6. Выводы

В работе представлены математические модели, методы и программные средства для получения компьютерной трехмерной геометрической модели винтовой обмотки торсатрона. Геометрические характеристики ВО позволяют провести целый ряд инженерных расчетов системы, в частности, расчетов напряженно-деформированного состояния системы, процессов теплообмена и определения удерживающих плазму свойств магнитного поля торсатрона.

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ОТНОШЕНИЯ МЕЖДУ СЛОЖНОСТЯМИ ВЫВОДОВ СТРОГО ЭКВИВАЛЕНТНЫХ ТАВТОЛОГИЙ В СИСТЕМАХ ФРЕГЕ

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THE RELATIONS BETWEEN THE PROOF COMPLEXITIES OF STRONGLY EQUAL CLASSICAL TAUTOLOGIES IN FREGE SYSTEMS

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АННОТАЦИЯ

В статье исследованы отношения между сложностями выводов строго эквивалентных тавтологий в системах Фреге. Показано, что существует последовательность пар тавтологий φ_n и ψ_n таких, что для каждого n формулы φ_n и ψ_n строго эквивалентны, основные характеристики сложностей выводов φ_n ограничены полиномом от длины φ_n, в то время как нижние оценки тех же характеристик сложностей выводов ψn являются экспоненциальными функциями от длины ψ_n.

ABSTRACT

In this paper the relations between the proof complexities of strongly equal tautologies are investigated in Frege systems. We show that there is the sequence of pairs tautologies φ_n and ψ_n such, that for every n φ_n and ψ_n are strongly equal, the main measures of proof complexities for φ_n are bounded by polynomial function in size of φ_n just as the lower bounds for the same measures of ψ_n are exponential function in size of φ_n.

Ключевые слова: *определяющий конъюнкт, определяющая дизъюнктивная нормальная форма, строгая эквивалентность классических тавтологий, системы Фреге, характеристики сложностей выводов.*

Keywords: *determinative conjunct, determinative disjunctive normal form, strong equality of classical tautologies, Frege systems, proof complexity measures.*

Introduction

The traditional assumption that all tautologies as Boolean functions are equal to each other is not fine-grained enough to support a sharp distinction among tautologies. The authors of [1] have provided a different picture of equality for classical tautologies. They have introduced in [2] the notion of “determinative conjunct”, on the basis of which the notion of strong equality of classical tautologies was suggested in [1]. The idea to revise the notion of equivalence between tautologies in such way that is takes into account an appropriate measure of their “complexity”. Such a modified notion of logical equivalence would have far-reaching consequences in classical logical theory.

The relations between the proof complexities of strongly equal classical tautologies in some “weak” proof systems are investigated in [3]. It was proved that in some proof systems the strongly equal tautologies have the same proof complexities, in the other proof systems some measures of proof complexities for strongly equal tautologies also are the same and the other measures differ from each other only by the sizes of tautologies.

In this paper the relations between the four main measures of proof complexities (length, size, space and width) for strongly equal tautologies are investigated in the most traditional proof systems of Classical Logic - Frege systems. We show that there is the sequence of tautology pairs φ_n and ψn such, that for every n φ_n and ψn are strongly equal, the main measures of proof complexities in Frege systems for φ_n are bounded by polynomial function in size of φ_n just as the lower bounds for the same measures of ψ_n are exponential function in size of φ_n.

2.Main Notions And Notations

We will use the current concepts of the unit Boolean cube (E^n), a propositional formula, a disjunctive normal form (DNF), a classical tautology, Frege proof systems for classical propositional logic, proof and proof complexity [4]. Let us recall some of them.

A Frege system F uses a denumerable set of propositional variables, a finite, complete set of propositional connectives; F has a finite set of inference rules defined by a figure of the form $\frac{A_1 A_2 \dots A_m}{B}$ (the rules of inference with zero hypotheses are the axioms schemes); F must be sound and complete, i.e. for each rule of inference $\frac{A_1 A_2 \dots A_m}{B}$ every truth-value assignment, satisfying $A_1 A_2 \dots A_m$, also satisfies B, and F must prove every tautology.

The particular choice of a language for presented propositional formulas is immaterial in this consideration. However, because of some technical reasons we assume that the language contains the propositional variables p_i (i≥1) and (or) p_{ij} (i ≥1; j≥1), logical connectives ¬,&,∨,Ɔ and parentheses (,). Note that some parentheses can be omitted in generally accepted cases.

By | φ | we denote the size of a formula φ, defined as the number of all variable entries in it. It is obvious that the full size of a formula, which is understood to be the number of all symbols, or the number of all entries of logical signs, is bounded by some linear function in | φ |.

2.1. Determinative disjunctive normal forms

Following the usual terminology we call the variables and negated variables literals. The conjunct K can be represented simply as a set of literals (no conjunct contains a variable and its negation simultaneously).

