

## IMPLICATION IN LEXICAL MEANING OF CHARACTER TRAITS AS A TOOL FOR THE RECONSTRUCTION OF CAUSAL RELATIONS IN A TEXT: THE CASE OF PERSONALITY TRAITS NOMINATIONS

**Antoshina D. V.** (dia1214@yandex.ru)

Moscow State University, Moscow

The paper describes the process of extracting internal, non-explicit semantic links of a text, this process is based on patterns of behaviour (“shablon povedenija”) for words denoting character traits (CHT). Pattern of behaviour is a formal representation of lexical meaning in the form of an implication that consists of antecedent and consequent. In our case we represent application of patterns of behaviour for CHT Groups “Greediness” and “Generosity” (on the material in English, German and Russian). In the antecedent of an implication for CHT-word we have useful characteristics of a person, i.e., his or her possessions, and the description of a situation which is relevant for this CHT. In the consequent of an implication there are typical actions of a person who has this CHT nomination. Using the information we can extract implicit links to sentences which contain CHT-word. In the paper we also describe the possibility of entailment extraction based on patterns of behaviour for CHT.

**Key words:** Lexical semantics, pragmatics, pattern of behavior, characterological predicates, implicit relations, entailment

### 1. Introduction

Our work explores the possibility of extracting internal, non-explicit semantic links of a text and possible entailments of a sentence based on lexical meaning of words, for example, nominations of character traits. The lexical meaning of words denoting character traits can be represented as pattern of behaviour (“shablon povedenija”, introduced in ([Martemianov, Dorofeyev 1969], [Martemianov 1999]) in the form of an **implication**. This implication consists of antecedent (characteristics of a person

and a situation relevant for the character trait) and consequent (person's action in this situation). It is important to mention that this implication is not a material implication, but probabilistic implication, it means that antecedent A implies B with high probability (in most cases). Using this implication, explicit information from the text and general assumptions about human behaviour (formulated as **axioms**) we can extract omitted links of a text or use this implication as an instrument for automatic entailment.

## 2. Related work

This work is based on assumption formulated in the paper of Martemianov and Dorofeyev [Martemianov, Dorofeyev 1969] that meaning of words can be represented in the form of an implicative assertion. The main aim of this paper is to elaborate this approach aimed at extraction of implicit implicative and causal relations between so called “descriptions”—elementary propositions of a text. Our work is an application of this approach for the semantic group of words denoting character traits.

Martemianov and Dorofeyev use the notion **pattern of behaviour** (“shablon povedeniya”) for the description of logico-semantic structure of words denoting character traits (CHT) which helps them to reconstruct omitted textual links. Those patterns have the form of an **implication** (X implies Y). The reconstructed links are called “*leads*” (“ved-jot”), “*covered distance*” (“projdennyj put”) and *implication*. The term **implication** in their work is used both for the part of formalized lexical meaning and for the type of links between descriptions. Further we will use this term only for the part of lexical meaning.

The procedure of relations' reconstructing assumes that meaning of words in the dictionary and meaning of the text are represented with the same semantic metalanguage and the system has a thesaurus or ontology that sets relations between metalanguage concepts. That procedure consists of the three steps. On the first step descriptions ( $D_1, D_2, D_3, \dots, D_n$ ) from the text are compared with antecedents of **patterns of behaviour** ( $P_1, P_2, P_3, \dots, P_n$ ) from the dictionary entries for CHT words, for example, we can conclude that description  $D_2$  corresponds to the antecedent of  $P_{10}$ . On the second step we substitute the value of  $P_{10}$  by the corresponding value from  $D_2$ , for example, the variable X in  $P_{10}$  will be replaced by the unique name of a person from the text that is used for referring to this person in semantic structure, e.g. REF\_3 (it is expected that the system is able to extract Named Entities). On the third step all possible conclusions (consequents— $C_1, C_2, C_3, \dots, C_n$ ) from the chosen pattern ( $P_{10}$  in our case) with the variable X already instantiated are matched against descriptions of the text, and if a conclusion coincides with some description, e.g.  $C_3$  with  $D_{20}$ , it means there is an implicative or causal relation between them (in our example above,  $D_2$  implies  $D_{20}$ ). On the other hand, if we encounter a word with implicative meaning in the text we can make a conclusion from its pattern of behaviour because its antecedent is true. We can use this feature for entailment from the text.

