

**Department of Software Engineering and  
Management Intelligent Technology**

**Educational and Scientific Institute of  
Computer Science and Information  
Technology**

**OUR RESEARCH PROPOSALS**



# Translation of Natural Language Business Rules into the Database Structure

Andrii Kopp & Dmytro Orlovskyi



Department of Software  
Engineering and  
Management Intelligent  
Technology

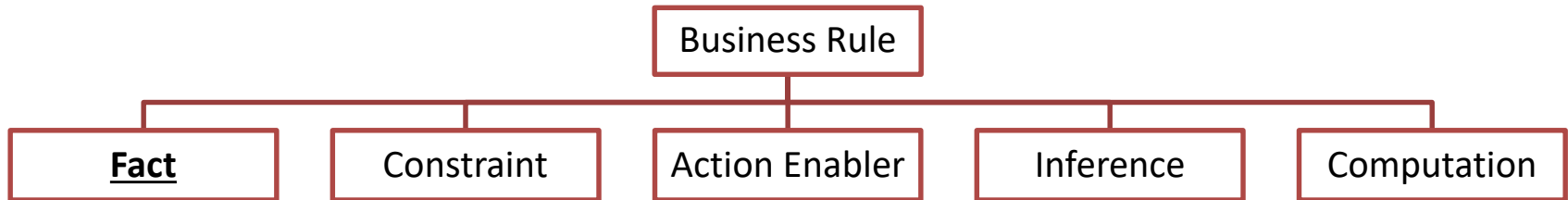
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## Business Rules in Database Design

- Business rules are used as sources for correct discovery of entities, attributes, constraints, and relationships.
- Business rules are brief, precise, and unambiguous textual descriptions of policies, processes, and principles within a certain organization.
- The main sources of business rules are people and documentation within organization: managers of different levels, company policies, or process manuals.



- Facts are statements that define entities, attributes, and relationships within data models.



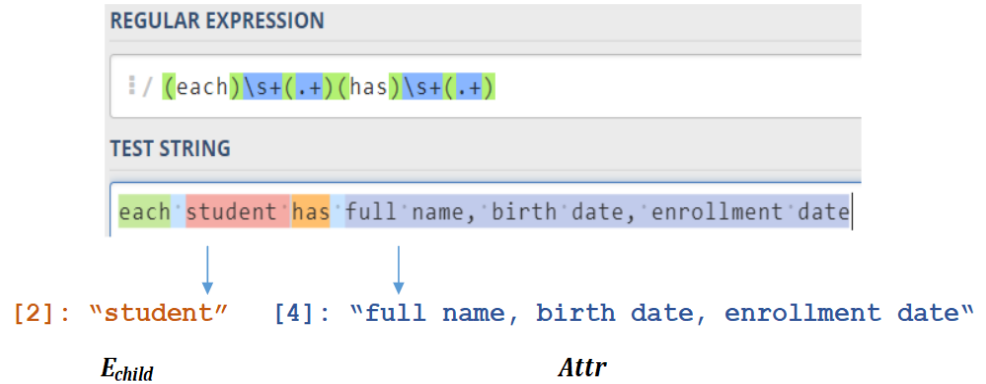
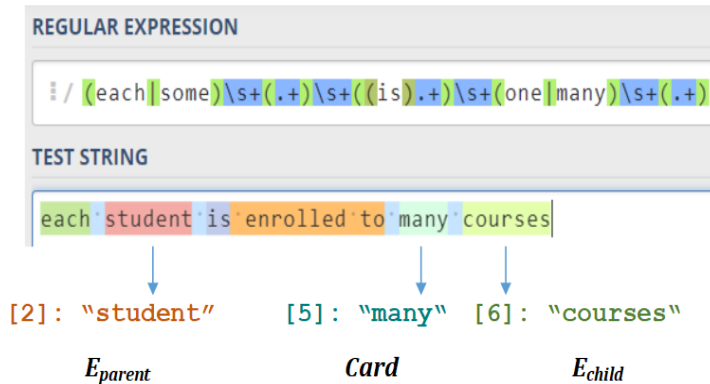
## Business Rules Extraction

Business rules that describe:

- relationships
- entities and their attributes

$\langle relationship\_business\_rule \rangle ::= \{each|some\} \langle parent\_entity \rangle$   
 $\{is \langle relation \rangle\} \{one|many\} \langle child\_entity \rangle.$

$\langle entity\_business\_rule \rangle ::= \{each\} \langle entity \rangle$   
 $\{has\} \{\langle attribute \rangle, \dots\}.$



