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CONSTRUCTION OF A FORMAL MODEL OF THE EXCURSION SELECTION PROCESS FOR STUDENTS: A CASE STUDY OF THE "PUSH" SCHOOL IN KHARKIV IN THE FORM OF A LOGICAL AFP-NETWORK

The article is devoted to the study of the finite predicate algebra toolkit for constructing a network model aimed at formalizing the process of selecting educational excursions for students of general secondary education institutions, in particular for the "Push" School in Kharkiv. The objective of this work is to develop a corresponding mathematical model in the form of a logical AFP-network. The organization of excursions constitutes an important component of the educational process, as it enables the integration of learning, recreation, social interaction, and career guidance for students. In the context of modern challenges—such as ensuring safety, aligning with educational objectives, and optimizing costs—there is a clear need for the development of effective methods for planning and selecting excursions, which determines the practical relevance of the research problem.

The application of predicate algebra in this domain has made it possible to formalize the excursion selection process while accounting for a wide range of parameters, including cost, duration, safety level, student categories, interests, educational objectives, accommodation conditions, and others. The methodology for constructing logical networks provides a systematic analysis of the subject area and enables the creation of a mathematical model in the form of a complex polyadic relation through the composition of corresponding binary relations derived from the subject area analysis, thereby optimizing the processing of input knowledge.

The mathematical model of the excursion selection process is represented as a polyadic predicate dependent on a set of variables, each associated with a specific domain of definition. Knowledge processing is carried out in the network nodes through conjunction and disjunction operations, with knowledge represented as predicates corresponding to subsets of the respective domains. Each binary predicate is described in the form of bipartite graphs and the corresponding formulas. The conjunction of all constructed binary predicates forms a logical network that enables iterative processing of information until a stable result is achieved.

The scientific novelty lies in the developed model, which facilitates the automation of the excursion selection process while accounting for the individual characteristics of students and the resources of the school. The results of this study represent an effective tool for optimizing educational programs.

Keywords: algebra of finite predicates, decomposition, AFP-logical network, formal model, binary relation, school, excursion.

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ПОБУДОВА ФОРМАЛЬНОЇ МОДЕЛІ ПРОЦЕСУ ВИБОРУ ЕКСКУРСІЇ ДЛЯ УЧНІВ НА ПРИКЛАДІ ШКОЛИ «PUSH У ХАРКОВІ» У ВИГЛЯДІ ЛОГІЧНОЇ АСП-МЕРЕЖІ

Статтю присвячено дослідженню інструментарію алгебри скінченних предикатів для побудови мережевої моделі для формалізації процесу вибору освітніх екскурсій учнями загальноосвітніх навчальних закладів, зокрема школи «Push у Харкові». Метою роботи є аналіз предметної області та побудова відповідної математичної моделі у вигляді логічної АСП-мережі. Організація екскурсій є важливою складовою освітнього процесу, адже дозволяє поєднувати навчання, розваги, соціальну інтеграцію та профорієнтацію учнів. У контексті сучасних викликів, таких як забезпечення безпеки, відповідність освітнім цілям та оптимізація витрат, постає необхідність у розробці ефективних методів планування та вибору екскурсій, що обумовлює практичну значимість поставленої задачі.Застосування алгебри предикатів у цій сфері дозволило формалізувати процес вибору екскурсій із урахуванням великої кількості параметрів, зокрема вартості, тривалості, рівня безпеки, категорії учнів, інтересів, освітніх цілей, умов проживання тощо. Методика побудови логічних мереж забезпечує системний аналіз предметної області і побудову математичної моделі у вигляді складного багатомісцевого відношення через композицію відповідних бінарних відношень, отриманих внаслідок проведеного аналізу предметної області, що дозволяє оптимізувати обробку вхідних знань.

Математична модель процесу вибору екскурсій представлено багатомісцевим предикатом, що залежить від множини змінних, де кожній змінній відповідає певна область визначення. Обробка знань відбувається у вузлах мережі через операції кон'юнкції та диз'юнкції, знання подаються у вигляді предикатів, що відповідають підмножинам областей визначення. Кожен із бінарних предикатів описано у вигляді дводольних графів та відповідних формул. Кон'юнкція всіх побудованих бінарних предикатів утворює логічну мережу, яка дозволяє ітераційно обробляти інформацію до досягнення сталого результату. Науковою новизною є розроблена модель, робота якої сприяє автоматизації процесу вибору екскурсій та врахуванню індивідуальних особливостей учнів і шкільних ресурсів. Результати роботи є ефективним інструментом для оптимізації освітніх програм.

Ключові слова: алгебра скінченних предикатів, декомпозиція, логічна АСП-мережа, формальна модель, бінарне відношення, школа, екскурсія.

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Introduction

The digital transformation era is marked by an exponential increase in information flows, creating an urgent need for more advanced data retrieval mechanisms. Users must rapidly identify relevant information within massive, heterogeneous datasets, driving the evolution of diverse search technologies with varying capabilities and application domains. Despite notable technical progress, existing solutions face inherent limitations and are prone to errors in domain-specific contexts. Addressing these challenges requires a solid mathematical foundation for designing efficient search systems and developing intelligent retrieval methodologies that accommodate the multidimensional and heterogeneous nature of modern information spaces.

Related works

The methodology of building logic networks using the algebra of finite predicates is an active research topic in many subject areas. Many scientists focus on the development of effective algorithms for modelling, process optimisation and analysis of complex systems. In the works of I. Shubin [1, 2], relational tools for constructing logical network models are described, emphasizing the importance of representing relationships between objects in a system and their formalization through predicates. This approach has also been analyzed and investigated in the study by I. D. Vechirska, M. S. Chernousova, and A. D. Vechirska [3], which focuses on developing a logical network to describe the process of reconciling balance sheet accounts for deposit management in both business entities and individuals. Their research demonstrates the practical significance of applying predicate algebra for modeling financial processes. In his work, I. Shubin [4,5] developed conjunctive decomposition tools that enable the optimization of complex polyadic relations by simplifying them into more manageable elements for processing. Z. Dudar and A. Kozyriev [6] applied the method of finite logical ASP networks to the analysis of educational data. Their research highlights the potential of predicate algebra in the field of education, although their focus did not extend to the organization of educational excursions.

An international research team comprising Charles Colla, Aniq Momtaz, Borzu Bonakdarpour, and Houssam Abbas [7] explored decentralized predicate detection for partially synchronous continuous-time signals. While their approach is applicable to high-tech analytical systems, it differs substantially from the educational context. Among related studies, the work by I. Vechirska and others “Construction of a Logical Network for Solving the Car Rental Problem Using Finite Predicate Algebra” [8], underscores the universality and efficiency of logical networks in modeling complex multifactor processes. The need for a more detailed investigation of how various factors influence long-term planning under conditions of digital transformation and dynamic change—namely, the identification and analysis of all system interconnections—and the concurrent absence of a comprehensive approach enabling their effective synthesis into existing strategic management systems while considering the specific features of particular organizations, can be addressed through the use of predicate analysis for constructing logical models [9, 10]. Thus, the aim of this study is to analyze the process of selecting educational excursions for students of the “Push” School in Kharkiv [11] and to construct a corresponding mathematical model in the form of a logical ASP network.

Building a mathematical model of choosing an excursion for students of the ‘Push in Kharkiv’ school in the form of a logical network using the algebra of finite predicates

Despite substantial progress in applying predicate algebra to the modeling of diverse processes, the domain of student field trip selection remains insufficiently explored. The model proposed in this study is innovative in that it constitutes the first formalization of this process using a logical network, incorporating multifactorial dependencies such as student interests, educational objectives, safety considerations, and institutional resources. This approach offers new prospects for integrating systems analysis into educational planning.