Patterns of behaviour have already been used for description of lexical meanings of character trait words. For example, in our work [Fedoseeva 2015, 2016] we used this approach for words expressing the concepts **Greediness** and **Generosity** in German and Russian language, representing their meaning as semi-formal patterns of behaviour. This work was inspired by the papers of N. Yu. Lukashevich

and I. M. Kobozeva [Lukashevich 2002, 2004]; [Kobozeva, Lukashevich 2012] and based on the material from lexical database “Character traits” (more about this database in [Kobozeva, Lukashevich 2014]). In these papers pattern of behaviour denotes as “a stereotype of behaviour which is realised with high probability in a relevant situation” [Kobozeva, Lukashevich 2014, p. 368]. Detailed information about other approaches to the lexis of this semantic field and their disadvantages could be found in [Lukashevich 2004], [Fedoseeva 2015].

We represent our axioms and patterns of behaviour with help of predicate logic. Such representation is widely used in linguistic papers, for example, Lacoff used “basic logic” in the representation of meaning postulates. For examples, meaning postulate for CONTAINER schema: “For all A, X, either IN(X,A) or not IN(X,A). For all A, B, X, if CONTAINER(A) and CONTAINER(B) and IN(A,B) and IN(X,A), then IN(X,B)” [Lacoff, 1987, p. 273].

The paper [Leng, Wiebe 2014] presents graph-based extraction of implicitly expressed sentiments based on **generalized opinion implicature rules** for so called *goodFor/badFor* (*gfbf*) events which positively (*goodFor*, for example, **raise**) or negatively (*badFor*, for example, **lower**) affect entities mentioned in text. Implicature rule schemas presented in this paper are similar to our axioms for evaluation: “sent( $\alpha$ ) =  $\beta$  means that the writer’s sentiment toward  $\alpha$  is  $\beta$ ” [Leng, Wiebe 2014: 379]. In this formula  $\beta$  could have values Positive (pos) or Negative (neg), our function EVALUATION has the same values but also extended by subtypes “rational” and “irrational”. In the sent( $\alpha$ )  $\alpha$  is used for denoting a *goodFor* or *badFor* event or an object/an agent in this event. The sign “ $\rightarrow$ ” is also used in the rules and means an **inference**: “sent(GOODFOR) = pos  $\rightarrow$  sent(object) = pos” [Leng, Wiebe 2014: 379]. It means that if an *gf* event has positive evaluation then an object in this event will also have positive evaluation.

### 3. Basic assumptions or Axioms

Our patterns of behaviour describing concepts, expressed by CHT-words (CHT-concepts) human character traits, are based on the non-derivable assumptions which could not be extracted from the text: common knowledge about the world, non-explicit norms and values. These assumptions that we call **axioms** describe extra-linguistic reality, common sense reasoning and are the part of a cognitive process that leads to conclusions made about a person on the basis of his / her behaviour. It should be noted that in our paper word **axiom** is used in not-mathematical sense: here, an axiom is “a statement or principle that is generally accepted to be true” (Cambridge Dictionary). Exploring axioms as a helpful way to represent common knowledge about the world. We are not using axiomatic method here, so our axiom system is not obligatory required to be consistent, complete and independent.

So, we are presenting an attempt to formulate general principles of human behavior related to the domain “**Greediness—Generosity**”. For example, “People need to have resources” is a description of a piece of common knowledge for all people.

Common knowledge and its axioms or principles have been recognized as a necessary component of the theories of language use (linguistic performance) (e.g., [Searle 1975], [Grice 1975]) and of NLU systems built in the realm of AI. Such axioms

have been formulated and used for explanatory purposes in numerous papers, for instance, “Every human dislikes the absence of pleasant things” (“Cheloveku nepriyatno otsutstvie priyatnogo”) [Martemianov, Dorofeyev 1983, p. 45], “It is human nature to seek to avoid what is unpleasant for him” (Cheloveku svojstvenno stremit’sya izbezhat’ togo, chto emu nepriyatno) [Paducheva 2004, p. 131]<sup>1</sup>. Paducheva remarks that some axioms are not universal and vary depending on the language.

