed the number of relationships relative to a similar study entity ent on Ent_O with entities on the same set Ent_O. This is due to the broader representation of conceptual structures in the structured domain, which is presented as an area of comparison, ie $Dom\ O \subseteq Dom\ Ds$. Structural alignment is based on a direct alignment of entities, as well as on the alignment of related entities within the relative sets.

The relationship between the entities ent and ent' not taking into account the direct relationship of similarity $entRent'$, $R = link_{O,Ds,filter(ent,ent')}$ i.e. $entlink_{O,Ds,filter(ent,ent')}ent'$ can be written as a non-transitive relationship

$$\exists(ent, ent'), ent \in Ent_O, ent' \in Ent_{Ds}: (entR_1x) \wedge (xR_2y) \wedge (yR_3ent') \Rightarrow (entRent'), \quad R_1 \in Link_O, R_2 \in Link_{O,Ds,filter}, R_1 \in Link_{Ds}, x \in Ent_O, y \in Ent_{Ds} \quad (6)$$

The best case of the degree of entities relationship ent and ent' is to consist of the ratio of transitivity of entities Ent_O realted to ent and related to ent'

$$\forall(x, ent'), x \in Ent_O, ent' \in Ent_{Ds} : (entR_1x) \wedge (xR_2y) \wedge (yR_3ent') \Rightarrow (entRent'), \\ R_1 \in Link_O, R_2 \in Link_{O,Ds,\,filter}, R_1 \in Link_{Ds}, ent \in Ent_O \tag{7}$$

To detect the degree of the ratio between entities $ent \in Ent_O$ and $ent' \in Ent_{Ds}$ present an example in the form of a graphical representation of the scheme of entities, their sets, and the related relationships within the sets of relationships $Link_O$, $Link_{Ds}$ and $Link_{O,Ds,\,filter}$ .Entity relationships are denoted as graph edges, with the corresponding relation vertices as entities. Relationships that are represented by edges denote within the affiliation of the corresponding sets of entities.