The subsequent analysis will address the attribute “Excursion”, characterized by the following set of values: “Kharkiv Underground” [12]; “City of Technology” [13]; “Musical Kharkiv”:[14]; “Chernobyl: Lessons from History” [15]; “Carpathian Adventure” [16]; “Inside the Trypillian Civilization” [17]; “Cossack Trails” [18]; “CERN: The Universe Under the Microscope” [19]; “Alps in Austria” [20]; “Gems of Italy: Venice, Milan, Rome” [21].

The subsequent analysis will address the attribute “Highlighted Features”, characterized by the following set of values: cost (in UAH per person) (Table 1); duration (1 day, 2 days, 3 days, 4 days, a week, etc.); name of the excursion; safety (related to the war in Ukraine) (high, medium, low); number of students (up to 50 students; from 50 to 150; more than 150); category of students (primary school, middle school, high school); transport (school bus, train, plane); distance from the school (within Kharkiv city, other cities of Ukraine, abroad); student interests required for a certain excursion (history, music, nature, science); educational goals (knowledge, social skills, career guidance); meals (three meals a day, intensive (five meals a day)); accommodation (basic (e.g., hostels), comfortable (e.g., mid-range hotels), premium (high-end hotels)); reviews and recommendations (good, neutral, poor); possibility of implementation for the school (no, yes); student interest in the excursion (high, medium, low); excursion program (intensive – only excursions; extended – additional visits or entertainment on request); travel time round trip (less than 4 hours, more than 4 hours and less than 3 days, more than 3 days).

Table 1

Paradigmatic table of the relationship between the name of the excursion, cost and category of students

Name of the excursion	Primary school	Middle school	High school
“Kharkiv Underground”	500	630	820
	450	550	800
	400	520	700
“City of Technology”	400	500	600
	350	450	550
	250	350	400
“Musical Kharkiv”	630	800	800
	600	720	720
	500	700	700
“Chernobyl: Lessons from History”	—	—	3500
“Carpathian Adventure”	7000	9000	10000
	6000	8500	9000
	5500	8000	8500
“Inside the Trypillian Civilization”	3000	4000	4500
	2800	4800	4100
	2200	4200	4700
“Cossack Trails”	2000	3800	3800
	2800	3000	3000
	2100	3500	3500
“CERN: The Universe Under the Microscope”	—	17000	17000
“Alps in Austria”	—	18500	19500
“Gems of Italy: Venice, Milan, Rome”	—	22000	22000

Now we will explore which features influence the cost: x_1– excursion name (“Underground Kharkiv” – UK, “City of Technology” – CT, “Musical Kharkiv”– MK, “Chernobyl: Lessons from History”– C, “Carpathian Adventure”– CA, “Inside the Trypillian Civilization” – TC, “Cossack Trails”– KP, “CERN: The Universe Under the Microscope”– CERN, “Alps in Austria”– AA, “Gems of Italy: Venice, Milan, Rome”– PI); x_2– safety (high – H, medium – M, low – L); x_3– number of students (up to 50 students – S; from 50 to 150 – M; from 150 and more – L); x_4 – student category (primary school – P, middle school – M, high school – H); x_5 – transport (school bus – B, school bus and train – BT, school bus, train and aeroplane – BTA); x_6 – distance from school (within the city of Kharkiv – N, other cities of Ukraine – R, abroad – A); x_7 – meals (three times a day – 3, intensive – 5); x_8 – accommodation (basic – B, comfortable – C, premium – P); x_9 – excursion program (intensive – I, extended – E).

The duration of the excursion also influences the cost, but it will be considered as a separate attribute.

Each populated cell of Paradigmatic Table 1 will be sequentially numbered from 1 to 61, with each cell formally represented by corresponding formulas $q^1 - q^{61}$ in finite predicate algebra.

$$x_1^{UK}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{1};\ x_1^{UK}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{2};x_1^{UK}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{3};x_1^{UK}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{4};$$
$$x_1^{UK}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{5};x_1^{UK}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{6};x_1^{UK}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{7};x_1^{UK}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{8};$$
$$x_1^{UK}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{9};x_1^{CT}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{10};x_1^{CT}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{11};x_1^{CT}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{12};$$
$$x_1^{CT}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{13};x_1^{CT}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{14};x_1^{CT}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{15};x_1^{CT}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{16};$$
$$x_1^{CT}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{17};x_1^{CT}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{18};x_1^{MK}x_2^{L}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{19};x_1^{MK}x_2^{L}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{20};$$
$$x_1^{MK}x_2^{L}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}=q^{21};x_1^{MK}x_2^{L}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{22};x_1^{MK}x_2^{L}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{23};x_1^{MK}x_2^{L}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}=q^{24};$$
$$x_1^{MK}x_2^{L}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{25};x_1^{MK}x_2^{L}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{26};x_1^{MK}x_2^{L}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}=q^{27};x_1^{C}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{28};$$
$$x_1^{CA}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{29};x_1^{CA}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{30};x_1^{CA}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{31};$$
$$x_1^{CA}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{32};x_1^{CA}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{33};x_1^{CA}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{34};$$
$$x_1^{CA}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{35};x_1^{CA}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{36};x_1^{CA}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}=q^{37};$$
$$x_1^{TC}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{38};x_1^{TC}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{39};x_1^{TC}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{40};$$
$$x_1^{TC}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{41};x_1^{TC}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{42};x_1^{TC}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{43};$$
$$x_1^{TC}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{44};x_1^{TC}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{45};x_1^{TC}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}=q^{46};$$
$$x_1^{KP}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{47};x_1^{KP}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{48};x_1^{KP}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{49};$$
$$x_1^{KP}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{50};x_1^{KP}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{51};x_1^{KP}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{52};$$
$$x_1^{KP}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{53};x_1^{KP}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{54};x_1^{KP}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}=q^{55};$$
$$x_1^{CERN}x_2^{H}x_3^{M}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}=q^{56};x_1^{CERN}x_2^{H}x_3^{M}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}=q^{57};x_1^{AA}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}=q^{58};$$
$$x_1^{AA}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}=q^{59};x_1^{PI}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}=q^{60};x_1^{PI}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}=q^{61}.$$

We will perform the operation of partial disjunction of as many related inequalities as possible and form the dependence of the influence number of the considered group of features that form the excursion price r on the cell numbers of the paradigmatic table q:

