

**AMSI SUMMER RESEARCH
SCHOLARSHIPS 2023-24**

SET YOUR SIGHTS ON
RESEARCH
THIS SUMMER



Diploma Seminar

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Engineering Thesis – what is about?

- my first *opus magnum*,
- it usually describes A) a solution of an engineering task or B) a formulated problem/issue,
- with a scientific apparatus (methodology, bibliography),
- usually 30-40 pages

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ABSTRACT

Includes summary description of the study including statement of the problem, purpose, scope, research tradition, data sources

INTRODUCTION

This abstract may consist of a brief summary, which is usually placed at the end of the work to get all the info easily

LITERATURE REVIEW

In this chapter you have to prove the dissertation/thesis statement with some valuable examples

RESEARCH METHODOLOGY

This includes details on the studies you've performed, the research methods, the utilization of dimensional tools and other specifications

DATA ANALYSIS

Analysis is the process of presenting and interpreting data

RESULTS

In this chapter you may specify the uncovered research areas and speak on the outcome

CONCLUSION

In this chapter where the students have to summarize the whole writing and provide with some useful predictions

- A classical (ideal) structure of the thesis

<https://missamandawatson.blogspot.com/2021/07/how-to-write-phd-thesis>



How to begin?????

- Indicate which area of my study cycle is '**mine**'/**interesting**/**intriguing**/**useful**
- Find a potential supervisor (engaged/active in my favourite area) willing to supervise me
- Explore the background/recognise the subproblems/subtasks to be perform
- Make a literature overview + formulate the questions/problems



Some General, but (Potentially) Useful Hints:

- Prepare your thesis **achronologically:**

- ① 'Core' of the thesis (experiments/data analysis)
- ② Theoretic background (dictionary, definitions, methods)
- ③ Conclusions (+ open problems, closing remarks, further perspectives)
- ④ Introduction (objective, structure, motivation)

- A well-written thesis forms a **compromise** between:

- ① conciseness and verboseness
- ② essay and encyklopedic compendium
- ③ a popular science text and a 'jargon' expert one



Why I shouldn't start from **Introduction?** You **can**, ...but be aware that:

- **your analysis will run differently than you announce in 'Introduction'** – e.g. because:
 - ① not all experiments appear noteworthy, fortunate, etc.– against your initial intuitions and goals
 - ② you detect/discover something intriguing and initially unexpected, etc.



Why I shouldn't work on **Theoretic background** before proper analysis and experiments? **You can**, ...but be aware that:

- **it is difficult to initially indicate all the concepts and methods – needed in your experiments and analysis**



Core of the thesis: experiments/data analysis

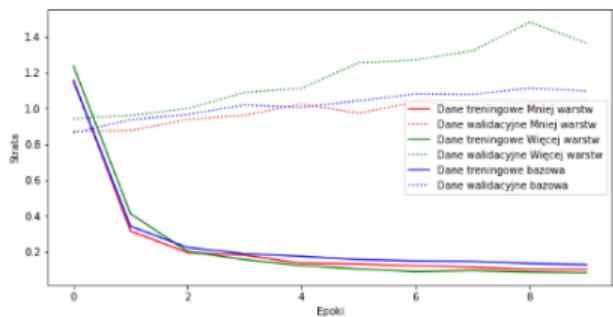
- Be possibly **precise** and **informative** in your data/experiments presentation
- Take care of **interference** between your data **visualisation** (diagrams, pseudocodes, tables, etc.) and their **text description**.