In [1] the following notions were introduced.

We call a replacement-rule each of the following trivial identities for a propositional formula ψ:

$0 \,\&\, \psi=0$, $\psi \,\&\, 0=0$, $1 \,\&\, \psi= \psi$, $\psi \,\&\, 1= \psi$,
$0 \vee \psi=\psi$, $\psi \vee 0=\psi$, $1 \vee \psi=1$, $\psi \vee 1=1$,
$0 Ɔ \psi=1$, $\psi Ɔ 0=\overline{\psi}$, $1 Ɔ \psi= \psi$, $\psi Ɔ 1=1$,
$\overline{0}=1$, $\overline{1}=0$, $\overline{\overline{\psi}}= \psi$,

Application of a replacement-rule to some word consists in the replacing of some its subwords, having the form of the left-hand side of one of the above identities, by the corresponding right-hand side.

Let φ be a propositional formula, $P=\{p_1,p_2,\dots,p_n\}$ be the set of all variables of φ, and $P'=\{p_{i1},p_{i2},\dots,p_{im}\}$ (1 ≤m ≤n) be some subset of P.

Definition 1. Given $\sigma = \{\sigma_1,\sigma_2,\dots,\sigma_m\}CE^m$, the conjunct $K^\sigma=\{p_{i1}^{\sigma 1},p_{i1}^{\sigma 2},\dots,p_{im}^{\sigma m}\}$ is called φ-1 -determinative (φ-0 -determinative) if assigning σ_j (1 ≤j ≤m) to each p_{ij} and successively using replacement-rules we obtain the value of φ (1 or 0) independently of the values of the remaining variables.

φ-1-determinative conjunct and φ-0-determinative conjunct are called also φ -determinative or determinative for φ.

Definition 2. φ-1 –determinative conjunct $K^\sigma=\{p_{i1}^{\sigma 1},p_{i2}^{\sigma 2},\dots,p_{im}^{\sigma m}\}\}$ is called minimal determinative if no subset of K^σ is determinative for φ.

Definition 3. DNF $D=\{K_1,K_2,\dots,K_j\}$ is called determinative DNF (dDNF) for φ if φ=D and every conjunct K_i (1 ≤i ≤j) is 1-determinative for φ.

It is obvious that for every propositional formula φ perfect DNF is φ-determinative, but not every DNF for φ is dDNF.

Definition 4. dDNF for formula φ is called shortest determinative DNF (sdDNF) if it consist of the minimal number of conjuncts among all dDNF of φ.

Definition 5. sdDNF for formula φ is called optimal determinative DNF (odDNF) if every conjunct in it is minimal determinative for φ.

Some arguments for the following definition were given in [1].

Main Definition. The classical tautologies φ and ψ are strongly equal if some DNF is odDNF both for φ and ψ.

The following notions and notations will be also useful further. For a conjunct $K=\{p_1,p_2,\dots,p_m\}$ we denote by fK the formula $(p_1\&(p_2 \& (\dots\&p_m)\dots))$ and for DNF $D=\{K_1,K_2,\dots,K_j\}$ we call formula form of D the formula $(fK_1\vee(fK_2\vee(\dots\vee fKj)\dots))$.

2.2. Proof complexity measures

In the theory of proof complexity four main characteristics of the proof are: t- complexity, defined as the number of proof steps (length), l-complexity, defined as total number of variable entries in proof (size), s-complexity (space), informal defined as maximum of minimal sum of sizes for formulas on blackboard needed to verify all steps in the proof (formal definitions are for example in [7]) and w-complexity (width), defined as the maximum of sizes of proof formulas.

Let ϕ be a proof system and φ be a tautology. We denote by t_φ^ϕ (l_φ^ϕ, s_φ^ϕ, w_φ^ϕ) the minimal possible value of t-complexity (l-complexity, s-complexity, w-complexity) for all ϕ-proofs of tautology φ.

Let M be some set of tautologies.

Definition 6. We call the ϕ-proofs of tautologies in a set M t-polynomially (l- polynomially, s- polynomially, w-polynomially) bounded if there is a polynomial p() such that $t_\varphi^\phi \le p(|\varphi|)$ ($l_\varphi^\phi \le p(|\varphi|)$, $s_\varphi^\phi \le p(|\varphi|)$, $w_\varphi^\phi \le p(|\varphi|)$) for φ in M.

2.3. Essential subformulas of tautologies

For proving the main results we use also the notion of essential subformulas, introduced in [5].

Let F be some formula and Sf(F) be the set of all non-elementary subformulas of formula F .

For every formula F , for every $\varphi \in Sf(F)$ and for every variable p by F_φ^p is denoted the result of the replacement of the subformulas φ everywhere in F by the variable p . If $\varphi \notin Sf(F)$, then F_φ^p is F .