$$x_1^{UK}x_2^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^1\vee q^2\vee q^3 = r^1, x_1^{UK}x_2^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^4\vee q^5\vee q^6 = r^2,$$
$$x_1^{UK}x_2^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^7\vee q^8\vee q^9 = r^3, x_1^{CT}x_2^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{10}\vee q^{11}\vee q^{12} = r^4,$$
$$x_1^{CT}x_2^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{13}\vee q^{14}\vee q^{15} = r^5, x_1^{CT}x_2^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{16}\vee q^{17}\vee q^{18} = r^6,$$
$$x_1^{MK}x_2^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{19}\vee q^{20}\vee q^{21} = r^7, x_1^{MK}x_2^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{22}\vee q^{23}\vee q^{24} = r^8,$$
$$x_1^{MK}x_2^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{25}\vee q^{26}\vee q^{27} = r^9, x_1^{C}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} = q^{28} = r^{10}, x_1^{CA}x_2^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}\wedge$$
$$\wedge(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{29}\vee q^{30}\vee q^{31} = r^{11}, x_1^{CA}x_2^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{32}\vee q^{33}\vee q^{34} = r^{12},$$
$$x_1^{CA}x_2^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{35}\vee q^{36}\vee q^{37} = r^{13}, x_1^{TC}x_2^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{38}\vee q^{39}\vee$$
$$\vee q^{40} = r^{14}, x_1^{TC}x_2^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{41}\vee q^{42}\vee q^{43} = = r^{15},$$
$$x_1^{TC}x_2^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{44}\vee q^{45}\vee q^{46} = r^{16}, x_1^{KP}x_2^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) =$$
$$q^{47}\vee q^{48}\vee q^{49} = r^{17}, x_1^{KP}x_2^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) == q^{50}\vee q^{51}\vee q^{52} = r^{18},$$
$$x_1^{KP}x_2^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}(x_3^{L}\vee x_3^{M}\vee x_3^{S}) = q^{53}\vee q^{54}\vee q^{55} = r^{19}, x_1^{CERN}x_2^{H}x_3^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}\wedge\wedge(x_4^{M}\vee x_4^{H}) = q^{56}\vee q^{57} =$$
$$r^{20}, x_1^{AA}x_2^{H}x_3^{S}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}(x_4^{M}\vee x_4^{H}) = q^{58}\vee q^{59} = r^{21},$$
$$x_1^{PI}x_2^{H}x_3^{S}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}(x_4^{M}\vee x_4^{H}) = q^{60}\vee q^{61} = r^{22}.$$

The dependencies of the influence number of the variable r on the variables $x_1 - x_9$ allow to binarise the relations linking the variable r with the variables $x_1 - x_9$ (1)-(9). The resulting relations are represented as bipartite graphs (Fig.1-9).

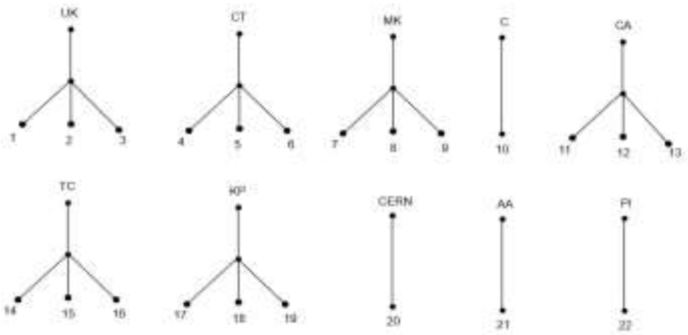

Fig. 1. Graph of the relationship between r and x_1 variables

$$P(x_1, r) = x_1^{UK}(r^1\vee r^2\vee r^3)\vee x_1^{CT}(r^4\vee r^5\vee r^6)\vee x_1^{MK}(r^7\vee r^8\vee r^9)\vee x_1^{C}r^{10}\vee x_1^{CA}(r^{11}\vee r^{12}\vee r^{13})$$
$$\vee x_1^{TC}(r^{14}\vee r^{15}\vee r^{16})\vee x_1^{KP}(r^{17}\vee r^{18}\vee r^{19})\vee x_1^{CERN}r^{20}\vee x_1^{AA}r^{21}\vee x_1^{PI}r^{22} \quad (1)$$

$$P(x_2, r) = x_2^{L}(r^7\vee r^8\vee r^9)\vee x_2^{M}(r^1\vee r^2\vee r^3\vee r^4\vee r^5\vee r^6\vee r^{10}\vee r^{11}\vee r^{12}\vee r^{13}\vee$$
$$r^{14}\vee r^{15}\vee r^{16}\vee r^{17}\vee r^{18}\vee r^{19})\vee x_2^{H}(r^{20}\vee r^{21}\vee r^{22}) \quad (2)$$

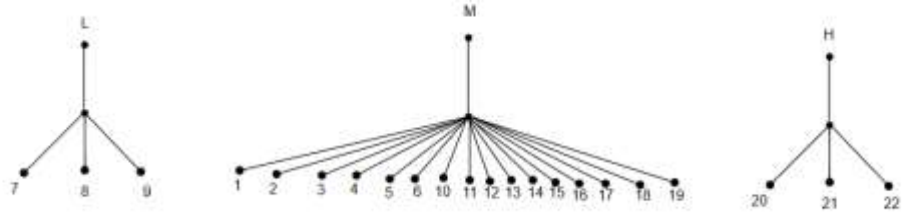

Fig. 2. Graph of the relationship between r and x_2 variables

$$P(x_3, r) = (x_3^{L}\vee x_3^{M}\vee x_3^{S})(r^1\vee r^2\vee r^3\vee r^4\vee r^5\vee r^6\vee r^7\vee r^8\vee r^9\vee r^{11}\vee r^{12}\vee r^{13}\vee$$
$$r^{14}\vee r^{15}\vee r^{16}\vee r^{17}\vee r^{18}\vee r^{19})\vee x_3^{S}(r^{10}\vee r^{21}\vee r^{22})\vee x_3^{M}r^{20} \quad (3)$$

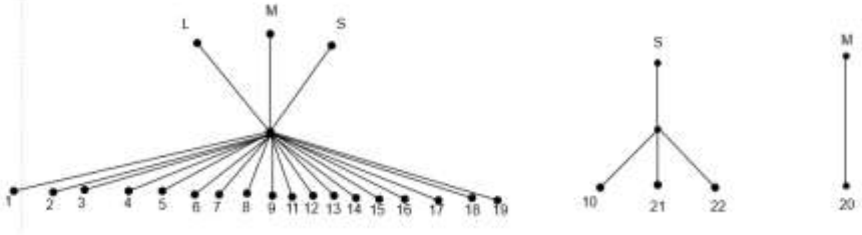

Fig. 3. Graph of the relationship between r and x_3 variables

$$P(x_4, r) = x_4^{P}(r^1\vee r^4\vee r^7\vee r^{11}\vee r^{14}\vee r^{17})\vee x_4^{M}(r^2\vee r^5\vee r^8\vee r^{12}\vee r^{15}\vee r^{18})\vee$$

$$x_4^H(r^3 \vee r^6 \vee r^9 \vee r^{10} \vee r^{13} \vee r^{16} \vee r^{19}) \vee (x_4^M \vee x_4^H)\ (r^{20} \vee r^{21} \vee r^{22}) \quad (4)$$

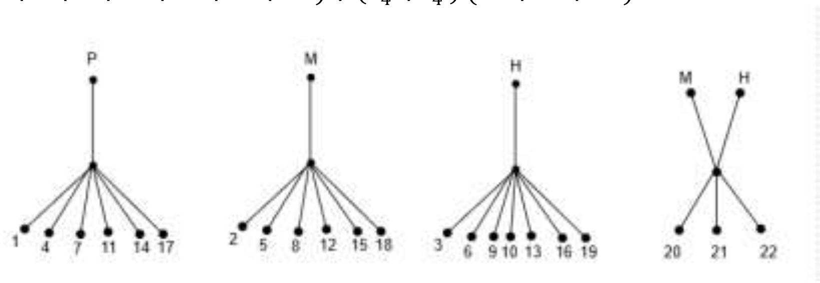

Fig. 4. Graph of the relationship between r and x_4 variables

$$P(x_5, r) = x_5^B\ (r^1 \vee r^2 \vee r^3 \vee r^4 \vee r^5 \vee r^6 \vee r^7 \vee r^8 \vee r^9) \vee x_5^{BT}(r^{10} \vee r^{11} \vee r^{12} \vee r^{13} \vee r^{14} \vee r^{15} \vee r^{16} \vee r^{17} \vee r^{18} \vee r^{19}) \vee x_5^{BTA}(r^{20} \vee r^{21} \vee r^{22}) \quad (5)$$