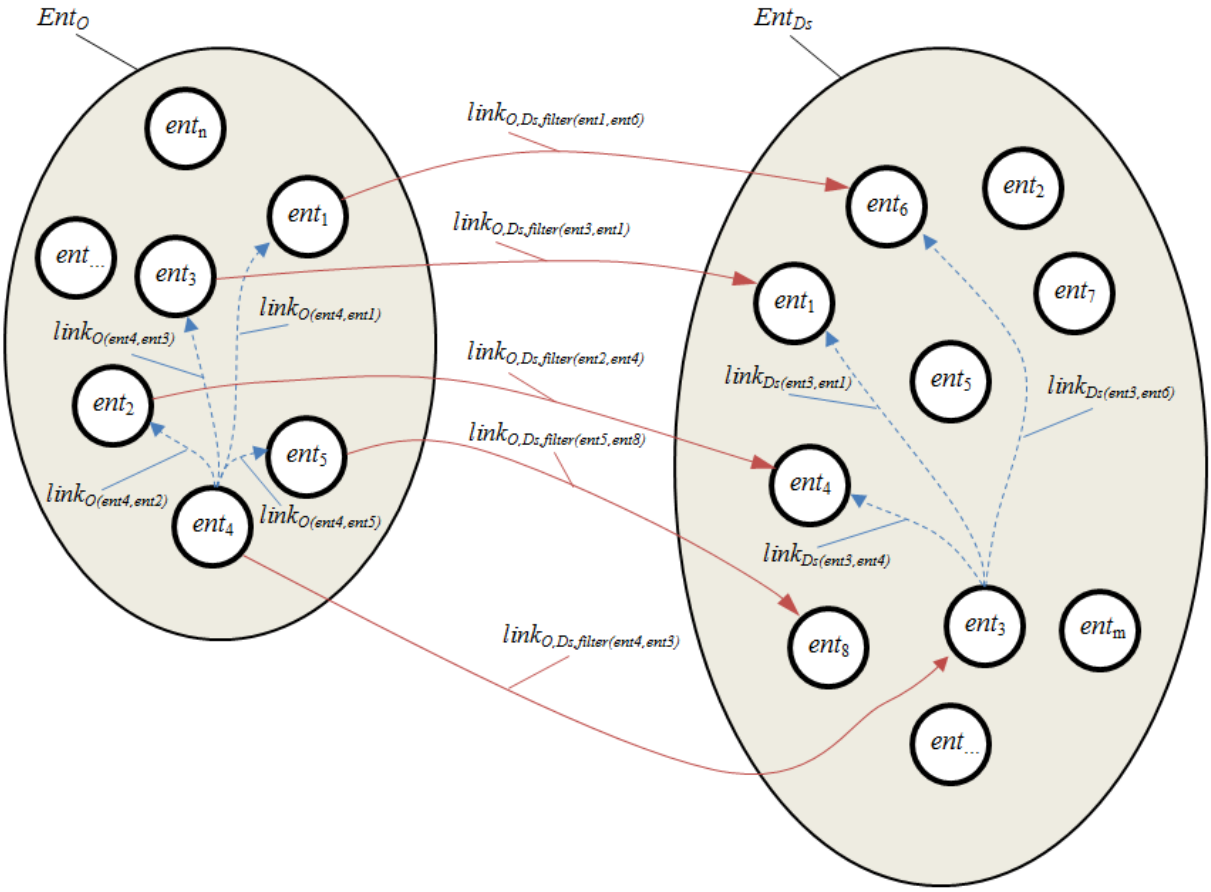

Figure 1: Scheme of relationships of structural alignment of entities $ent_4 \in Ent_O$ and $ent_3 \in Ent_{Ds}$ for detection of the alignment degree

Thus, according to the figure, we define three types of relationships that combine entities in alignment system:

1. Relationships within the trust ontology AI domain $dom\ O$, and connect entities that have a certain relationship to the study entity, i.e. the entity relatively which the structure of relations with other entities of this domain.

2. Relationships within the structured domain of the corpus $dom\ Ds$, and connect entities that have a certain relationship to the entity that in the current step is maximum similar as possible to the study entity. The structure of relations to other entities of the domain Ds is built concerning this entity. The structure is built using informativeness, which is limited exclusively to this domain without taking into account similarity to the ontology domain O. This is due to the fact that the

informativeness present in the field of ontology did not affect the structure of relations in the field of alignment.

3. Relationships between entities of domains O and Ds. In the study of detecting the degree of alignment with the structural approach, we build links between the entities of domains that have the appropriate links within the respective domains with the entities of the baseline comparison, i.e. the study entity and the closest relative entity at the current stage of alignment.

To detect the degree of alignment concerning the entity of trust ontology $ent_4 \in Ent_O$ and a similar entity from a structured domain $ent_3 \in Ent_{Ds}$. The possibility of comparison is due to existing the similarity $link_{O,Ds,\,filter(ent4,ent3)} \in Link_{O,Ds,\,filter}$. It should be noted that studies are conducted based on the value of the weighting relationships. That is, at the current stage, the only similarities between the entities are established to the one that corresponds to the only one connection represented by the edges between these entities. That is, at the current stage, we study one similarity that exists between the entities from Ent_O and Ent_{Ds} that correspond to the only one connection represented by the edges between these entities. If the entity has several similar elements, an alignment scheme is studied for each case. In the final case, the choice is made by the numerical value of the degree of the greatest compliance.

The entity $ent_4 \in Ent_O$ has a relationship to the entities from Ent_O. Relationships are defined on $Link_O$.

$ent_4 \in Ent_O$

$\rightarrow \quad link_{O(ent4,ent1)} \quad \rightarrow \quad ent_1$

$\rightarrow \quad link_{O(ent4,ent2)} \quad \rightarrow \quad ent_2$

$\rightarrow \quad link_{O(ent4,ent3)} \quad \rightarrow \quad ent_3$

$\rightarrow \quad link_{O(ent4,ent5)} \quad \rightarrow \quad ent_5$

We get a set of entities $\{ent_1, ent_4, ent_6\} \in Ent_{Ds}$ and a set of relationships $\left\{link_{Ds(ent3,ent1)}, link_{Ds(ent3,ent4)}, link_{Ds(ent3,ent6)}\right\} \in Link_{Ds}$. The entity $ent_3 \in Ent_{Ds}$ has relationships to the entities from Ent_{Ds}. Relationships are defined on $Link_{Ds}$.