In this paper we are presenting only axioms which are crucial for the domain “**Greediness—Generosity**”, they could be considered as universal and could be applied to any pattern of behaviour from other domain. Obviously, our list of axioms is not comprehensive and should be expanded for other domains if needed.

Our axioms and **patterns of behaviour** are based on primary concepts from a universal ontology analogous to described in [Nirenburg, Raskin 2004]. The key concepts are described in the Table 1.

**Table 1.** Definition of the basic concepts used in axioms and patterns of behavior

<b>Resource (R)</b>	All things which could be in possession of a human being. By default resources are understood as material resources. These things ensure the existence of a person at one or another level, starting with a minimum, i.e. necessary for survival.	
<b>Relation (REL)</b>	Relation between two people, for example, kinship, friendship, love and other social relations in which affection is involved.	
<b>Norm (N)</b>	“An accepted way of behaving in particular society” (Cambridge dictionary).	
<b>Types of norms</b>	<b>Legal</b>	Norm regulated by law.
	<b>Moral/ethical</b>	Norm of morality, ethics or religion, regulated by society.
	<b>Professional</b>	Norm of an occupation, regulated within a professional community.

There are two types of axioms: axioms of existence and others, more complicated axioms that are important for understanding of various aspects of common knowledge. In our paper we describe axioms that represent the sphere of belonging and social relationships.

**Axioms of existence:**

- 1) There are people.
- 2) There are social relations between people.
- 3) There are norms of the society.
- 4) There are resources.

This list of axioms could be extended, we present only axioms used for description of CHT of group “Greediness”. There are similar ontological axioms for all basic concepts.

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<sup>1</sup> In [Paducheva 2004] axioms are used for the modeling of incident inferences of components of lexical meaning.

On the second step we want to introduce the most general assumptions about relations between people and necessity of resources for a person. For these axioms we will use predicate logic, in Tables below we present predicates and functions that are used for description.

**Table 2.** One-place predicates used in the descriptions

Predicate	Short name	Description
ACTION (X)	ACT (X)	X commits an action.
EVENT (X)	E (X)	X is an event.
NORM (X)	N (X)	X is a norm of the society. Examples of norms are discussed below.
PERSON (X)	P (X)	X is a human being.
RESOURCE (X)	R (X)	X is a valuable resource.

**Table 3.** Two-place and three-place predicates used in the descriptions

Predicate	Description
DISPOSE (A, B)	A can do everything with B.
GAIN (A, B)	A gets B.
GIVE (A, B, C)	A gives B to C.
NEED (A, B)	For A it is crucial to have B.
OBEY(A, B)	A acts as prescribed by B.
POSSESS (A, B)	A has B.
REL(A, B)	A and B are relatives, they are in relationship or they are friends.
RETURN (A, B, C)	A gives B back to C.
SAVE (A, B)	= $\neg$ SPEND (A, B). A doesn't spend B unless it is necessary.
SPEND (A, B, C)	A spend resource B on C. C could be an event or a resource.
WANT (A, B)	A wants B. Having B is not crucial for A.

**Table 4.** Functions used for denoting possible consequences and evaluations

Predicate	Description
BAD (A)	Negative consequences for A.
GOOD (A)	Positive consequences for A.
POSSIBLE_BAD (A)	There is a possibility of negative consequences for A.
POSSIBLE_GOOD (A)	There is a possibility of good consequences for A.
EVALUATE(A, B)	A gives B an evaluation. Function values are: "Positive" (Pos): good, rational etc. "Negative" (Neg): bad, irrational etc. The list of values could be extended.

**Table 5.** Logical operators

Symbol	Operator	Description
&	AND	Conjunction
→	IMPLY	Implication
¬	NOT	Negation
∨	OR	Disjunction
~>	POSSIBLY_IMPLY	L implies M with high probability (in most cases, but not always).