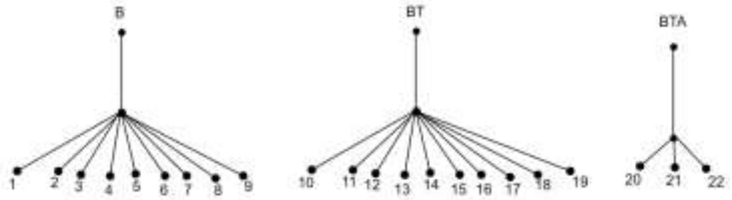

Fig. 5. Graph of the relationship between r and x_5 variables

$$P(x_6, r) = x_6^N\ (r^1 \vee r^2 \vee r^3 \vee r^4 \vee r^5 \vee r^6 \vee r^7 \vee r^8 \vee r^9) \vee x_6^R(r^{10} \vee r^{11} \vee r^{12} \vee r^{13} \vee r^{14} \vee r^{15} \vee r^{16} \vee r^{17} \vee r^{18} \vee r^{19}) \vee x_6^A(r^{20} \vee r^{21} \vee r^{22}) \quad (6)$$

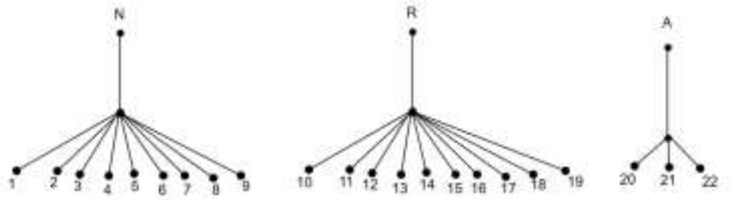

Fig. 6. Graph of the relationship between r and x_6 variables

$$P(x_7, r) = x_7^3(r^{10} \vee r^{14} \vee r^{15} \vee r^{16} \vee r^{17} \vee r^{18} \vee r^{19}) \vee x_7^5(r^{11} \vee r^{12} \vee r^{13} \vee r^{20} \vee r^{21} \vee r^{22}) \quad (7)$$

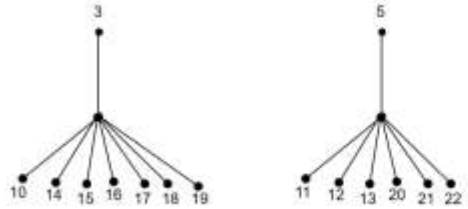

Fig. 7. Graph of the relationship between r and x_7 variables

$$P(x_8, r) = x_8^B(r^{14} \vee r^{15} \vee r^{16}) \vee x_8^C(r^{11} \vee r^{12} \vee r^{13} \vee r^{20} \vee r^{22}) \vee x_8^P r^{21} \quad (8)$$

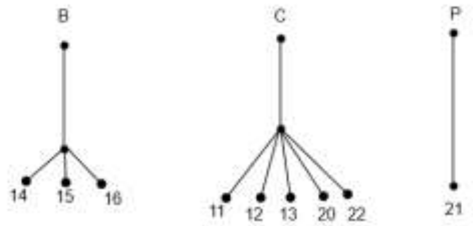

Fig. 8. Graph of the relationship between r and x_8 variables

$$P(x_9, r) = x_9^I(r^1 \vee r^2 \vee r^3 \vee r^4 \vee r^5 \vee r^6 \vee r^7 \vee r^8 \vee r^9 \vee r^{10} \vee r^{14} \vee r^{15} \vee r^{16} \vee r^{17} \vee r^{18} \vee r^{19}) \vee x_9^E(r^{11} \vee r^{12} \vee r^{13} \vee r^{20} \vee r^{21} \vee r^{22}) \quad (9)$$

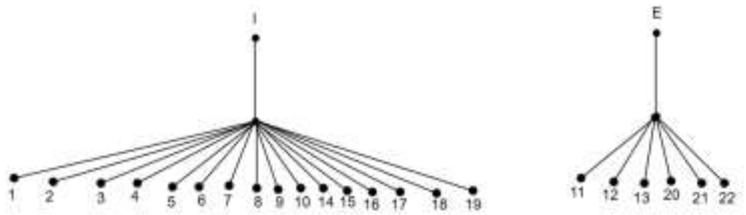

Fig. 9. Graph of the relationship between r and x_9 variables

Table 2 shows a paradigmatic table of the dependence of the name of the excursion, the category of students, and the priority of choice (1 – will not go; 2 – low probability of attending this excursion; 3 – 50/50; 4 - high probability of choosing the excursion; 5 – very high probability that this excursion will be attended in the spring). In other words, this is essentially a table of preliminary interest in excursions, both by the school, students and parents.

Table 2

Paradigmatic table of the relationship between the name of the excursion, the category of students, and the priority of choice

Name of the excursion	Primary school	Middle school	High school
“Kharkiv Underground”	4	5	5
“City of Technology”	5	4	5
“Musical Kharkiv”	3	3	2
“Chernobyl: Lessons from History”	—	—	1
“Carpathian Adventure”	5	5	4
“Inside the Trypillian Civilization”	4	4	3
“Cossack Trails”	5	4	3
“CERN: The Universe Under the Microscope”	—	3	4
“Alps in Austria”	—	5	3
“Gems of Italy: Venice, Milan, Rome”	—	5	5

This way, the priority is influenced: x_1– excursion name (“Underground Kharkiv” – UK, “City of Technology” – CT, “Musical Kharkiv”– MK, “Chernobyl: Lessons from History”– C, “Carpathian Adventure”– CA, “Inside the Trypillian Civilization” – TC, “Cossack Trails”– KP, “CERN: The Universe Under the Microscope”– CERN, “Alps in Austria”– AA, “Gems of Italy: Venice, Milan, Rome”– PI); x_2– safety (high – H, medium – M, low – L); x_4 – student category (primary school – P, middle school – M, high school – H); x_{10} – students' interests (history – H, music – M, nature – N, science – S); x_{11} – educational goals (knowledge – K, social skills – S, career guidance – C); x_{12} – feedback and recommendations (good – G, neutral – N, bad – B); x_{13} – the possibility of organising an excursion for the school (no – N, yes –Y); x_{14} – students' interest in the excursion (high – H, medium – M, low – L).

Cost also has an impact, but this is also a separate pole that we will connect to this later.