Experiments/data analysis

Sieć	Ilość parametrów	Czas treningu	Dokładność	Strata
Bazowa	5,176,458	143 s	0.7930	1.0876
Mniej neuronów	1,296,274	34.5 s	0.7992	1.0372
Więcej neuronów	10,562,370	360 s	0.7867	1.2342
Mniej warstw	5,144,110	142 s	0.7970	0.9865
Więcej warstw	5,282,186	110 s	0.7903	1.4197

Tabela 3.2. Porównanie wyników wg złożoności sieci



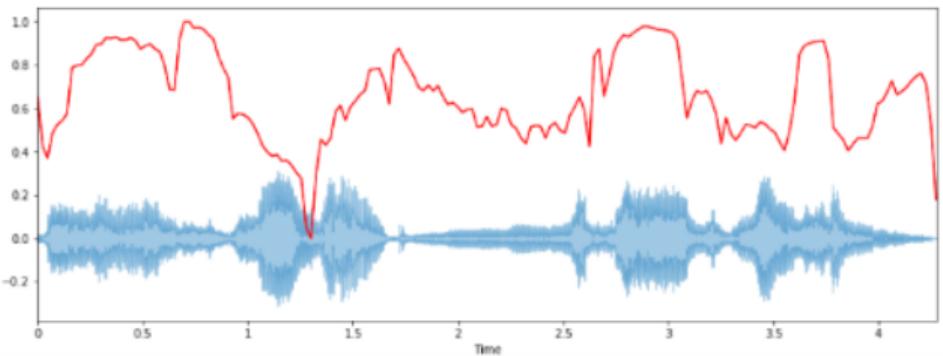
Rys. 3.7. Wykres straty dla różnych ilości warstw sieci. Źródło: Opracowanie własne

Evaluation

- Data – presented
- The diagram axes and units – named
- The role of colours – explained



Experiments/data analysis Evaluation



Rys. 2.9. Wizualizacja spadku spektralnego utworu Krzysztof Krawczyk - Chciałem
być

- Data – presented
- The diagram axes and units – (partially) named
- The colour-visualized data – only partially indicated



Experiments/data analysis

Evaluation

- The Model-checking pseudocode presented
- A general description is given
- The key pseudocode line – explained in the text

The model-checking for a formula ϕ in a multi-modal Kripke frame M , in its state w , is given by Algorithm 1. It specifies a unique ϵ -dependent procedure $\text{VERIFY}(M, w, \phi, s, \epsilon)$. Since the procedure is standard for atomic formulas, we omit its description in Algorithm 1. We only define the procedure for modal formula $\beta = \Diamond\gamma$, and $\beta = (BI)\gamma$ for some γ atomic.

In the case $\beta = \Diamond\gamma$ (lines 2–6 of Algorithm 1), the procedure works for every $w \in W$. If one can existentially choose v such that $w \leq_i v$, for a given w , v , then the procedure (positively) verifies that γ is satisfied in M, v (we denote it by $\text{VERIFY}(M, v, \gamma, \epsilon)$), then the procedure returns ‘true’. Otherwise – it returns ‘false’. In the case $\beta = (BI)\gamma$ (lines 7–14 of Algorithm 1), the procedure works for every $w \in M$, for arbitrarily large, but finite set of $s \in \{1, \dots, N\}$ and $\epsilon \in \{a_1, \dots, a_l\}$, for some natural l . If we can find such k that every $s \leq k$ there exists such $u \in W$ that the

An (Almost) Fuzzy Logic of Action and Preferences, its Quasi-model Interpretations, ...

Algorithm 1 Procedure $\text{VERIFY}(M, w, \phi, s, \epsilon)$, where
 $\epsilon := \{\langle c_n, BI_n^{<\epsilon}, \dots, BI_n^{>\epsilon}, Mw_n^{<\epsilon}, \dots, Mw_n^{>\epsilon}, Val \rangle\}$, $i \in I$, $n \in \{1, \dots, N\}$, $s \in \{a_1, \dots, a_l\}$, w