**Table 6.** Logical quantifiers

Symbol	Description
∀x	Universal quantifier
∃x	Existential quantifier

**Axioms and theorems (conclusions from axioms) describing possession of resources and actions with them:**

1) If a person has no useful resources (for example, food, clothes), then there are negative consequences for her/him (up to death). More formally:

$$(1) \quad \forall X \exists Z ((P(X) \& R(Z) \& \neg(\text{POSSESS}(X, Z))) \rightarrow \text{BAD}(X))$$

From this axiom we have following conclusions:

Conclusion 1: There are resources that every person need to have.

$$(2) \quad \forall X \exists Z (P(X) \& R(Z) \& \text{NEED}(X, \text{POSSESS}(X, Z)))$$

Conclusion 2: Possession of some resources has possible positive consequences for a person.

$$(3) \quad \forall X \exists Z (P(X) \& R(Z) \& \text{POSSESS}(X, Z)) \rightarrow \text{POSSIBLE\_GOOD}(X)$$

2) If a person has a resource then this person can dispose of it.

$$(4) \quad \forall X \forall Z ((P(X) \& R(Z) \& \text{POSSESS}(X, Z)) \rightarrow \text{DISPOSE}(X, Z))$$

3) If a person disposes of a resource then this person can spend it or save it (=not spend it).

$$(5) \quad \forall X \forall Z \exists Q ((P(X) \& R(Z) \& (E(Q) \vee R(Q)) \& \text{DISPOSE}(X, Z)) \rightarrow$$

(SPEND(X, Z, Q) OR SAVE(X, Z)))

4) If a person doesn't spend a resource than with high probability he/she won't stop to possess a resource.

$$(6) \quad \forall X \forall Z ((P(X) \& R(Z) \& \text{SAVE}(X, Z)) \sim\> \neg\neg\text{POSSESS}(X, Z))$$

From axioms (3) and (6) we have the following conclusion:

Conclusion 3: If a person saves a resource then with high probability it leads to possible consequences for him/her.

(7)  $\forall X\forall Z((P(X) \& R(Z) \& \text{SAVE}(X, Z)) \sim\> \text{POSSIBLE\_GOOD}(X))$

5) If a person gets a resource, he/she starts to possess it.

(8)  $\forall X\forall Z((P(X) \& R(Z) \& \text{GAIN}(X, Z)) \rightarrow \text{POSSESS}(X, Z))$

From axioms (3) and (8) we have the following conclusion:

Conclusion 4: If a person gain a resource then with high probability it leads to possible consequences for him/her.

(9)  $\forall X\forall Z((P(X) \& R(Z) \& \text{GAIN}(X, Z)) \rightarrow \text{POSSIBLE\_GOOD}(X))$

6) If a person needs to possess a resource then he/she needs to gain it.

(10)  $\forall X\forall Z((P(X) \& R(Z) \& \text{NEED}(X, \text{POSSESS}(X, Z))) \rightarrow \text{NEED}(X, \text{GAIN}(X, Z)))$

7) If a person doesn't obey social norms then it leads to possible negative consequences for her/him.

(11)  $\forall X\forall W((P(X) \& N(W) \& \neg\text{OBEY}(X, W)) \rightarrow \text{POSSIBLE\_BAD}(X))$

8) If a person doesn't spend a resource then with high probability there is no negative consequences for him/her.

(12)  $\forall X\forall Z((P(X) \& R(Z) \& \neg\text{SPEND}(X, Z)) \sim\> \neg\text{BAD}(X))$

9) If a person spends a resource and doesn't gain it, then with high probability he/she will not possess it.

(13)  $\forall X\forall Z((P(X) \& R(Z) \& \text{SPEND}(X, Z) \& \neg\text{GAIN}(X, Z)) \sim\> \neg\text{POSSESS}(X, Z))$

There are examples of norms which are used in our conclusions about person's attitude to a property.

***Examples of Legal Norms which refer to crimes against property:***

- 1) People should not steal (also a moral norm).
- 2) People should not bribe (also a moral norm).

***Examples of Moral and Ethical Norms:***

- In particular, they should supply them with resources in case the latter are in need.
- 1) People should take care of other people with whom they are in relations.
  - 2) People should take care of other people (in general).
  - 3) Non-material values are more important than material values.

**Axioms of Evaluation:**

10) If a person obeys social norms then with high probability he/she has positive evaluation from other people. Otherwise he/she has negative evaluation.

(14)  $\forall X\forall Y\forall W(P(X) \& P(Y) \& N(W) \& \text{OBEY}(X, Y)) \sim\> (\text{EVALUATE}(Y, X) = \text{POS})$

(15)  $\forall X\forall Y\forall W(P(X) \& P(Y) \& N(W) \& \neg\text{OBEY}(X, Y)) \sim\> (\text{EVALUATE}(Y, X) = \text{NEG})$

11) If an action of a person leads to negative consequences for himself, this action is evaluated by other people as not rational (generally, as negative).