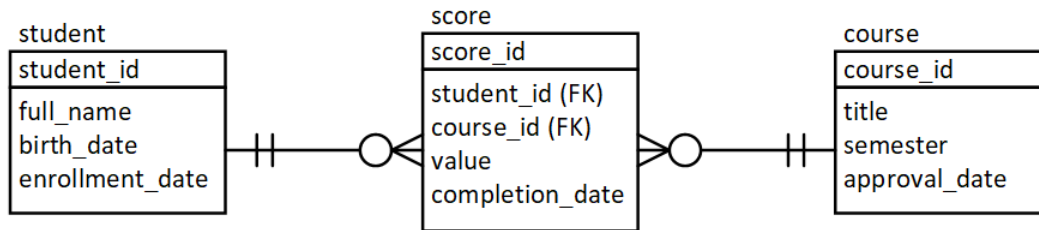


## Database Scripts Generation

### Business Rules $\Rightarrow$ Relational Model $\Rightarrow$ SQL Scripts

Each student has full name, student card id, birth date, enrollment date.  
Each student is given by many scores.  
Each course has title, semester, approval date. Each course is evaluated by many scores. Each score has value, completion date.

student  $\rightarrow$   $\langle PK = \{student\_id\}, FK = \emptyset, Cols = \{full\_name, student\_card\_id, birth\_date, enrollment\_date\} \rangle$   
score  $\rightarrow$   $\langle PK = \{score\_id\}, FK = \{student\_id, course\_id\}, Cols = \{value, completion\_date\} \rangle$   
course  $\rightarrow$   $\langle PK = \{course\_id\}, FK = \emptyset, Cols = \{title, semester, approval\_date\} \rangle$



```
CREATE TABLE `student` (`student_id` INTEGER,
`full_name` VARCHAR(255), `student_card_id`
VARCHAR(255), `birth_date` DATETIME,
`enrollment_date` DATETIME);
CREATE TABLE `score` (`score_id` INTEGER,
`student_id` INTEGER, `course_id` INTEGER, `value`
DECIMAL(8,2), `completion_date` DATETIME);
CREATE TABLE `course` (`course_id` INTEGER, `title`
VARCHAR(255), `semester` DECIMAL(8,2),
`approval_date` DATETIME);
```

```
ALTER TABLE `student` MODIFY `student_id`
INTEGER AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `score` MODIFY `score_id` INTEGER
AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `course` MODIFY `course_id` INTEGER
AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `score` MODIFY `student_id` INTEGER
NOT NULL;
ALTER TABLE `score` ADD FOREIGN KEY
(`student_id`) REFERENCES `student`(`student_id`);
ALTER TABLE `score` MODIFY `course_id` INTEGER
NOT NULL;
ALTER TABLE `score` ADD FOREIGN KEY (`course_id`)
REFERENCES `course`(`course_id`);
```



## Software Tool Prototype: Homepage Example

User interface elements are:

- Text area for business rules
- Control buttons (clear text area, translate rules into SQL, copy code to clipboard)
- Generated code area
- Text input for database name
- Check boxes for optional settings
- Radio button to select SQL dialect

**BR2SQL – Translate Business Rules into a Database Schema**

**Business Rules**

**Attributes:** Each "entity name" has "attribute", "attribute", ... "attribute".

**e.g.** Each student has full name, student card id, birth date, enrollment date.

**Relationships:** (Each | Some) "entity name" is "relationship description" (one | many) "entity name".

**e.g.** Each student is given by many score.

Each student has full name, student card id, birth date, enrollment date. Each student is given by many score. Each course has title, semester, approval date. Each course is evaluated by many score. Each score has value, completion date.

**SQL Statements**

```
DROP DATABASE IF EXISTS `sample_db`;  
  
CREATE DATABASE IF NOT EXISTS `sample_db`;  
  
USE `sample_db`;  
  
CREATE TABLE `student` (`student_id` INTEGER, `full_name` VARCHAR(255), `student_card_id` INTEGER, `birth_date` DATE, `enrollment_date` DATE);  
  
CREATE TABLE `score` (`score_id` INTEGER, `student_id` INTEGER, `course_id` INTEGER, `value` DECIMAL(10,2), `completion_date` DATE);  
  
CREATE TABLE `course` (`course_id` INTEGER, `title` VARCHAR(255), `semester` VARCHAR(10));  
  
ALTER TABLE `student` MODIFY `student_id` INTEGER AUTO_INCREMENT PRIMARY KEY;  
  
ALTER TABLE `score` MODIFY `score_id` INTEGER AUTO_INCREMENT PRIMARY KEY;  
  
ALTER TABLE `course` MODIFY `course_id` INTEGER AUTO_INCREMENT PRIMARY KEY;  
  
ALTER TABLE `score` MODIFY `student_id` INTEGER NOT NULL;  
  
ALTER TABLE `score` ADD FOREIGN KEY (`student_id`) REFERENCES `student` (`student_id`);  
  
ALTER TABLE `score` MODIFY `course_id` INTEGER NOT NULL;  
  
ALTER TABLE `score` ADD FOREIGN KEY (`course_id`) REFERENCES `course` (`course_id`);
```