- 1: for all $\beta \in Sub(w)$ such that $|\beta| = i$ do
 - 2: while
 - 3: if $\exists i: w \leq_i v \wedge \gamma \in V(v)$ then
 - 4: set := $Val(w) = Val(w) \cup \{\beta\}$ and $\text{VERIFY}(M, v, s, \gamma, \epsilon)$
 - 5: return true
 - 6: end if
 - 7: return false
 - 8: end while
 - 9: $\beta = (BI)^{<\epsilon}\gamma$
 - 10: for every $w \in M$, $n \in \{1, \dots, N\}$, $\epsilon \in \{a_1, \dots, a_l\}$ do
 - 11: if $\exists k: \forall n \geq k \exists_{w'W} (w(BI^{>\epsilon}a) \wedge \gamma \in V(w))$ then
 - 12: set := $Val(w) = Val(w) \cup \{\beta\}$ and $\text{VERIFY}(M, w, s, \gamma, \epsilon)$ and
 - 13: return true
 - 14: end if
 - 15: return false
 - 16: end while
 - 17: end for



Experiments/data analysis

Evaluation

Algorithm 1 Procedure VERIFY($M, w, \phi, *, \varepsilon$), where

```

 $\alpha = | <_i, BI_1^{<\varepsilon}, \dots, BI_n^{<\varepsilon}, Move_1^{<\varepsilon}, \dots, Move_n^{<\varepsilon}, Val \rangle |, i \in I, n \in \{1, \dots, N\}, \varepsilon \in \{a_1, \dots, a_l\}, \alpha$ 

1: for all  $\beta \in Sub(\alpha)$  such that  $|\beta| = i$  do
2:   while
3:      $\beta = \Diamond_i \gamma$ 
4:     for every  $w \in M, i \in I$  do
5:       if  $\exists v. w <_i v \wedge \gamma \in V(v)$  then
6:         set  $Val(w) = Val(w) \cup \{\beta\}$  and VERIFY( $M, v, *, \gamma, \varepsilon$ )
7:         return true
8:       end if
9:     end while
10:    return false
11:  end while
12: ...
13: end for

```

- The Model-checking pseudocode presented
- No general description is given
- No pseudocode line explained in the text



Why are these two aspects so important?

- Your analysis is **transparent** and **comprehensible**,
- Your experiments are **verifiable/falsifiable**,
- Your work gains a **didactic value** (a reader might repeat your experiments and might learn from you.)



Thanks to this, there is more **science** inside!



Theoretic Background-Definitions

Definition – a statement (usually expressed in a natural language) of the meaning of a term (a word, phrase, or other set of symbols).

Types of definitions:

- ① **intensional** (explain the meaning of the statements)

Ex: A *formal language* is a subset of a set of words over a given alphabet.

- ② **extensional** (list the objects that the term describes)

Ex: A set of PC formulae is a set given by the grammar: ϕ , $\neg\phi$, $\phi \wedge \psi$, $\phi \rightarrow \psi$, $\phi \rightarrow \psi$.



Due to another criterion:

Types of definitions:

- ① **classical** (introduces a unique equality between a defined term and a phrase which explains the term)

Ex: A *circle* is a subset of points on a plane equidistant from a given centre.

- ② **extensive** (convey the meaning of a term by pointing out examples.)

Ex: This is the R-code for linear regression for two given

```
lm(formula = y ~ x)
```

variables *x* and *y*:



Theoretic Background-Definitions

Due to another criterion:

Types of definitions:

- ① **real** (refers to the defined objects)

Ex: A *circle* is a subset of points on a plane equidistant from a given centre.

- ② **nominal** (refers to the names of the defined objects)

Ex: A word "*circle*" means a subset of points on a plane equidistant from a given centre.

- ③ **projective** (project some concepts, establish some arrangements)

Ex: By the phrase 'declarative languages' we mean here PROLOG and ASP.



Typical Errors in Defining:

- ① *Idem per Idem:*

Ex 1:

"Logic is a research branch on reasoning due to logical rules".

Ex 2:

"Mathematics is a research branch on different mathematical objects".