(16)  $\forall X \forall Y ((P(Y) \& P(X) \& (ACT(X) \rightarrow (GOOD(X) \vee POSSIBLE\_GOOD(X)))) \sim \rightarrow$   
 (EVALUATE (Y, X) = POS))

(17)  $\forall X \forall Y ((P(Y) \& P(X) \& (ACT(X) \rightarrow (BAD(X) \vee POSSIBLE\_BAD(X)))) \sim \rightarrow$   
 (EVALUATE (Y, X) = NEG))

In the society where altruistic behaviour is evaluated higher than egoistic, the axioms 14 and 15 describing norms of behaviour in society should have more weight than the axioms 16 and 17 or we can say that they stay higher in the hierarchy of Evaluation axioms, so the possible evaluation of person's actions should be based on them. The axioms about possessions do not have hierarchy.

#### 4. Patterns of behaviour

In this paper we are going to demonstrate the possibility to build implicative links between sentences and make entailment based on lexical meaning of CHT-words that we semi-formally represent as patterns of behavior. In this part we are going to describe the procedure of creating the patterns of behaviour and take a brief look at their formal description.

**Pattern of behaviour** for words denoting character traits are based on generalization of content of various examples extracted from corpora in English, Russian and German (Russian National Corpora, Leeds Corpora, DWDS Corpora). This pattern represents probabilistic implication and consists of **antecedent** that contains fulfillment conditions for this pattern and **consequent** that describes consequences that follow with high probability from the antecedent. It means that if the antecedent is true then there is a high probability that the consequent is also true.

The procedure of building the pattern of behaviour for a particular word consists of the following steps. On the first step we extract useful contexts containing this word from corpora and put it in the Database (more about that procedure in (Kobozeva, Lukashevich 2014)). For example, for the word *generous* we are extracting the useful context from the following text:

- (1) *One of her joys in life <...> is sharing how she gives her excess, unused medicine to friends who can't afford to see the doctor or pay their mortgage. She enjoys telling us how **generous** she is to others who "have it rough"*  
 (<http://www.waiterrant.net/2008/04/the-taxman-cometh/>).

From this raw example we can extract the information about actions which are done by a person who calls herself *generous* (highlighted text) and reformulate it as the following **pattern instance**: Such person gives his/her excess and unused valued things to poor friends. This pattern instance combined with another similar examples could be generalized as follows: **Generous P** gives his/her resource R to relatives and friends (F) who need R.

So the first, not generalized version of pattern of behaviour for *generous* only for this example and similar to that could be (1) (more generalized version will be presented below):



- (1) *IF P is generous,*  
**THEN IF (P has R AND (F needs R) THEN (P gives R to F).**

Below we are going to present examples of patterns of behaviour for English, Russian and German words denoting character traits, we are expecting that this patterns could be applied to other languages which have lexicon for the concept *Greediness*.

For such translation equivalents as rus. *skupoj*, ger. *geizig* and eng. *stingy* we have the following patterns of behaviour (in brackets “< >” we have optional components, “=>” means “in result”) based on more than circa 200 examples from corpora texts:

**Pattern №1:**

**IF X is *stingy* THEN**

$\forall X \forall Z \exists F$

$P(X) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**

**POSSESS(X, Z) & (NEED(X, F)  $\vee$  WANT(X, F))**

**Consequent**

**$\neg$ SPEND(X, Z, F) &  $\neg$ GAIN(X, F)**

Behaviour of X is not rational because it leads to bad consequences for X (X doesn't get a resource that he needs). So he has a Negative evaluation from other people (axiom 17).

**Pattern №2:**

**IF X is *stingy* THEN**

$\forall X \forall Y \forall Z \exists F$

$P(X) \ \& \ P(Y) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**

**POSSESS(X, Z) & (NEED(Y, F)  $\vee$  WANT(Y, F))**

**Consequent**

**$\neg$ SPEND(X, Z, F) &  $\neg$ GAIN(Y, F)**

X doesn't obey the moral/ethical norm 1, therefore he/she gets Negative evaluation (based on axiom 15), but he/she also saves his/her resources (Positive evaluation based on axiom 16). Axiom 15 has higher priority than axiom 16 so the final evaluation is negative.