For further construction, it is necessary to express the numbers q of the cells of the paradigmatic priority table through the features introduced above $x_1, x_2, x_4, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}$ and perform the operation of partial disjunction of as many related inequalities as possible and form the dependence of the influence number of the considered group of features that form the priority of choosing an excursion, z, on the numbers of cells in the paradigmatic table q:

$$x_1^{UK}x_2^{M}x_4^{P}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{M}=q^1=z^1, x_1^{UK}x_2^{M}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{H}(x_4^{M}\vee x_4^{H})=q^2\vee q^3=z^2, x_1^{CT}x_2^{M}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}x_{14}^{H}\wedge$$
$$\wedge(x_4^{P}\vee x_4^{H})=q^4\vee q^6=z^3, x_1^{CT}x_2^{M}x_4^{M}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}x_{14}^{M}=q^5=z^4, x_1^{MK}x_2^{L}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{M}(x_4^{P}\vee x_4^{M})=q^7\vee q^8=z^5,$$
$$x_1^{MK}x_2^{L}x_4^{H}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{L}=q^9=z^6, x_1^{C}x_2^{M}x_4^{H}x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{N}x_{14}^{L}=q^{10}=z^7,$$
$$x_1^{CA}x_2^{M}x_{10}^{N}x_{11}^{S}x_{12}^{G}x_{13}^{Y}x_{14}^{H}(x_4^{P}\vee x_4^{M})=q^{11}\vee q^{12}=$$
$$=z^8, x_1^{CA}x_2^{M}x_4^{H}x_{10}^{N}x_{11}^{S}x_{12}^{G}x_{13}^{Y}x_{14}^{M}=q^{13}=z^9, x_1^{TC}x_2^{M}x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{Y}x_{14}^{H}(x_4^{P}\vee x_4^{M})=q^{14}\vee q^{15}=z^{10},$$
$$x_1^{TC}x_2^{M}x_4^{H}x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{Y}x_{14}^{M}=q^{16}=z^{11}, x_1^{KP}x_2^{M}x_4^{P}x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{H}=q^{17}=z^{12}, x_1^{KP}x_2^{M}x_4^{M}x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{M}=$$
$$q^{18}=z^{13},$$
$$x_1^{KP}x_2^{M}x_4^{H}x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{L}=q^{19}=z^{14}, x_1^{CERN}x_2^{H}x_4^{M}x_{10}^{S}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{L}=q^{20}=z^{15}, x_1^{CERN}x_2^{H}x_4^{H}x_{10}^{S}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{M}=q^{21}=$$
$$=z^{16}, x_1^{AA}x_2^{H}x_4^{M}x_{10}^{N}x_{11}^{S}x_{12}^{N}x_{13}^{Y}x_{14}^{H}=q^{22}=z^{17}, x_1^{AA}x_2^{H}x_4^{H}x_{10}^{N}x_{11}^{S}x_{12}^{N}x_{13}^{Y}x_{14}^{L}=q^{23}=z^{18},$$
$$x_1^{PI}x_2^{H}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{H}(x_4^{M}\vee x_4^{H})=q^{24}\vee q^{25}=z^{19}.$$

The dependencies of the influence number of the variable z on the variables $x_1, x_2, x_4, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}$ allow binarisation of relations linking the variable z with the variables $x_1, x_2, x_4, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}$:

$$P(x_1,z) = x_1^{UK}(z^1 \vee z^2) \vee x_1^{CT}(z^3 \vee z^4) \vee x_1^{MK}(z^5 \vee z^6) \vee x_1^{C} z^7 \vee x_1^{CA}(z^8 \vee z^9) \vee x_1^{TC}(z^{10} \vee z^{11}) \vee x_1^{KP}(z^{12} \vee z^{13} \vee z^{14}) \vee \vee x_1^{CERN}(z^{15} \vee z^{16}) \vee x_1^{AA}(z^{17} \vee z^{18}) \vee x_1^{PI} z^{19};\ P(x_2,z) = x_2^{L}(z^5 \vee z^6) \vee \vee z^2 \vee z^3 \vee z^4 \vee z^7 \vee z^8\ x_2^{M}(z^1 \vee z^2 \vee z^3 \vee z^4 \vee z^7 \vee z^8 \vee z^9 \vee z^{10} \vee z^{11} \vee z^{12} \vee z^{13} \vee z^{14}) \vee x_2^{H}(z^{15} \vee z^{16} \vee z^{17} \vee z^{18} \vee z^{19});$$

$$P(x_4,z) = (x_4^{M} \vee x_4^{H})(z^2 \vee z^{19}) \vee (x_4^{P} \vee x_4^{H}) z^3 \vee (x_4^{P} \vee x_4^{M})(z^5 \vee z^8 \vee z^{10}) \vee x_4^{P}(z^1 \vee z^{12}) \vee x_4^{M}(z^4 \vee z^{13} \vee z^{15} \vee z^{17}) \vee \vee x_4^{H}(z^6 \vee z^7 \vee z^9 \vee z^{11} \vee z^{14} \vee z^{16} \vee z^{18});\ P(x_{10},z) = x_{10}^{H}(z^1 \vee z^2 \vee z^7 \vee z^{10} \vee z^{11} \vee z^{12} \vee z^{13} \vee z^{14} \vee z^{19}) \vee \vee x_{10}^{S}(z^3 \vee z^4 \vee z^{15} \vee z^{16}) \vee x_{10}^{M}(z^5 \vee z^6) \vee x_{10}^{N}(z^8 \vee z^9 \vee z^{17} \vee z^{18});\ P(x_{11},z) = x_{11}^{K}(z^1 \vee z^2 \vee z^5 \vee z^6 \vee z^7 \vee z^{10} \vee z^{11} \vee z^{12} \vee \vee z^{13} \vee z^{14} \vee z^{15} \vee z^{16} \vee z^{19}) \vee x_{11}^{S}(z^8 \vee z^9 \vee z^{17} \vee z^{18}) \vee x_{11}^{C}(z^3 \vee z^4);$$

$$P(x_{12},z) = x_{12}^{G}(z^1 \vee z^2 \vee z^8 \vee z^9 \vee z^{15} \vee z^{16} \vee z^{19}) \vee \vee x_{12}^{N}(z^3 \vee z^4 \vee z^5 \vee z^6 \vee z^{12} \vee z^{13} \vee z^{14} \vee z^{17} \vee z^{18}) \vee x_{12}^{B}(z^7 \vee z^{10} \vee z^{11});\ P(x_{13},z) = x_{13}^{Y}(z^1 \vee z^2 \vee z^3 \vee z^4 \vee z^5 \vee z^6 \vee z^8 \vee \vee z^9 \vee z^{10} \vee z^{11} \vee z^{12} \vee z^{13} \vee z^{14} \vee z^{15} \vee z^{16} \vee z^{17} \vee z^{18} \vee z^{19}) \vee x_{13}^{N} z^7;\ P(x_{14},z) = x_{14}^{H}(z^2 \vee z^3 \vee z^8 \vee z^{10} \vee z^{12} \vee z^{17} \vee \vee z^{19}) \vee x_{14}^{M}(z^1 \vee z^4 \vee z^5 \vee z^9 \vee z^{11} \vee z^{13} \vee z^{16}) \vee x_{14}^{L}(z^6 \vee z^7 \vee z^{14} \vee z^{15} \vee z^{18}).$$

The resulting relations can be represented similarly to the first option in the form of bipartite graphs.

Table 3

Paradigmatic table of the relationship between the name of the excursion, the category of students, and the duration of the excursion

Name of the excursion	Primary school	Middle school	High school
“Kharkiv Underground”	6 hours	7 hours	7 hours
“City of Technology”	5 hours	5 hours	6 hours
“Musical Kharkiv”	4 hours	5 hours	6 hours
“Chernobyl: Lessons from History”	—	—	2 дні
“Carpathian Adventure”	8 days	10 days	10 days
“Inside the Trypillian Civilization”	3 days	3 days	3 days
“Cossack Trails”	1 day	1 day	1 day
“CERN: The Universe Under the Microscope”	—	12 days	12 days
“Alps in Austria”	—	13 days	15 days
“Gems of Italy: Venice, Milan, Rome”	—	14 days	14 days

The duration of the tour for primary, middle and high school may differ, because, for example, the intensive tour programme ‘Dungeons of Kharkiv’ for primary school is 1 hour shorter, because children are still young and get tired faster than middle and high school. Features that affect the duration of the tour: x_1– excursion name (“Underground Kharkiv” – UK, “City of Technology” – CT, “Musical Kharkiv”– MK, “Chernobyl: Lessons from History”– C, “Carpathian Adventure”– CA, “Inside the Trypillian Civilization” – TC, “Cossack Trails”– KP, “CERN: The Universe Under the Microscope”– CERN, “Alps in Austria”– AA, “Gems of Italy: Venice, Milan, Rome”– PI); x_4 – student category (primary school – P, middle school – M, high school – H); x_9 – excursion program (intensive – I, extended – E); x_{15} – travelling time in both directions (less than 4 hours – LF, more than 4 hours and less than 3 days – M4L3, more than 3 days – M3).