$ent_3 \in Ent_{Ds}$

$\rightarrow \quad link_{Ds(ent3,ent1)} \quad \rightarrow \quad ent_1$

$\rightarrow \quad link_{Ds(ent3,ent4)} \quad \rightarrow \quad ent_4$

$\rightarrow \quad link_{Ds(ent3,ent6)} \quad \rightarrow \quad ent_6$

We get a set of entities $\{ent_1, ent_4, ent_6\} \in Ent_{Ds}$ and a set of relationships $\left\{link_{Ds(ent3,ent1)}, link_{Ds(ent3,ent4)}, link_{Ds(ent3,ent6)}\right\} \in Link_{Ds}$.

$ent_4 \in Ent_O \rightarrow \quad link_{O,Ds,\,filter(ent4,ent3)} \quad \rightarrow \quad ent_3 \in Ent_{Ds}$

$ent_1 \rightarrow \quad link_{O,Ds,\,filter(ent1,ent6)} \quad \rightarrow \quad ent_6$

$ent_2 \rightarrow \quad link_{O,Ds,\,filter(ent2,ent4)} \quad \rightarrow \quad ent_4$

$ent_3 \rightarrow \quad link_{O,Ds,\,filter(ent3,ent1)} \quad \rightarrow \quad ent_1$

$ent_5 \rightarrow \quad link_{O,Ds,\,filter(ent5,ent8)} \quad \rightarrow \quad ent_8$

Next we note that

$ent_3 \in Ent_{Ds}$

$\rightarrow \quad \cancel{link_{Ds(ent3,ent8)}} \quad \rightarrow \quad ent_8$

That is the corresponding relation between the entities $ent_3 \in Ent_{Ds}$ and $ent_8 \in Ent_{Ds}$ is not detected.

There may also be cases of lack of relationships, i.e. a similar element from Ent_{Ds} for the entities that belong to Ent_O and are related to the study entity $ent \in Ent_O$.

In the general case, this can be noted as follows

$ent \in Ent_O \rightarrow link_{O,Ds,\,filter(ent,ent')} \rightarrow ent' \in Ent_{Ds}$

$ent_x \rightarrow \cancel{link_{O,Ds,\,filter(entx,enty)}} \rightarrow ent_y$

However, it should be noted the following: to detect the degree of alignment of the study entity $ent \in Ent_O$, there must always be a similar entity $ent' \in Ent_{Ds}$ and at the current stage only one relationship is explored $\exists! link_{O,Ds,\,filter(ent,ent')}$. This link is selected from a list of links sorted by the maximum previous similarity level. Subsequently, the processed relationship is removed from this list and with the corresponding numerical indicator, defined as the result of the structural method of alignment and relocated to the list of studied relationships for further analysis.

Also, entities $x \in Ent_O$ that have nothing to do with the study entity $ent \in Ent_O$, $\cancel{link_{O(ent,x)}}$ cannot be considered, although they may have similar entities $y \in Ent_{Ds}$ and links to it $\exists link_{O,Ds,\,filter(x,y)}$.

4. Experimental studies

The analysis using a structural alignment of the ontology and the structured domain allowed us to determine the importance of the concepts of AI trustworthiness.