- ② *Ignotum per Ignotum:*

Ex 3: "Conjunction is a unique two-argumental functor of PC"



Typical Errors in Defining:

① *Ignoramus per Ignotus:*

Neighborhood – - Set of nearby, usually adjacent cells, surrounding the considered cell. It is typically defined by relative positions respecting the position of the central cell. The neighborhood can be also defined in various ways and while in most cases it is defined by adjacency, it not necessarily needs to be close in Cartesian understanding. Using other words, neighborhood is the definition of what cells are used by a transition function when calculating the state in the proceeding iteration. The most common types of neighborhood used in the field of cellular automata are: *von Neumann neighborhood* and *Moore neighborhood*. The previous one consist of four cells that are orthogonally adjacent [2], the second, in addition, includes four, diagonally adjacent cells [3].

Ex 4:



Typical Errors in Defining:

① Categorical Translation:

Ex 5: "Mathematics is a class of all objects that are a subject of interest of mathematicians"

② Impreciseness:

Ex 6: A convolution is a mathematical operation on two functions (f and g) that produces a third function $f * g$ that expresses how the shape of one is modified by the other.



Typical Errors in Defining:

① Imprecision:

Ex 6: "A convolution is a mathematical operation on two functions (f and g) that produces a third function $f * g$ that expresses how the shape of one is modified by the other".

② Falsehood:

Ex 7: "Declarative languages are the programming languages in which each object forms a class".



① Imprecise definition:

Ex 6: "A convolution is a mathematical operation on two functions (f and g) that produces a third function $f * g$ that expresses how the shape of one is modified by the other".

② Precise definition:

Ex 6*: Let f, g be Lebesgue integrable function on \mathbb{R} (symb. $f, g \in L^1(\mathbb{R})$)¹, and let $Con : L^1(\mathbb{R}) \times L^1(\mathbb{R}) \rightarrow L^1(\mathbb{R})$ be a mapping associating to the pair (f, g) a new function

$$f * g(t) = \oint f(t)g(x - t)dt \in [0, 1].$$

The function $f * g(t)$ is said to be called a *convolution* of f and g .



How to omit the errors?:

① Precise definition:

Definition 8: (Convolution.) Let f, g be Lebesgue integrable function on \mathbb{R} (symb. $f, g \in L^1(\mathbb{R})$)⁶, and let $Con : L^1(\mathbb{R}) \times L^1(\mathbb{R}) \rightarrow L^1(\mathbb{R})$ be a mapping associating to the pair (f, g) a new function

$$f * g(t) = \int f(t)g(x-t)dt \in [0, 1].$$

Ex 6*: The function $f * g(t)$ is said to be called *a convolution* of f and g □

- **Hint:** Since your definitions will usually be technical concepts, they may require **additional** support definitions to be precise.



Introduction of the Thesis

STRUCTURE OF THE THESIS INTRODUCTION	
1. Opening statement	<ul style="list-style-type: none">introducing the research fieldstating the research problemlayout of the chapter
2. Background of the study	<ul style="list-style-type: none">Secondary research-based factsEvidence with referencesFoundation of the research and its concepts
3. Research problem	<ul style="list-style-type: none">Identifies the research gapsIdentifies the missing informationNeed for filling the research gaps
4. Research aim and objectives	<ul style="list-style-type: none">Aim3–6 objectives supporting the aim
5. Significance of the study	<ul style="list-style-type: none">Contribution to academiaContribution to industryContribution to government/economy
6. Limitations of the study	<ul style="list-style-type: none">Methodological limitationsConceptual limitationsTheoretical limitations
7. Thesis structure	<ul style="list-style-type: none">Structure of the rest of the thesisCan be presented in the form of text/diagram

- An exemplary structure of the '**Introduction**'



Introduction of the Thesis

① Motivation:

- It explains **why** the problem is formulated, **why** is interesting, noteworthy, etc.)
- It usually infers the need to formulate the problem from the lacks and shortcomings of previous approaches.