For further construction, it is necessary to express the numbers q of the cells of the paradigmatic table in terms of the above features x_1, x_4, x_9, x_{15} and perform the operation of partial disjunction of as many related inequalities as possible and form the dependence of the influence number of the considered group of features that form the duration of the excursion, s, on the numbers of cells in the paradigmatic table q:

$$x_1^{UK} x_9^{I} x_{15}^{LF}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^1 \vee q^2 \vee q^3 = s^1;\ x_1^{CT} x_9^{I} x_{15}^{LF}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^4 \vee q^5 \vee q^6 = s^2; x_1^{MK} x_9^{I} x_{15}^{LF}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^7 \vee q^8 \vee q^9 = s^3;\ x_1^{C} x_4^{H} x_9^{I} x_{15}^{M4L3} = q^{10} = s^4;\ x_1^{CA} x_9^{E} x_{15}^{M3}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^{11} \vee q^{12} \vee q^{13} = s^5;\ x_1^{TC} x_9^{I} x_{15}^{M4L3}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^{14} \vee q^{15} \vee q^{16} = s^6;\ x_1^{KP} x_9^{I} x_{15}^{M4L3}(x_4^{P} \vee x_4^{M} \vee x_4^{H}) = q^{17} \vee q^{18} \vee q^{19} = s^7; x_1^{CERN} x_9^{E} x_{15}^{M3}(x_4^{M} \vee x_4^{H}) = q^{20} \vee q^{21} = s^8;\ x_1^{AA} x_9^{E} x_{15}^{M3}(x_4^{M} \vee x_4^{H}) = q^{22} \vee q^{23} = s^9;\ x_1^{PI} x_9^{E} x_{15}^{M3}(x_4^{M} \vee x_4^{H}) = q^{24} \vee q^{25} = s^{10}.$$

The dependencies of the influence number of the variable s on the variables x_1, x_4, x_9, x_{15} allow to binarise the relations that connect the variable s with the variables x_1, x_4, x_9, x_{15} (18)-(21). The resulting relations can be represented similarly to the first option in the form of bipartite graphs.

$$P(x_1,s) = x_1^{UK} s^1 \vee x_1^{CT} s^2 \vee x_1^{MK} s^3 \vee x_1^{C} s^4 \vee x_1^{CA} s^5 \vee x_1^{TC} s^6 \vee x_1^{KP} s^7 \vee x_1^{CERN} s^8 \vee x_1^{AA} s^9 \vee x_1^{PI} s^{10} \quad (18)$$

$$P(x_4,s) = (x_4^{P} \vee x_4^{M} \vee x_4^{H})(s^1 \vee s^2 \vee s^3 \vee s^5 \vee s^6 \vee s^7) \vee x_4^{H} s^4 \vee (x_4^{M} \vee x_4^{H})(s^8 \vee s^9 \vee s^{10}) \quad (19)$$

$$P(x_9,s) = x_9^{I}(s^1 \vee s^2 \vee s^3 \vee s^4 \vee s^6 \vee s^7) \vee x_9^{E}(s^5 \vee s^8 \vee s^9 \vee s^{10}) \quad (20)$$

$$P(x_{15},s) = x_{15}^{LF}(s^1 \vee s^2 \vee s^3) \vee x_{15}^{M4L3}(s^4 \vee s^6 \vee s^7) \vee x_{15}^{M3}(s^5 \vee s^8 \vee s^9 \vee s^{10}) \quad (21)$$

As we mentioned earlier, the priority of choosing an excavation depends on its cost.

Table 4

Paradigmatic table of the dependence of the priority of the choice of execution on its cost

Name of the excursion	Primary school	Middle school	High school
"Kharkiv Underground"	$x_1^{UK}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}$ $x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{M}$	$x_1^{UK}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$	$x_1^{UK}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$
	$x_1^{UK}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}$	$x_1^{UK}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$	$x_1^{UK}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$
	$x_1^{UK}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}$	$x_1^{UK}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$	$x_1^{UK}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}$
"City of Technology"	$x_1^{CT}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}$	$x_1^{CT}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$	$x_1^{CT}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$
	$x_1^{CT}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}$	$x_1^{CT}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$	$x_1^{CT}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$
	$x_1^{CT}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}$	$x_1^{CT}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$	$x_1^{CT}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}$
"Musical Kharkiv"	$x_1^{MK}x_2^{L}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}$	$x_1^{MK}x_2^{L}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$	$x_1^{MK}x_2^{L}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$
	$x_1^{MK}x_2^{L}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}$	$x_1^{MK}x_2^{L}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$	$x_1^{MK}x_2^{L}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$
	$x_1^{MK}x_2^{L}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}$	$x_1^{MK}x_2^{L}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$	$x_1^{MK}x_2^{L}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}$
Name of the excursion	Primary school	Middle school	High school
"Chernobyl: Lessons from History"	——	——	$x_1^{C}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{B}$
"Carpathian Adventure"	$x_1^{CA}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}$	$x_1^{CA}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$	$x_1^{CA}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$
	$x_1^{CA}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}$	$x_1^{CA}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$	$x_1^{CA}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$
	$x_1^{CA}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}$	$x_1^{CA}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$	$x_1^{CA}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{10}^{N}x_{11}^{S}$
"Inside the Trypillian Civilization"	$x_1^{TC}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}$	$x_1^{TC}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{TC}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$
	$x_1^{TC}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}$	$x_1^{TC}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{TC}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$
	$x_1^{TC}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}$	$x_1^{TC}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{TC}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{10}^{H}x_{11}^{K}$
"Cossack Trails"	$x_1^{KP}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{KP}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$	$x_1^{KP}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$
	$x_1^{KP}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{KP}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$	$x_1^{KP}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$
	$x_1^{KP}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}$	$x_1^{KP}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$	$x_1^{KP}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{N}$
"CERN: The Universe Under the Microscope"	——	$x_1^{CERN}x_2^{H}x_3^{M}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{S}$	$x_1^{CERN}x_2^{H}x_3^{M}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{S}$
"Alps in Austria"	——	$x_1^{AA}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{10}^{N}x_{11}^{S}$	$x_1^{AA}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{10}^{N}x_{11}^{S}$
"Gems of Italy: Venice, Milan, Rome"	——	$x_1^{PI}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{H}x_{11}^{K}$	$x_1^{PI}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{H}x_{11}^{K}$