For comparison there is a patterns of behaviour with the similar antecedents describing words rus. *ekonomny*, *berezlivy*, ger. *sparsam*, eng. *thrifty* based on circa 200 examples from texts:

**Pattern №3:**

**IF X is *thrifty* THEN**

$\forall X \forall Z \exists F$

$P(X) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**

**POSSESS(X, Z) & NEED(X, F)**

**Consequent**

**SPEND(X, Z, F) & GAIN(Y, F)**

Evaluation of X is positive (based on axioms 9 and 16) because his/her actions are rational—he/she spends resources on useful things which are needed.

**Pattern №4:**

**IF X is *thrifty* THEN**

$\forall X \forall Z \exists F$

$P(X) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**                    **POSSESS(X, Z) &  $\neg$ NEED(X, F) & WANT(X, F)**

**Consequent**                     **$\neg$ SPEND(X, Z, F) &  $\neg$ GAIN(X, F)**

Evaluation of X is positive (based on axioms 7 and 16) because his/her actions are rational—he/she doesn't spend resources on things that are not useful and saves his valuable resources.

**Pattern №5:**

**IF X is *thrifty* THEN**

$\forall X \forall Y \forall Z \exists F$

$P(X) \ \& \ P(Y) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**                    **POSSESS(X, Z) & NEED(Y, F)**

**Consequent**                    **SPEND(X, Z, F) & GAIN(Y, F)**

X obeys the moral/ethical norm 1, therefore he/she gets **Positive** Evaluation (based on axiom 14).

**Pattern №6:**

**IF X is *thrifty* THEN**

$\forall X \forall Y \forall Z \exists F$

$P(X) \ \& \ P(Y) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**                    **POSSESS(X, Z) &  $\neg$ NEED(Y, F) & WANT(Y, F)**

**Consequent**                     **$\neg$ SPEND(X, Z, F) &  $\neg$ GAIN(Y, F)**

X does not disobey the moral/ethical norm 1 (so he/she does not get negative evaluation from axiom 15) and also saves his/her resources, so Evaluation of X is positive (based on axioms 7 and 15).

This patterns of behaviour differs from the patterns of the word *stingy* (№1 and №2) mostly in the part of consequent—the contrast is that such person usually spends money if it is necessary but doesn't spent that in case that there is no need. Such behaviour is rather rational and does not lead to negative consequences. Thrifty person also gives resources to people that need it and it has a positive evaluation in an altruistic society. This is reason why the word *thrifty* has positive evaluation and the word *stingy* has the opposite.

To conclude this part we would like to present the pattern of behaviour for the word *generous* from the example above based on circa 300 analogous examples:

**Pattern №7:**

**IF P is *generous* THEN**

$\forall X \forall Y \forall Z \exists F$

$P(X) \ \& \ P(Y) \ \& \ R(Z) \ \& \ R(F)$

**Antecedent**                    **POSSESS(X, Z) & (NEED(Y, F)  $\vee$  WANT(Y, F))**

**Consequent**                    **SPEND(X, Z, F) & GAIN(Y, F) &  $\neg$ (WANT(X, RETURN(Y, Z)))**

X obeys the moral/ethical norms, therefore X gets Positive Evaluation (based on axiom 14). This axiom has higher priority than axiom 17 that prescribes possible Negative evaluation for a person that spends money on things that are not useful.

For the pattern of behaviour of CHT *generous* it is obligatory to have second person, which wants or needs resources. This pattern of behaviour has the same antecedent as the pattern №2 for *stingy* and is similar to antecedents of patterns №5 and №6 for *thrifty*. As we can see, consequent of the pattern №2 could be presented as the negation of the consequent of the pattern 7. So, such way of meaning representation also demonstrates the paradigmatic relations such as antonymy, for example, for *generous* and *stingy*, and synonymy (for CHT-words which have similar antecedent and consequent). Also, in some contexts *thrifty* could be an antonym of *generous*, that conclusion comes from comparison of consequents of patterns №7 for *generous* and №6 *thrifty*.

The full list of patterns of behaviour for words of group “**Greediness—Generosity**” and their paradigmatic relations could be found in [Fedoseeva 2016].