In his groundbreaking article [1], Per Lindström characterized the first-order logic as the maximal logic which satisfies both Compactness Theory and the Skolem-Löwenheim Theorem. These ideas initiated and influenced many other attempts at a similar characterizability of other classes of logical systems, such as modal logic systems in van Benthem's and de Rijke's approach in [2] and [3] (resp.) or the so-called infinitary chain logic systems as in Shelah's logic in [4] and – very recently – in Džamonja-Väänänen's approach [5].

Although the abstract model-theoretic treatment of analytic structures, such as Banach spaces, has been well-grounded since such works as [6], [7], their Lindström's-type characterisation has still been elaborated for a small number of types of the structures, such as continuous metric spaces [9], [12] or – for structures with measures and integrals as in [11].

Unfortunately, no attempt to Lindström's characterizability of structures of real and compact analysis has been yet proposed. In particular, we need more information about the appropriate maximal logic suitable to describe analytic



Introduction of the Thesis

① Objectives:

- They explain **what** is/are the thesis goal(s))
- They usually refer to the motivation factors.

Against this dominating trend in the research tradition and in some reference to the problems and questions, formulated above, the article is aimed at the following goals.

G1: To **propose** an (almost) fuzzy logic of action and preferences AFLAP – introduced both syntactically and semantically from its non-fuzzy 'surrogate' interpreted over finite game trees (breaking **Tend**₂). (breaking **Tend**₃).

G2: To **prove** the decidability of AFLAP using advanced and modified machinery of quasi-models (breaking **Tend**₁).

G3: To **give** an outline of potential applications of AFLAP in 3 areas: a) in decision-making scenarios and b) in automated reasoning.

Ex:

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2.	Czy treść pracy odpowiada tematowi określonymu w tytule?
b)	Częściowo
3.	Czy struktura pracy – podział treści, kolejność rozdziałów, itp. – jest odpowiednia?
a)	Tak
4.	Czy dobór źródeł oraz ich wykorzystanie są właściwe?
a)	Tak
5.	Czy praca jest poprawna językowo?
a)	Tak
6.	Czy technika edycji, spis rzeczy, odsyłacze – są poprawne?
a)	Tak
7.	Dodatkowe uwagi dotyczące pracy
	W niektórych miejscach opisy są zbyt lapidarne, wręcz encyklopedyczne. Można by pukonkretniające rozwinięcia. W przypadku braku dodatkowych uwag powyższe pole proszę uzupełnić słowem „brak”.
8.	Ocena pracy
	4,5

- **How does your reviewer evaluate your thesis?**
- She/he has to answer to the following questions:



1. Merytoryczna ocena pracy

Praca dotyczy zagadnienia detekcji korelacji między typami utworów muzycznych a rodzajami emocji, jakie te utwory wzbudzają u słuchaczy. Tak określony cel pracy został w pełni zrealizowany poprzez konstrukcję modelu predykcyjnego, bazującego na sieciach neuronowych. Autor zastosował tu swoiste podejście porównawcze, wykorzystując dwa typy sieci neuronowych jako podstawę konstrukcji modelu. Do predykcji wykorzystał autor ponad 10 tysięcy ścieżek dźwiękowych z

Nyquista, są uznane za powszechnie znane (chyba niesłusznie). Zaletą podejścia autora - oprócz pomysłu aproksymacji dobrych rezultatów poprzez użycie innego rodzaju sieci neuronowej - jest też pewna szczerość prezentacji. Autor podaje fragmenty kodu, np. dla reprezentacji utworu w bazie Google Colab. Zupełnie jednak, że brakuje pewnych elementów opisu, które pozwoliliby czytelnikowi w szczegółach powtórzyć eksperymenty autora.