**Database Settings**

**Database Name**

**Optional Scripts**

Drop database

Create database

Drop tables

**SQL Dialect**

MySQL

SQL Server

Oracle

Postgres

[Contact or Contribute](#)

This service is a prototype created for academic purposes, therefore certain features may not work properly.

BR2SQL CC BY-ND License 2020-2021



## Example of Business Rules Translation into Database Structure

Sample set of business rules:

- “Each student has full name, student card id, birth date, enrollment date”.
- “Each student is given by many scores”.
- “Each course has title, semester, approval date”.
- “Each course is evaluated by many scores. Each score has value, completion date”.

sample_db student	
student_id	: int(11)
full_name	: varchar(255)
student_card_id	: varchar(255)
birth_date	: datetime
enrollment_date	: datetime

sample_db score	
score_id	: int(11)
student_id	: int(11)
course_id	: int(11)
value	: decimal(8,2)
completion_date	: datetime

sample_db course	
course_id	: int(11)
title	: varchar(255)
semester	: decimal(8,2)
approval_date	: datetime

```
DROP DATABASE IF EXISTS `sample_db`;
CREATE DATABASE IF NOT EXISTS `sample_db`;
USE `sample_db`;

CREATE TABLE `student` (`student_id` INTEGER, `full_name` VARCHAR(255), `student_card_id`
VARCHAR(255), `birth_date` DATETIME, `enrollment_date` DATETIME);
CREATE TABLE `score` (`score_id` INTEGER, `student_id` INTEGER, `course_id` INTEGER, `value`
DECIMAL(8,2), `completion_date` DATETIME);
CREATE TABLE `course` (`course_id` INTEGER, `title` VARCHAR(255), `semester` DECIMAL(8,2),
`approval_date` DATETIME);

ALTER TABLE `student` MODIFY `student_id` INTEGER AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `score` MODIFY `score_id` INTEGER AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `course` MODIFY `course_id` INTEGER AUTO_INCREMENT PRIMARY KEY;
ALTER TABLE `score` MODIFY `student_id` INTEGER NOT NULL;
ALTER TABLE `score` ADD FOREIGN KEY (`student_id`) REFERENCES `student`(`student_id`);
ALTER TABLE `score` MODIFY `course_id` INTEGER NOT NULL;
ALTER TABLE `score` ADD FOREIGN KEY (`course_id`) REFERENCES `course`(`course_id`);

ALTER TABLE `student` ADD UNIQUE (`student_card_id`);
```



## Classifiers Validation

Vocabularies content after the business rules of previous example were translated

Another attempt of different business rules translation has resulted into the automatically suggested domains, corresponding MySQL data types, and UNIQUE alternate keys

Vocabulary	Classification	Data
Column domains	DateTime	birth_date, enrollment_date, completion_date, approval_date
	Number	value, semester
	Text	full_name, student_card_id, title
Alternate keys	UNIQUE	student_card_id

Each person has full name, birth date.



```
CREATE TABLE `person` (`person_id` INTEGER, `full_name` VARCHAR(255), `birth_date` DATETIME);  
ALTER TABLE `person` MODIFY `person_id` INTEGER AUTO_INCREMENT PRIMARY KEY;
```

Each progress paper has student card id, title, semester, value, completion date.



```
CREATE TABLE `progress_paper` (`progress_paper_id` INTEGER, `student_card_id` VARCHAR(255), `title` VARCHAR(255), `semester` DECIMAL(8,2), `value` DECIMAL(8,2), `completion_date` DATETIME);  
ALTER TABLE `progress_paper` MODIFY `progress_paper_id` INTEGER AUTO_INCREMENT PRIMARY KEY;  
ALTER TABLE `progress_paper` ADD UNIQUE (`student_card_id`);
```