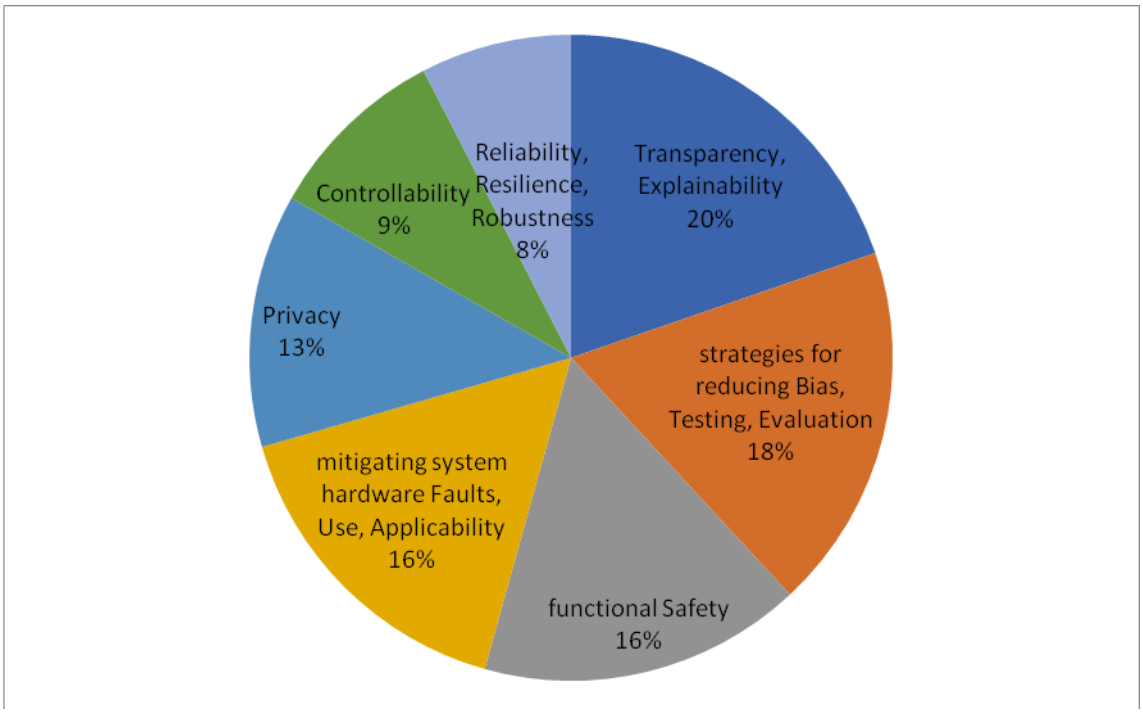

Figure 2: The relative importance of the concept based on the data of Jobin A. (2019) [19] distribution of ethical principles of AI using structural alignment

The change of the named designations of concepts was also taken into account, i.e. concepts that had a similar structure could have different lexical names. At the level of categories of concepts {Transparency} and {Privacy}, in accordance, the importance is determined by the share of 20% and 13%. The structure of the {Explainability} attachment has a complete match with {Transparency}. Next, alignments were made using lexical variability using codes for named designations {strategies for reducing Bias} is the code of the concept of {Justice & fairness} and {functional Safety} is the code of the concept {Non-maleficence} and are relevant to 18% and 16% respectively. For smaller shares of similarity, i.e. not complete structural equivalents are {Controllability} has a lexical equivalent {Freedom & autonomy} and has an importance of 9%. Further, with less overlap of structural relationships, the concept of {Reliability, Resilience, Robustness} partially corresponds to {Trust} has a relative importance of 8%, the concept of {Testing, Evaluation} partially corresponds to {Justice & fairness} has a relative importance of 18% with almost similar structural relationships. The categories {mitigating system hardware Faults}, {Use}, {Applicability} are presented at the level of group proximity by structural links. The alignment was made in order to maximize the inclusion of concepts and generalizations. The alignment showed the effectiveness of the method of structural alignment of ontology and structured domain.

5. Discussion and conclusions

The developed method of structural alignment of ontologies showed the effectiveness of practical application on the example of alignment of ontology and structured domain. It should be noted that the structured domain is presented as a result of content analysis of the corps of gray literature provides ample opportunities for practical alignment. A structured domain is less formalized and more flexible in finding matches to ontology concepts. The presence of semantic correspondence codes and descriptions allows for structural alignment. Given that the method was developed for manual alignment of formalized structures, it makes it possible to obtain a convenient tool for alimenting ontologies.

Among other methods, it allows a comprehensive and objective approach to alimenting concepts that have structural relationships. The proposed method represents only one approach based on structural relationships. It can be effectively applied to structural ontologies as areas with common principles. It is also an effective method that, along with methods based on other principles of alignment, provides objectivity and comprehensiveness. One of the advantages is the formalization of practical application.

The practical implementation of the structural method of alignment made it possible to determine the level of importance of the structural components of the concept of AI trustworthiness. Also, generalize the structural relationship of the concept with the definition of directions for further practical implementation in specific embodiment of AI. That is, related concepts are practically provided by one tool within the implementation of AI. This has a significant advantage in terms of a systems approach with the allocation and integration of areas of responsibility in areas without losing aspects of implementation.

The accordance of the ontology of trustworthy AI with the global landscape of ethical AI has shown the correctness of the need to further formalize AI methods at a practical level while ensuring compliance with ethics AI.

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