- Before that, she/he creates a review and indicates positive and negative sides of the thesis:



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Technical Support of the Mutual Interaction with My Supervisor

The image shows a LaTeX editor interface. On the left, there's a sidebar with files like 'praca.tex', 'rozdzial1-wprowadz...', 'rozdzial2-natura-przet...', 'rozdzial3-metody-zap...', and 'rozdzial4-wnioski.tex'. Below it is a 'File outline' section which says 'We can't find any sections or subsections in this file.' and 'Find out more about the file outline'. The main area has a 'Code Editor' tab where the 'praca.tex' file is open. The code includes LaTeX commands for document class, packages (english, polish, babel, inputenc, mathbb, todonotes, algorithm2e), and bibliography. To the right of the code editor is a 'Recompile' button and a preview window showing two plots: (a) Wykres dla dalszych i (b) Wykres dla kolejnej.

3.6. Wpływ użycia dropout'u na przetwarzanie modelu

(a) Wykres dla dalszych

(b) Wykres dla kolejnej

Rys. 3.11. Wykresy dla dalszych i kolejnej warunków λ oraz z modelu. Źródło: Opracowanie własne

3.6. Wykres dla kolejnej

Rys. 3.12. Wykres dekompozycji L2 z różnymi warunkami λ oraz z modelu. Źródło: Opracowanie własne

3.6. Wpływ użycia dropout'u na przetwarzanie modelu

Dopóźnienie powoduje zmniejszenie ilości neuronów i może być również traktowany jako jedna z technik regularizacji. Aby to z pewnością obiecującą techniką, która rzadko jeszcze zostaje wykorzystana.

Prace, w których zaproponowano metodę dropout [11], opisują wpływ jej użycia na zmianę różnych zmiennych z zakresu obracania, naszyj, klasyfikacji tekstu oraz gierek. W przypadku danych układowych błędne są zmniejszone z 30,03% do 29,62%. Jest to jednak stosunkowo mała poprawa, jeśli porównać ją z zmianą w tle, mimo że zmiana skonsolidowała dane i ulepszyła. Należy zauważyć,

Technical Support of the Mutual Interaction with My Supervisor

The screenshot shows a LaTeX editor interface. On the left, the file outline pane lists various files including 'rozdzial2-natura...', 'rozdzial3-metody-zap...', and 'rozdzial4-wnioski.tex'. The main area is a code editor with the following LaTeX code:

```

\begin{figure}[h]
\centering
\includegraphics[width=0.9\textwidth]{Overfitting_IBM.png}
\caption{\label{fig:overfittingIBM} Porównanie niedotrenowania z przetrenowaniem modelu. Źródło: \cite{overfittingIBM}}
\end{figure}

Oznacza to, że model ma wysoki błąd wariancji (ang. \textit{variance}) i zapominał losowe rzeczy bez względu na sygnał. Przeciwnieństwo błędu wariancji jest błąd obciążenia (ang. \textit{bias}), gdzie model uczy się z tym samych, błędnych danych.
```

Line 63 contains a tooltip: "Wariancja nie została wcześniej wyjaśniona".

On the right, there is a preview pane showing two plots labeled (a) Wykres dokładności and (b) Wykres błądów. Below the plots is a bar chart titled Rys. 3.11. Porównanie regularizacji L2 z różnymi wartością λ oraz z modelem bazowym. Drodze Opracowanie własne.

3.6. Wpływ użycia dropout'u na przetrenowanie modelu

Dropout z powodu redukcji aktywności sieci neuronowej i czasu był uważany traktowany jako jedna z technik regularizacji. Jest to z powodu obciążenia techniki, które wciąż muszą zostać rozwiążone.