Each payment has value, approval date, completion date.



```
CREATE TABLE `payment` (`payment_id` INTEGER, `value` DECIMAL(8,2), `approval_date` DATETIME, `completion_date` DATETIME);  
ALTER TABLE `payment` MODIFY `payment_id` INTEGER AUTO_INCREMENT PRIMARY KEY;
```





## Validation of Database Operability, Integrity, and Consistency

SELECT \* FROM 'student'

student_id	full_name	student_card_id	birth_date	enrollment_date
1	Patrick G. Harrington	239-09	1988-07-28 00:00:00	2003-07-30 00:00:00
2	Stephen J. Dantzler	389-13	1993-04-30 00:00:00	2011-07-28 00:00:00
3	David B. Bailey	421-94	1998-02-10 00:00:00	2017-07-30 00:00:00

SELECT \* FROM 'score'

score_id	student_id	course_id	value	completion_date
1	3	1	84.00	2018-01-20 00:00:00
2	3	2	91.00	2018-07-03 00:00:00
3	3	3	78.00	2019-01-12 00:00:00
4	3	4	74.00	2019-06-21 00:00:00
5	3	5	81.00	2020-01-11 00:00:00

SELECT \* FROM 'course'

course_id	title	semester	approval_date
1	Introduction to Software Engineering	1	2017-05-30 00:00:00
2	Basics of Object-Oriented Programming	2	2017-11-30 00:00:00
3	Introduction to Databases	3	2018-05-30 00:00:00
4	Design of Databases	4	2018-11-30 00:00:00
5	Architecture and Design of Software	5	2019-05-30 00:00:00
6	Design of Information Systems	6	2019-11-30 00:00:00
7	Software Quality	7	2020-05-30 00:00:00
8	Systems Analysis	8	2020-05-30 00:00:00

```
INSERT INTO score (student_id, course_id, value, completion_date) VALUES (4, 1, 94, '2020-01-16');
```

```
#1452 - Cannot add or update a child row: a foreign key constraint fails ('sample_db`.`score`, CONSTRAINT `score_ibfk_1` FOREIGN KEY (`student_id`) REFERENCES `student` (`student_id`))
```

```
INSERT INTO student (full_name, student_card_id, birth_date, enrollment_date) VALUES ('Larry S. Ruiz', '389-13', '1999-01-02', '2018-07-27');
```

```
#1062 - Duplicate entry '389-13' for key 'student_card_id'
```

# Improving Item Searching On Trading Platform Based On Reinforcement Learning Approach

Olga Cherednichenko et al.



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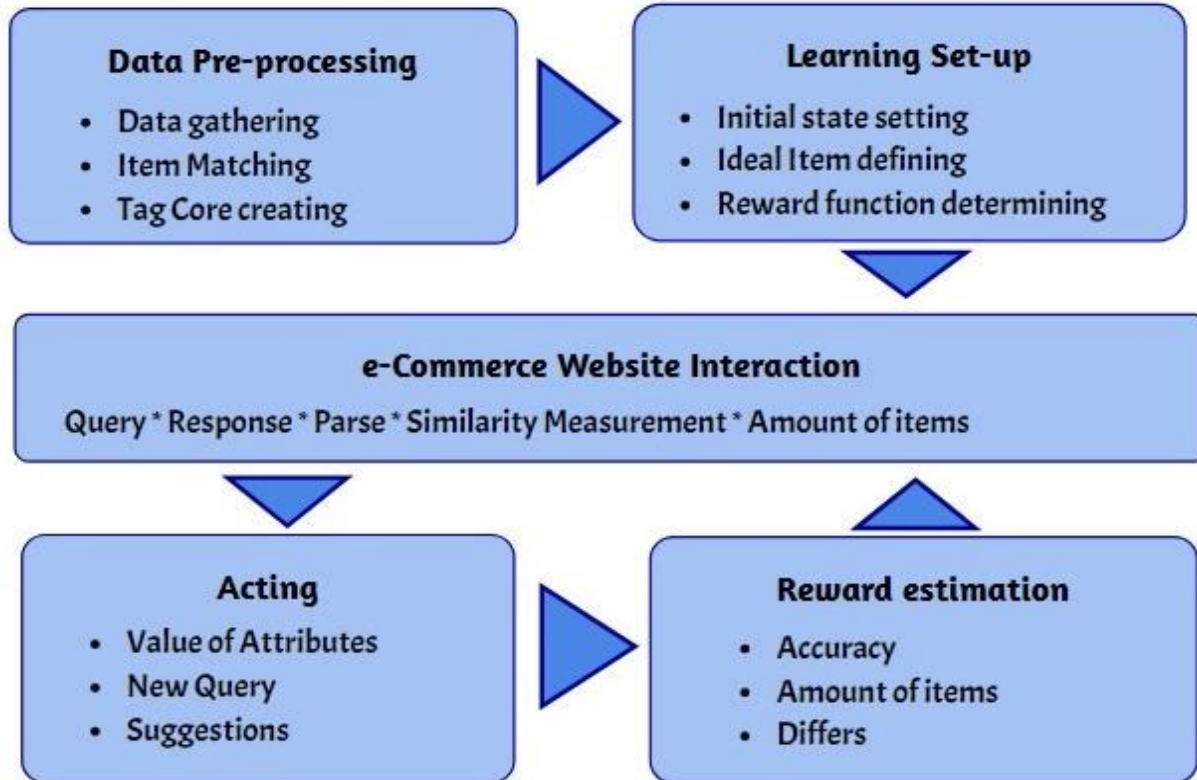