Perform a binarisation of the relation r and *z*. Accordingly, the predicate *P(r,z)* represents the composition of all 61 conjuncts listed in Table 4, which, after the applied transformations, assumes the following form:

$$P\,(r,z\,)= x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{M}\,(x_1^{UK}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}) \vee$$
$$\vee\, x_{10}^{H}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{H}\,(x_1^{UK}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$x_1^{UK}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$x_1^{UK}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{PI}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{PI}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}) \vee$$
$$\vee\, x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}x_{14}^{H}\,(x_1^{CT}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{CT}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{CT}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{CT}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$\vee x_1^{CT}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{CT}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}) \vee x_{10}^{S}x_{11}^{C}x_{12}^{N}x_{13}^{Y}x_{14}^{M}(x_1^{CT}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{CT}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$\vee x_1^{CT}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}) \vee x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{M}\,(x_1^{MK}x_2^{L}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{MK}x_2^{L}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{MK}x_2^{L}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$x_1^{MK}x_2^{L}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{MK}x_2^{L}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{MK}x_2^{L}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}) \vee x_{10}^{M}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{L}(x_1^{MK}x_2^{L}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee$$
$$\vee x_1^{MK}x_2^{L}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{MK}x_2^{L}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}) \vee x_1^{C}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{N}x_{14}^{L} \vee x_{10}^{N}x_{11}^{S}x_{12}^{G}x_{13}^{Y}x_{14}^{H} \wedge$$

$$\wedge (x_1^{CA}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{CA}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{CA}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee$$
$$\vee x_1^{CA}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{CA}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}) \vee x_{10}^{N}x_{11}^{S}x_{12}^{G}x_{13}^{Y}x_{14}^{M}\ x_1^{CA}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \wedge$$
$$\wedge (x_1^{CA}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{CA}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E} \vee x_1^{CA}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}) \vee x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{Y}x_{14}^{H} \wedge$$
$$\wedge (x_1^{TC}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee x_1^{TC}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee x_1^{TC}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee$$
$$x_1^{TC}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee x_1^{TC}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}) \vee x_{10}^{H}x_{11}^{K}x_{12}^{B}x_{13}^{Y}x_{14}^{M}(x_1^{TC}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee$$
$$x_1^{TC}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I} \vee x_1^{TC}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}) \vee x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{H}\ (x_1^{KP}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee$$
$$\vee x_1^{KP}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee x_1^{KP}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}) \vee x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{M}(x_1^{KP}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee$$
$$\vee x_1^{KP}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee x_1^{KP}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}) \vee x_{10}^{H}x_{11}^{K}x_{12}^{N}x_{13}^{Y}x_{14}^{L}(x_1^{KP}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee$$
$$x_1^{KP}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I} \vee x_1^{KP}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}) \vee x_1^{CERN}x_2^{H}x_3^{M}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{S}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{L}$$
$$\vee x_1^{CERN}x_2^{H}x_3^{M}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{10}^{S}x_{11}^{K}x_{12}^{G}x_{13}^{Y}x_{14}^{M} \vee x_1^{AA}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{10}^{N}x_{11}^{S}x_{12}^{N}x_{13}^{Y}x_{14}^{H} \vee$$
$$\vee x_1^{AA}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{10}^{N}x_{11}^{S}x_{12}^{N}x_{13}^{Y}x_{14}^{L}.$$

Also, the cost of the tour is related to the duration of the excursion, because the longer the tour, the higher the price.

Table 5

The paradigmatic relationship between the cost of excision and duration

Name of the excursion	Primary school	Middle school	High school
"Kharkiv Underground"	$x_1^{UK}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{UK}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{UK}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{UK}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
"City of Technology"	$x_1^{CT}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{CT}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{CT}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{CT}x_2^{M}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
"Musical Kharkiv"	$x_1^{MK}x_2^{L}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{L}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{MK}x_2^{L}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{M}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{M}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
	$x_1^{MK}x_2^{L}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{S}x_4^{M}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$	$x_1^{MK}x_2^{L}x_3^{S}x_4^{H}x_5^{B}x_6^{N}x_9^{I}x_{15}^{LF}$
"Chernobyl: Lessons from History"	——	——	$x_1^{C}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$
"Carpathian Adventure"	$x_1^{CA}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$
	$x_1^{CA}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$
	$x_1^{CA}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{CA}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$
Name of the excursion	Primary school	Middle school	High school
"Inside the Trypillian Civilization"	$x_1^{TC}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L}$	$x_1^{TC}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$	$x_1^{TC}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$
	$x_1^{TC}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L}$	$x_1^{TC}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$	$x_1^{TC}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$
	$x_1^{TC}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L}$	$x_1^{TC}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$	$x_1^{TC}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_8^{B}x_9^{I}x_{15}^{M4L3}$
"Cossack Trails"	$x_1^{KP}x_2^{M}x_3^{L}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{L}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{L}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$
	$x_1^{KP}x_2^{M}x_3^{M}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{M}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{M}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$
	$x_1^{KP}x_2^{M}x_3^{S}x_4^{P}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{S}x_4^{M}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$	$x_1^{KP}x_2^{M}x_3^{S}x_4^{H}x_5^{BT}x_6^{R}x_7^{3}x_9^{I}x_{15}^{M4L3}$
"CERN: The Universe Under the Microscope"	——	$x_1^{CERN}x_2^{H}x_3^{M}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_1$	$x_1^{CERN}x_2^{H}x_3^{M}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_1$
"Alps in Austria"	——	$x_1^{AA}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{15}^{M3}$	$x_1^{AA}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{P}x_9^{E}x_{15}^{M3}$
"Gems of Italy: Venice, Milan, Rome"	——	$x_1^{PI}x_2^{H}x_3^{S}x_4^{M}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$	$x_1^{PI}x_2^{H}x_3^{S}x_4^{H}x_5^{BTA}x_6^{A}x_7^{5}x_8^{C}x_9^{E}x_{15}^{M3}$

Perform a binarisation of the relation r and s. Similarly, *P(r,s)* constitutes the composition of the 61 conjuncts listed in Table 5, which, upon transformation, assumes the following form:

$$P(r,s)=x_{15}^{LF}\ (x_1^{UK}x_2^{M}x_3^{L}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{M}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{S}x_4^{P}x_5^{B}x_6^{N}x_9^{I} \vee x_1^{UK}x_2^{M}x_3^{L}x_4^{M}x_5^{B}x_6^{N}x_9^{I} \vee$$

