Olympiad for students and graduates - 2017

Educational direction «Business Informatics»

Profile (Master program): «Big Data Systems» **ID – 173**

Job time– 180 мин.

1. Give detailed answers

1.1. What is a CRM (Customer Relationship Management) system? Explain the main principles. What kinds of data they use?

1.2. Give 3 examples and a brief description of services that use social networks analytics.

2. Solve a task

2.1. In a relational database, the company that owns the set of online stores, which sell printing products, the following data is stored: store name, URL, contact person, telephone.

The assortment of each online store is determined by its profile and contains many different products, their names and short descriptions. Each online store keeps records of goods sold for each day, where the product name is taken into account, its quantity, current sale price per unit and the details of the buyer.

The buyer in one order can have multiple different products from the catalog. On delivery to the company's warehouse each consignment contains the delivery date, product name, manufacturer, purchase price, quantity and date of production.

Do the following*:*

a) draw the database schema that meets the third normal form, with primary and foreign keys, type and direction of relation, using any accepted notation
b) make a detailed description of the tables with a breakdown of the field names, data types and properties
c) write queries to retrieve the following information using MySQL:
   - names of online stores, revenue from the sale of a product which a month exceeds 100 000 RUB, indicating the URL of the store and the amount of revenue. sort online stores in descending order of the sum of revenues;
   - the number of orders per month, from the beginning of the calendar year to the present for each online stores.

2.2. Let we have N cells and n particles ($n < N$). Assumed particles with each other and are indistinguishable in each cell can be any number of particles. The particles are randomly placed in the cells.

What is the probability of hitting one particle in the set of cells n?

2.3. *Denotations and terms.*

Alphabet is a finite set of symbols.

A non-empty string in the alphabet A is an arbitrary sequence *d[1], ..., d[n]*, where *n* >=1, and for *k* = 1,..., *n* the element *d[k]* is a symbol from the alphabet A.

That is why, for instance, the expression *bbbddcccc* is a non-empty string in the alphabet {b, c, d}.

Type expression xy where x is a symbol, y is the symbol or character chain, will be understood as a substitution when the left part, i.e. x is replaced with the right part, i.e. y.

Let the set (in other words, language) *L* be defined as follows: *L* contains such non-empty strings z in the alphabet {0, 1}, that in case *z* contains the symbol 1, every occurence of the symbol 1 is followed by the expression 00.

Examples of the strings from *L*: 0, 000, 00100, 100, 00100100, 0100.

Examples of the strings not belonging to *L*: 0, 000, 001, 10, 0010, 011.

Let *Help-set* be an arbitrary finite set of symbols not containing the digits 0, 1. The symbols from the set *Help-set* will be considered as auxiliary symbols.

Let's say that an arbitrary finite set of expressions of the form x→y is a productions system for the set *Help-set* if and only if x is an arbitrary symbol from the set *Help-set* , and the expression *y* satisfies one of the following conditions:

(1) *y* is one of the digits 0, 1;

(2) *y* is an expression of the form *h E*, where *h* is one of the digits 0, 1, and *E* is any symbol from the set *Help-set*;

(3) *y* is the expression *void-string*.

The application of the substitution of the form $x \rightarrow$ *void-string* means the deletion of the symbol *x*.

Task statement. Invent such set of auxiliary symbols *Help-set* including the symbol *start* and such productions system *P* for the set *Help-set* that the given set (or language) *L* is the collection of all expressions (or strings) in the alphabet {*0,1}* that can be obtained by any substitutions from P (arbitrary many substitutions) on condition that at the first step any substitution with the left side *start* is applied.

2.4. Suppose that some point particle moves in discrete moments of time in integer points (n) of the number line, located vertically. Let at the initial time $t = 0$ the particle is at the origin, and in each subsequent time $t = 1,2,3, \ldots$ it makes moving unit up or down by one (move equally likely). We call the *paths* the broken lines that go from the origin, with vertices at points with integer coordinates (n).

What is the number of all paths leading to a point (t, n), if t and n have the same parity and $n \leq t$?

2.5. Taken at random two numbers x and y, where $0 \leq x \leq 1$ and $0 \leq y \leq 1$.

What is the probability that the sum of $x + y \leq 1$, and the product $xy \leq \frac{2}{9}$?