# Research Questions

- How to combine similar product offers from different sellers on the e-commerce website into groups based on the pre-trained core of tags
- How response information from e-commerce websites could clarify the item query and increase the accuracy of proposed items



# The pipeline of e-commerce website interaction





# Examples of similar items

**Adidas originals Samoa Men's Sneaker EG6089 White Shoes Trainers Sport Shoes**

Condition: **New with box**

US Shoe Size:  (Men's):

Color:

Quantity:  2 available / [1 sold](#)

Price: **US \$94.73** [Buy It Now](#)



### Item specifics

Condition: New with box: A brand-new, unused, and unworn item (including handmade items) in the original packaging (such as ... [Read more](#)) Info: brandstyle24 since 2003 on ebay !

Activity1: Leisure Style: Sneaker

MPN: EG6089

Season: Full Year Article

Brand: adidas

Shoe Shank Type: Low Top

Outsole Material: Rubberband

Product Line: adidas Samoa

Shoe Width: Standard

Features2: Comfort

Manufacturer Color: Cloud White / Collegiate Green / Gum

Features1: Anti-slip

**Adidas originals stan smith Sneaker BD8023 Leather White Shoes Trainers Sports**

Condition: **New with box**

US Shoe Size (Men's):

Color:

Quantity:  1 available

List price: ~~US \$121.37~~

You save: **US \$14.86 (12% off)**

Now: **US \$106.51** [Buy It Now](#)



### Item specifics

Condition: New with box: A brand-new, unused, and unworn item (including handmade items) in the original packaging (such as ... [Read more](#))

Activity1: Leisure

MPN: BD8023

Season: Full Year Article

Brand: adidas

Shoe Shank Type: Low Top

Outsole Material: Rubberband

Fastening: Lacing

Product Line: adidas Stan Smith

Shoe Width: Standard

Features2: Comfort

Manufacturer Color: Ftwwht/ftwwht/Rawamb

Features1: Anti-slip

Style: Sneaker

Year Of Manufacture: 2010-2019

Vintage: No

UPC: Does not apply

Upper Material: Leather

Feed Material: Fabric

Activity: Fashion

Department: Unisex

Occasion: Casual

Model: adidas Stan Smith

Type: Casual Shoes

Features: Breathable



# List of words in the core of tags

All tags	>0.70	>0.75
adidas casual leather white apply men	leather	leather
comfort unworn new brand unused top	white	white
standard breathable low shoes training	comfort	comfort
sneakers year full article lacing	breathable	low
rubberband lace fabric originals	low	shoes
running athletic slip anti smith stan	shoes	fitness
fitness studio rubber jogging unisex	fabric	summer
textile solid cushioned leisure core	athletic	trainers
superstar summer eur continental black	fitness	toe
spring limited fall edition ftwwht	summer	sports
lightweight light lifestyle classic	lightweight	basketball
weight boost tennis medium barricade	trainers	school
trainers retro toe gym indonesia walking	toe	outsole
campus winter foam performance upper	sports	skate
blue motion support sports control	basketball	
suede	plaid	
trainer cloud basketball grey clear	school	
vietnam cross plaid round sneaker arch	outsole	
scarlet rainbow collegiate green samba	skate	
athletics whtin pattern adv coated	bodybuilding	
twinstrike adjustable jeans one	yamamoto	