$$\vee x_1^{UK} x_2^M x_3^M x_4^M x_5^B x_6^N x_9^I \vee x_1^{UK} x_2^M x_3^S x_4^M x_5^B x_6^N x_9^I \vee x_1^{UK} x_2^M x_3^L x_4^H x_5^B x_6^N x_9^I \vee x_1^{UK} x_2^M x_3^M x_4^H x_5^B x_6^N x_9^I \vee$$
$$x_1^{UK} x_2^M x_3^S x_4^H x_5^B x_6^N x_9^I \vee\vee x_1^{CT} x_2^M x_3^L x_4^P x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^M x_4^P x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^S x_4^P x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^L x_4^M x_5^B x_6^N x_9^I \vee$$
$$\vee x_1^{CT} x_2^M x_3^M x_4^M x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^S x_4^M x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^L x_4^H x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^M x_4^H x_5^B x_6^N x_9^I \vee x_1^{CT} x_2^M x_3^S x_4^H x_5^B x_6^N x_9^I \vee$$
$$\vee x_1^{MK} x_2^L x_3^L x_4^P x_5^B x_6^N x_9^I \vee x_1^{MK} x_2^L x_3^M x_4^P x_5^B x_6^N x_9^I \vee x_1^{MK} x_2^L x_3^S x_4^P x_5^B x_6^N x_9^I \vee x_1^{MK} x_2^L x_3^L x_4^M x_5^B x_6^N x_9^I \vee x_1^{MK} x_2^L x_3^M x_4^M x_5^B x_6^N x_9^I \vee$$
$$\vee x_1^{MK} x_2^L x_3^S x_4^H x_5^B x_6^N x_9^I) \vee x_{15}^{M4L3} (x_1^C x_2^M x_3^S x_4^H x_5^{BT} x_6^R x_7^3 x_9^I \vee x_1^{TC} x_2^M x_3^L x_4^P x_5^{BT} x_6^R x_7^3 x_8^B x_9^I$$
$$\vee x_1^{TC} x_2^M x_3^M x_4^P x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee$$
$$x_1^{TC} x_2^M x_3^S x_4^P x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee x_1^{TC} x_2^M x_3^L x_4^M x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee x_1^{TC} x_2^M x_3^M x_4^M x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee x_1^{TC} x_2^M x_3^S x_4^M x_5^{BT} x_6^R x_7^3 x_8^B x_9^I$$
$$\vee \vee x_1^{TC} x_2^M x_3^L x_4^H x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee x_1^{TC} x_2^M x_3^M x_4^H x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee x_1^{TC} x_2^M x_3^S x_4^H x_5^{BT} x_6^R x_7^3 x_8^B x_9^I \vee$$
$$x_1^{KP} x_2^M x_3^L x_4^P x_5^{BT} x_6^R x_7^3 x_9^I \vee \vee x_1^{KP} x_2^M x_3^M x_4^P x_5^{BT} x_6^R x_7^3 x_9^I \vee x_1^{KP} x_2^M x_3^S x_4^P x_5^{BT} x_6^R x_7^3 x_9^I$$
$$\vee x_1^{KP} x_2^M x_3^L x_4^M x_5^{BT} x_6^R x_7^3 x_9^I \vee x_1^{KP} x_2^M x_3^M x_4^M x_5^{BT} x_6^R x_7^3 x_9^I \vee \vee x_1^{KP} x_2^M x_3^S x_4^M x_5^{BT} x_6^R x_7^3 x_9^I \vee x_1^{KP} x_2^M x_3^L x_4^H x_5^{BT} x_6^R x_7^3 x_9^I \vee$$
$$x_1^{KP} x_2^M x_3^M x_4^H x_5^{BT} x_6^R x_7^3 x_9^I \vee x_1^{KP} x_2^M x_3^S x_4^H x_5^{BT} x_6^R x_7^3 x_9^I) \vee x_{15}^{M3} (x_1^{CA} x_2^M x_3^L x_4^P x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee$$
$$x_1^{CA} x_2^M x_3^M x_4^P x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee x_1^{CA} x_2^M x_3^S x_4^P x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee$$
$$\vee x_1^{CA} x_2^M x_3^L x_4^M x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee x_1^{CA} x_2^M x_3^M x_4^M x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee x_1^{CA} x_2^M x_3^S x_4^M x_5^{BT} x_6^R x_7^5 x_8^C x_9^E$$
$$\vee x_1^{CA} x_2^M x_3^L x_4^H x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee$$
$$\vee x_1^{CA} x_2^M x_3^M x_4^H x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee x_1^{CA} x_2^M x_3^S x_4^H x_5^{BT} x_6^R x_7^5 x_8^C x_9^E \vee x_1^{CERN} x_2^H x_3^M x_4^M x_5^{BTA} x_6^A x_7^5 x_8^C x_9^E$$
$$\vee x_1^{CERN} x_2^H x_3^M x_4^H x_5^{BTA} x_6^A x_7^5 x_8^C x_9^E \vee x_1^{AA} x_2^H x_3^S x_4^M x_5^{BTA} x_6^A x_7^5 x_8^P x_9^E \vee x_1^{AA} x_2^H x_3^S x_4^H x_5^{BTA} x_6^A x_7^5 x_8^P x_9^E \vee x_1^{PI} x_2^H x_3^S x_4^M x_5^{BTA} x_6^A x_7^5 x_8^C x_9^E \vee$$
$$\vee x_1^{PI} x_2^H x_3^S x_4^H x_5^{BTA} x_6^A x_7^5 x_8^C x_9^E).$$

Thus, we managed to split the multi-location relation, all the links of which are reflected in the corresponding paradigmatic tables, into 23 relations of smaller dimension. This makes it possible to process information and perform the necessary search simultaneously in the three internal nodes of the built network. Thus, a mathematical model of choosing an excursion for students of the Push in Kharkiv school was built in the form of a logical network. It is characterised by a composition of binary relations:

$$P(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}, r, z, s) = P(x_1, r) \wedge P(x_2, r) \wedge P(x_3, r) \wedge P(x_4, r) \wedge P(x_5, r) \wedge P(x_6, r) \wedge P(x_7, r) \wedge P(x_8, r) \wedge P(x_9, r) \wedge P(x_1, z) \wedge P(x_2, z) \wedge P(x_4, z) \wedge P(x_{10}, z) \wedge P(x_{11}, z) \wedge P(x_{12}, z) \wedge P(x_{13}, z) \wedge P(x_{14}, z) \wedge P(x_1, s) \wedge P(x_4, s) \wedge P(x_9, s) \wedge P(x_{15}, s) \wedge P(r, z) \wedge P(r, s).$$

Conclusions

The constructed mathematical model can be represented as a logical network (Fig. 10). A logic network consists of poles and branches. Each pole corresponds to its own subject variable of the model, which is called the attribute of this pole. Each pole is denoted by its own subject variable. Each pole is associated with its domain, i.e. the area of definition of the attribute of this pole. Any pole of a logical network at a certain point in time carries some knowledge about the value of its attribute. This knowledge is called the state of the pole, and it is one of the subsets of the pole's domain. If you specify the state of all the network's poles at a certain moment in time, you can get the state of the network at that moment. For our model, the logic network will look like this:

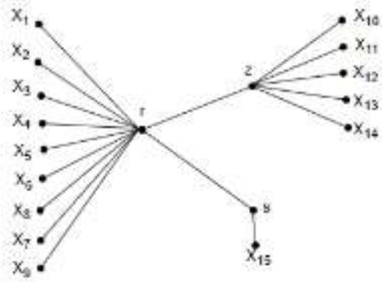

Fig. 10. Logical network

With the help of the constructed logical network, the following tasks can be solved: selection of the optimal excursion taking into account given criteria (student category, cost, duration, safety, transport, etc.), it is possible to find the excursion that best meets the needs of the school and students; assessment of student interest based on excursion parameters and students' interests, it is possible to predict the likelihood of choosing a particular excursion for different age groups (primary, middle, high school) ; excursion budget planning the logical network allows for the estimation of excursion costs depending on the number of participants, type of transport, meals, accommodation, and other factors; comparison of multiple excursions by analyzing attributes, different excursion options can be compared, and the best one can be chosen according to specific criteria; safety and feasibility assessment based on the safety parameter and current conditions (e.g., the war in Ukraine), it is possible to assess how realistic the organization of a particular excursion is; analysis of educational goals determining which excursions best support the achievement of educational goals (knowledge, social skills, career orientation) for different student groups; logistics optimization taking into account transport parameters, travel time, and excursion programs, it is possible to optimize the logistical aspects of the trip; development of personalized recommendations the logical network allows the creation of personalized recommendations for each age group based on students' priorities and interests; analysis of reviews and recommendations using feedback data, it is possible to predict how popular and successful an excursion will be among students and parents; forecasting the impact of parameter changes analyzing how changes in certain parameters (e.g., increased budget, duration, or transport changes) will affect the overall assessment of the excursion and its priority for the school.

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