Praca, w której zaproponowane metody dropout [13], sprawiły, że jego użycie na sieciach różnych zbiory testowych z zakresu obrazów, mowy, klasyfikacji teksta oraz gier. W przypadku danych zbiory testowych błąd udało się zmniejszyć z 31.05% do 29.62%. Jest to jednak mniejsze mala poprawa, jeśli porównać ją z opisaną w tej pracy metodą użycia dropout'u na obrazach. Najlepszy model



ENGINEERING EXAM

- ① **Termin:** c.a. od 15/16 stycznia przez następne 2 tygodnie, sloty 9:00-12:00, 15:00-18:00
- ② **Forma:** Ustna: 5-7 min prezentacji + 3 pytania Komisji + Ocena i Ogłoszenie wyników
- ③ 1 pytanie dotyczy pracy ("obronne"), 2 dotyczą programu studiów



EXAM-FINAL GRADES

Your final grade is a **weighted average** of the following components:

- ① **60%** – the average grade from the partial grades from the study period
- ② **20%** – the average grade from the diploma thesis evaluation
- ③ **20%** – the average grade from the diploma exam



EXAM – FINAL GRADES

Oceny, o których mowa w rozdz. 3, a także wynik ukończenia studiów ustala się do dwóch miejsc po przecinku, bez zaokrągleń, zgodnie z następującą zasadą w zależności od wartości liczbowej:

- 1) od 3,00 ocena słowna: dostateczny (3.0)
- 2) od 3,21 ocena słowna: plus dostateczny (3.5)
- 3) od 3,71 ocena słowna: dobry (4.0)
- 4) od 4,21 ocena słowna: plus dobry (4.5)
- 5) od 4,71 ocena słowna: bardzo dobry (5.0).

Figure: The Method of Establishing the Final Exam Grades



EXAM – HOW TO ANSWER IN A CLEVER WAY

- ① (The 'defence' question): Feel free to create your own narration, answer broadly, initiate some references, play with the associations, and indicate some interesting aspects of the problem.
- ② (The 'exam' questions:):
 - ① try to be precise and concise
 - ② do not forget about examples (1-2)
 - ③ use an academic language (at least the typical vocabulary)
 - ④ try to not use any 'Polish-English" mix



① try to be precise and concise....

= say (only) what is needed to answer your question/what correctly exposes the nature and properties of the objects you are being asked about.

Example

An **Algorithm** is a finite sequence of rigorous instructions, typically used to solve a class of specific problems or to perform a computation, satisfying the properties: A) correctness, B) finiteness, C) extensionality, D) effectiveness.



I. An **Algorithm** is a finite sequence of rigorous instructions, typically used to solve a class of specific problems or to perform a computation, satisfying the properties: A) correctness, B) finiteness, C) extensionality, D) effectiveness.

II. We indicate the following algorithmic techniques (methods of their constructions:)

- ① brute force, divide and conquer, greedy, heuristic, dynamic, evolutionary.

III. We can single out two important classes of algorithms:

- ① searching algorithms and sorting algorithms

IV. Examples: Fermat's algorithm, Dijkstra's algorithm, Euclidean algorithm, etc.



Errors by Answering....

- ① Distinctive properties of our objects instead of their Definitions

Example

A predicate calculus is based on quantifiers.

- ② Semantic fields of our concepts is too narrow.

Example

A database is a collection of relational data.



Errors by Answering....

- ① **Operational/ostensive describing** of our objects instead of their **classical defining**

Example

I used a database in Chapter 5, on a page 23 of my thesis.

- ② **A definition** of our concepts is **partially false**.

Example

Algorithm is an infinite procedure.



Errors by Answering....

- ① Descriptions involved in classical defining errors (*idem per idem/ignotum per ignotum*)

Example

A **cell neighbourhood** is a spatial structure consisting of a finite collection of **orthogonally adjacent** cells.



Errors by Answering....

① Defining involved in the error of Categorial Translation

Example

A propositional calculus is a set of axioms.

② Defining by Applications

Example

The relation might be found in a relational database.



What to do in difficult situations?

- ① I didn't understand the question (or I am not sure that I understand it correctly)
- ② I know nothing about the subject of the question/I completely forgot

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