# The key idea

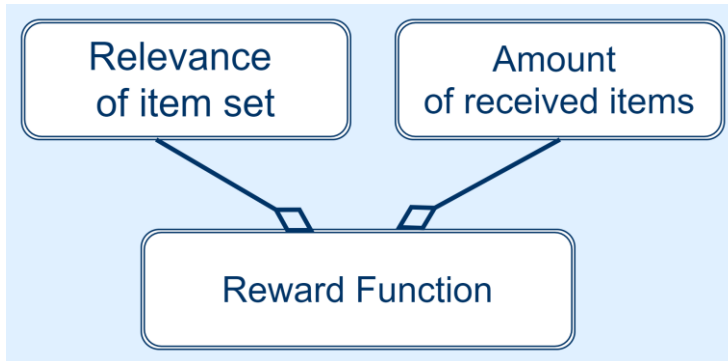
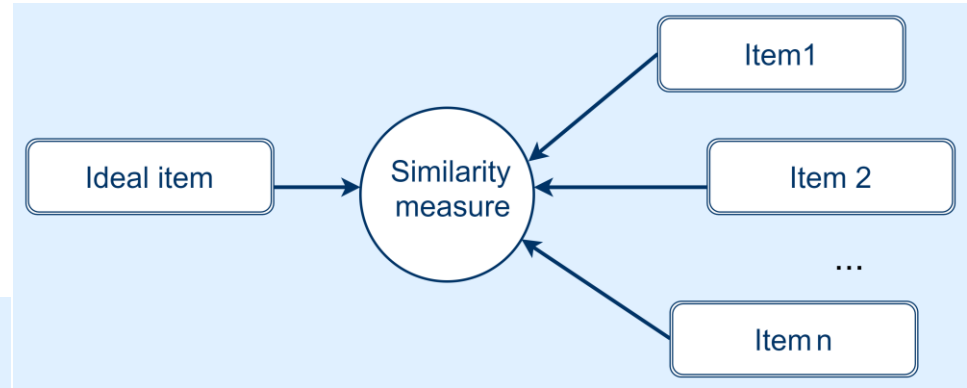


$A_{jk} = \langle a_{jk1}, a_{jk2}, \dots, a_{jkn} \rangle$  represents an item

$K$  is a set of groups of items

$I_k$  is a set of attributes of  $k$ -th group

$J_k$  is a set of items of  $k$ -th group



$A_k^* = \langle t_1, \dots, t_s \rangle$  represents the ideal item



# The results of experiment on different platforms

## eBay


All Listings Accepts Offers Auction Buy It Now Condition

0 results for shoes fitness trai... [Save this search](#) Shipping to: Ukraine


**No exact matches found**

Save this search to receive email alerts and notifications when new items are available. [Save this search](#)

**Results matching fewer words**



**Mens Casual Sports Lace up Leather Skate Shoes Outdoor Sneakers Running Trainers**  
New (Other) Unbranded  
**\$49.95 to \$52.24** From China  
Was: \$64.99 5% off More colors  
Buy It Now  
Free International Shipping



**Slazenger Mens Warrior Trainers Sports Shoes Low Slip On Leather Upper**  
Brand New Slazenger  
**\$25.42** From United Kingdom  
List price: \$60.76 58% off More colors  
Buy It Now  
+\$16.48 shipping  
34+ sold

## Amazon

Use fewer keywords or try these instead

No results for shoes fitness trainers leather white comfort low sports basketball  
Price and other details may vary based on size and color

shoes fitness leather See all 123 results



Merrell Men's Move Glove Fitness Shoes, US 8.5  
★★★★☆ ~ 129  
\$103<sup>75</sup>

Men's Winter Warm Sports Running Shoes Leather Cushiony Casual Jogging Walking Fitness Shoes

leather comfort low See over 1,000 results

Best Seller



Columbia Men's Newton Ridge Plus II Waterproof Hiking Boot Shoe  
★★★★☆ ~ 15,356  
\$79<sup>99</sup>



Sorel Women's Emelie Chelsea Boot - Light and Heavy Rain - Waterproof  
★★★★☆ ~ 1,828  
\$112<sup>46</sup> \$150.00

## Aliexpress

AliExpress

leather white comfort low shoes fitness summer trainers toe sports basketball school outs

All Categories > "leather white comfort low shoes fitness summer trainers toe sports basketball school outside skate" (0 Results)

Sorry, your search "leather white comfort low shoes fitness summer trainers toe sports basketball school outside skate" did not match any products. Please try again.