We denote by $Var(F)$ the set of variables in F .

Definition 7. Let p be some variable that $p \notin Var(F)$ and $\varphi \in Sf(F)$ for some tautology F . We say that φ is an essential subformula in F iff F_φ^p is non-tautology.

We denote by $Essf(F)$ the set of essential subformulas in tautology F.

If F is minimal tautology, i.e. F is not a substitution of a shorter tautology, then $Essf(F) = Sf(F)$.

In [5] the following statement is proved.

Proposition. Let F be a minimal tautology and $\varphi \in Essf(F)$, then in every F-proof of F subformula φ must be essential either at least in some axiom, used in proof or in formulae A1Ɔ (A2Ɔ (…ƆAm)…) Ɔ B for some used in proof inference rule $\frac{A_1 A_2 \dots A_m}{B}$.

Note that for every Frege system the number of mentioned essential subformulas is bounded with some constant.

3. Main result

Here we give the main theorem.

Theorem. There is the sequence of strongly equal tautologies pairs φ_n and ψ_n such, that the main measures (t,l,s,w) of F-proof complexities for φ_n are bounded by polynomial function in size of φ_n just as the lower bounds for the same measures of F-proof complexities of ψ_n are exponential function in $\sqrt{|\varphi_n|}$.

Proof. Let us consider the tautologies $\varphi_n = TTM_{n,2n-1}$, where:

$TTM_{n,m}=V_{(\sigma1,\sigma2,\ldots,\sigma n)\epsilon En}\&_{j=1}^{m} V_{i=1}^{n} p_{ij}^{\sigma j}$ (n≥1,1≤m≤2ⁿ-1).

It is not difficult to see that $|\varphi_n \models n2^{2n}$ and every φ_n- determinative conjunct contains at least 2^n -1 literals, therefore every dDNF of φ_n must have at least 22^n-1 conjuncts.

In [6] is proved that F-proofs of tautologies φ_n are t-polynomially and l- polynomially bounded, therefore also s- polynomially and w- polynomially bounded (it is obvious that for every ϕ-proof of tautology φ $w_\varphi^\phi \le s_\varphi^\phi \le l_\varphi^\phi$).

As ψ_n we take formulae form of some odDNF of φ_n. The strong equality of φn and ψn is obvious and $|\psi n| \ge 2^{2^n-1}$ x(2^n -1). Note that every ψ_n is minimal tautology and at least fK of every conjunct K from this odDNF is essential for ψ_n, therefore t-complexity of ψ_n is Ω(22^n). It is obvious that l-complexity≥ t-complexity and s-complexity≥ w-complexity≥|ψn|.

Remark. Note that the set of tautologies ψ_n is itself t-polynomially (l- polynomially, s- polynomially, w- polynomially) bounded.

4.Conclusion

We show that in Frege systems the proof complexity measures of strongly equal tautologies can distinguish one from the other by order, just as in some “weak” proof systems they are the same.

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ОСНОВНЫЕ ПСИХОЛОГИЧЕСКИЕ ДЕТЕРМИНАНТЫ МЕЖЛИЧНОСТНОЙ АТТРАКЦИИ

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MAIN PSYCHOLOGICAL DETERMINANTS OF INTERPERSONAL ATTRACTION

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АННОТАЦИЯ

В статье рассматриваются основные теоретические подходы к пониманию понятия «межличностная аттракция», приводятся внешние и внутренние детерминанты, оказывающие наибольшее влияние на процесс формирования взаимного притяжения людей друг к другу. Обосновываются доводы о практической значимости учета факторов, обусловливающих явление аттракции, в контексте межличностного взаимодействия.

ABSTRACT

In article the main theoretical approaches to understanding of the concept «interpersonal attraction» are considered, the external and internal determinants having the greatest impact on process of formation of a mutual attraction of people to each other are given. Arguments about the practical importance of the accounting of the factors causing the attraction phenomenon in the context of interpersonal interaction locate.

Ключевые слова: *межличностная аттракция, детерминанты, взаимодействие, партнер, внутренние факторы, внешние факторы.*

Keywords: *interpersonal attraction, determinants, interaction, partner, internal factors, external factors.*

Проблема взаимодействия людей друг с другом является одной из центральных в психологической науке. В советской и зарубежной психологии в качестве термина для широкого круга феноменов эмоциональных отношений, от симпатии, возникающей на самом первом этапе знакомства, до любовных переживаний, утвердился термин «межличностная аттракция». Впервые термин был использован в международном справочнике психологических исследований «Psychological Abstracts», который в 1965 году выделяет работы, посвященные проблеме аттракции, в специальный раздел [1, с. 89].

«Аттракция» (лат. attrahere – привлекать, притягивать) – понятие, обозначающее возникновение при