## 5. Pattern of behaviour as a useful tool for links reconstruction and entailment

The procedure of extraction of internal links between sentences based on patterns of behaviour was firstly described in [Martemianov, Dorofeyev 1969]. In our paper we would like to introduce our own system that shares the same ideas.

On the first step we are going to describe examples of the most frequent pattern instances of a consequent. For example, for “P not spend R” of *stingy* we have such pattern instances:

Pattern instances of NOT(SPEND(X, Q)): “not spend”, “not pay”, “never buy”, “not give money” etc.

These patterns could be applied to all synonyms or derivatives of the word *stingy*, f.e., *avaricious* or *stinginess*.

In order to demonstrate the possible approach to extract implicit links we are going to analyse the following example:

- (2) *The other issue is that he <Arsène Wenger, football manager> is **stingy** despite the fact that Arsenal is a very rich club—the revenues are reaching the level of the top European clubs. They are just below the €500 million mark. So yes, they are close to the clubs who dominate European football. So it is all good in terms of finance. I can understand that they don't want to spend €80m like Manchester United did with Anthony Martial and I appreciate this but it has been a few years that he has been **stingy**. It would be good for Arsenal to recruit a centre-back and*

*a holding midfielder.*

(<http://www.goal.com/en/news/1862/premier-league/2015/10/03/15968472/stingy-wenger-must-win-premier-league-to-repair-damaged>).

In the underlined sentence there is explanation why football manager is called stingy—he doesn't want to spend a lot of money on acquisition/requirement. In order to define the link between these two descriptions we need to parse this text on sentences and tokens with any available tool.

On the next step we are going to search all character traits defined in our dictionary. In our example such words are found in sentences (1) and (5). If a person was called, for example, *stingy*, it means that the implication in the pattern of behaviour for *stingy* described above is true. It means that with high probability the consequent of this implication is also true. If we can find this information in text it means that our implication is confirmed and the sentences are bounded with the link which could be called "Confirmation" or, in terms of Mann and Thompson, "Justification" (Mann, Thompson 1988). For reconstructing this link we narrow the field of search to the nearest five-seven sentences before and after (1) and (5). In the sentences after and before and also in the same sentence we are searching for patterns stingy of described above. Such pattern in our example is found in (5): "don't want to spend". As a result between sentence (1) and sentence (5) we have the link which we will call "Confirmation" or "Justification" as it describes why person was called by such character trait.

Inside the sentence (5) we also have link "Leads to" (or "Summary" in terms of Mann and Thompson)—the pattern followed by the word denoting character trait—a conclusion made by speaker based on consequent which was confirmed.

Pattern of instance described above also could be used for automatic detection of entailment. There are various approaches for textual entailment extraction based on syntax [Basak, Naskar, Pakray, Gelbukh, 2015], monotonicity and semantic relations [MacCartney 2009], [MacCartney, Manning 2007].

As a part of any system based on semantic relations and descriptions could be used implications as part of lexical meaning described in our paper. For example, the article title from the example above is "Stingy Wenger must win Premier League to repair damaged image—Petit". In this example person Wenger is called *stingy*. It means that in pattern of behaviour of *stingy* "P is stingy" is true and antecedent is also true—Wenger has resource (usually, money) and he needs to make some event (E) happen. It means that consequent is true with high probability: Wenger does not spend money to make E happen or Wenger spend as little as possible money for that.

Such description helps us to reconstruct entailment between article titles in the example above and the example below:

"Arsene Wenger: Arsenal will not pay 'stratospheric' transfer fees this summer" (<http://metro.co.uk/2015/06/01/arsene-wenger-arsenal-will-not-pay-stratospheric-transfer-fees-this-summer-5224166/>). In this example we have the same person (Wenger) and pattern "not pay...fees". This is one of Pattern instances for *stingy*. So, "Arsene Wenger: Arsenal will not pay 'stratospheric' transfer fees this summer" entails "Stingy Wenger" from the example above.

## 6. Conclusion

To sum up all the above we would like to suggest the implication as a part of semi-formal description of words denoting character traits. Such description is helpful for automatic denoting links between sentences and for constructing an entailment from the sentence. The main advantages of this approach are axioms describing common knowledge about world and society and patterns of behaviour that reflect human cognitive processes.

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