# Experiment results

## Some results of experiment #9

Все Категории | "shoes fitness trainers leather white comfort" (12 результатов)

Цена:  |  |  |  |  |  | Товары на распродаже | Бесплатная доставка

<b>Мужские туфли из искусствен...</b> 1 406,64 - 1 827,56 руб. 4 303,61 - 5 564,54 руб. +50%	<b>Высокие женские полуботинк...</b> 1 564,29 - 1 738,02 руб. 4 038,21 - 5 300,00 руб. +30%	<b>Кроссовки женские ковзиные...</b> 1 480,11 - 1 644,65 руб. 4 002,75 - 5 128,25 руб. +27%	<b>Оригинальный брендовый кр...</b> 4 070,68 руб. 5 914,20 - 7 648,40 руб. +28%	<b>Мужские Woerni спортивные б...</b> 1 381,39 - 1 737,25 руб. 3 543,64 - 4 543,64 руб. +33%
<b>Новеньки 2021, удобные кроссовк...</b> 1 826,03 - 1 978,33 руб. 4 744,15 - 5 302,06 руб. +28%	<b>Туфли для ходьбы из натуральн...</b> 4 766,64 - 5 088,54 руб. 12 179,63 - 15 828,13 руб. +33%	<b>Кроссовки мужские/женские дв...</b> 3 561,75 руб. 4 719,53 - 5 039,03 руб. +40%	<b>Мужская обувь для скейтбордин...</b> 2 410,73 руб. 3 145,27 - 3 569,79 руб. +48%	<b>Единообразная обувь для игры в п...</b> 5 332,67 руб. 6 978,21 - 7 648,40 руб. +28%

## Some results of experiment #10

<b>Новые мужские кроссовки с водо...</b> 2 180,37 - 2 543,89 руб. 5 459,64 - 6 978,21 руб. +26%	<b>Мужская повседневная обувь, м...</b> 560,98 - 795,16 руб. 1 406,64 - 1 827,56 руб. +40%	<b>Женские спортивные обувь унисе...</b> 1 557,41 - 1 990,57 руб. 4 038,21 - 5 300,00 руб. +26%	<b>Кроссовки женские из вельветой ко...</b> 1 745,67 - 1 981,39 руб. 4 543,64 - 5 914,20 руб. +29%	<b>Кожаный ремень, белый шифон...</b> 1 834,45 - 1 983,68 руб. 4 809,60 - 5 128,25 руб. +30%
<b>Кроссовки женские амальгамы н...</b> 4 744,15 - 5 302,06 руб. 12 179,63 - 15 828,13 руб. +48%	<b>Высокие женские спортивные б...</b> 1 771,69 - 2 152,82 руб. 4 428,81 - 5 790,42 руб. +60%	<b>Обувь для ходьбы: Мужская ковз...</b> 1 483,94 - 1 871,18 руб. 3 768,40 - 4 809,60 руб. +40%	<b>Кроссовки унисекс для вельветой б...</b> 1 894,91 - 2 315,83 руб. 4 719,53 - 5 039,03 руб. +40%	<b>Плоскостные женские кроссовки...</b> 566,33 - 672,71 руб. 1 406,64 - 1 827,56 руб. +40%

## Experiment result (models in different colour including white colour)

**DEVOOM®**

New Running Shoes Men Air Cushion White Sneakers Men Comfort Chaussure Hom me Sport Shoes Footwear Jogging Gym Trainers Shoes Men

**807,28 - 941,88 грн.** 1.345,37 — 1.569,79 грн. -40%

Color:

Shoe Size: 8 8.5 9 9.5 10 10.5 11 11.5 [See Info](#)

Fit: Fits true to size, take your normal size

Quantity: 1 + 26664 Pair available (188 Pair at most per customer)

[Buy Now](#) [Add to Cart](#) [♥ 2](#)

Men Woerni Sport Martial Arts Kung Fu Shoes White Black Comfortable Man Tai Chi Leather Sneakers Women Wushu Sneakers Trainer

1 order

**511,46 - 643,22 грн.** 913,54 — 1.148,73 грн. -44%

**56,67 грн. New User Coupon** **36,34 грн. off on 1 671,81 грн.** [Get coupons](#)

Colour:

Shoe Size: 35 36 37 38 39 40 41 42 43 44

Fit: Fits true to size, take your normal size


Quantity: 1 + 11098 pieces available

**Shipping: 42,79 грн.** to Ukraine via AliExpress Standard Shipping - Estimated Delivery on Apr 03



# Experiment results (continuation)


## Some results of the experiments #4 and #10



**Men's Shoes Ghoud White Leather Terry Sneaker SS2021**  
Brand New

**\$360.29**  
Buy It Now  
+16.92 shipping


Top Rated Seller  
From Italy



Sponsored  
**Men's Shoes Ghoud White Blue Green Leather Sneaker SS2021**  
Brand New

**\$309.08**  
Buy It Now  
+16.92 shipping

Top Rated Seller  
From Italy



Sponsored  
**NEW LISTING Nike Men's Air Monarch IV White Metallic Gold Lucky Green Shoes 415445-103 Sz 13**  
New (Other) - Nike - US Shoe Size (Men's) 13 - Nike Air Monarch

**\$69.97**  
Buy It Now  
+64.54 shipping estimate

Top Rated Seller  
From United States  
Customs services and international tracking provided

All Listings Accepts Offers Auction Buy It Now Condition ▾


190 results for shoes trainers sp... Save this search

Shipping to: Ukraine ▾

Best Match ▾

Price


Under \$35.00 \$35.00 to \$75.00 Over \$75.00



Sponsored  
**K Swiss Mens Trainers Leather Lace Up Shoes Sports Casual Sneakers UK Sizes**  
Brand New - K-Swiss

**\$31.78 to \$57.22**  
Was: \$63-68 10% off  
Buy It Now  
+21.18 shipping

Top Rated Seller  
From United Kingdom  
More colors



Sponsored  
**Reebok Classic Trainers Leather Club C 85 Retro Mens White Sports Shoes DV8817**  
Brand New - Reebok

**\$77.16**  
Buy It Now  
Free International Shipping

Top Rated Seller  
From United Kingdom

18

# Virtual Promotion Based on Machine Learning

Sergey Orekhov



Department of Software  
Engineering and  
Management Intelligent  
Technology

Educational and  
Scientific Institute of  
Computer Science and  
Information Technology



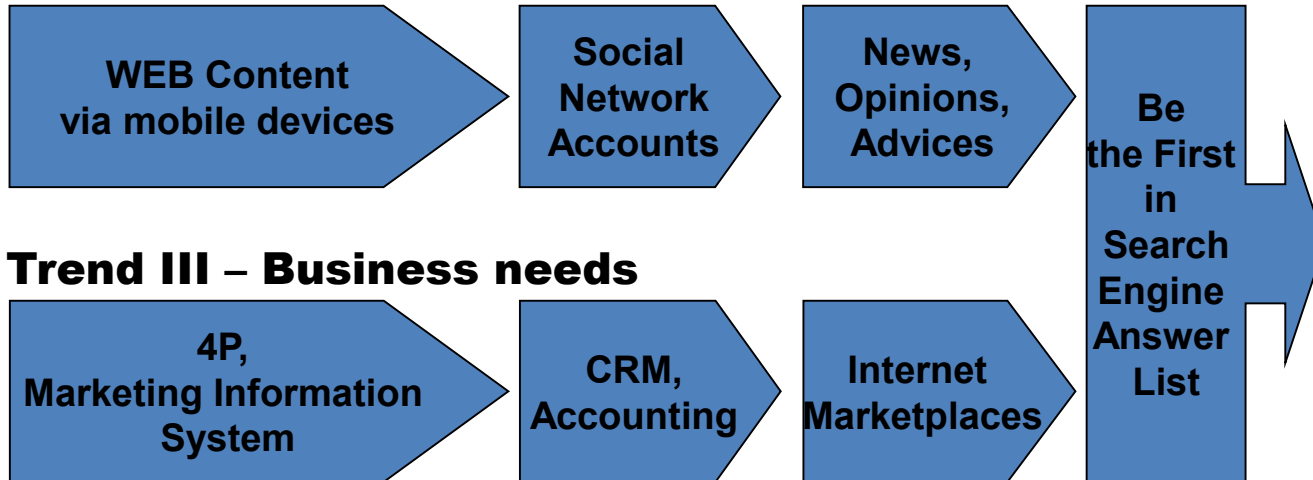


# Modern topics

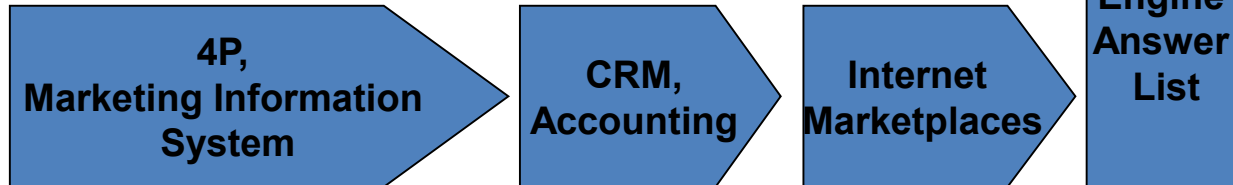
## Trend I – Technology evolution



## Trend II – Customer expectations

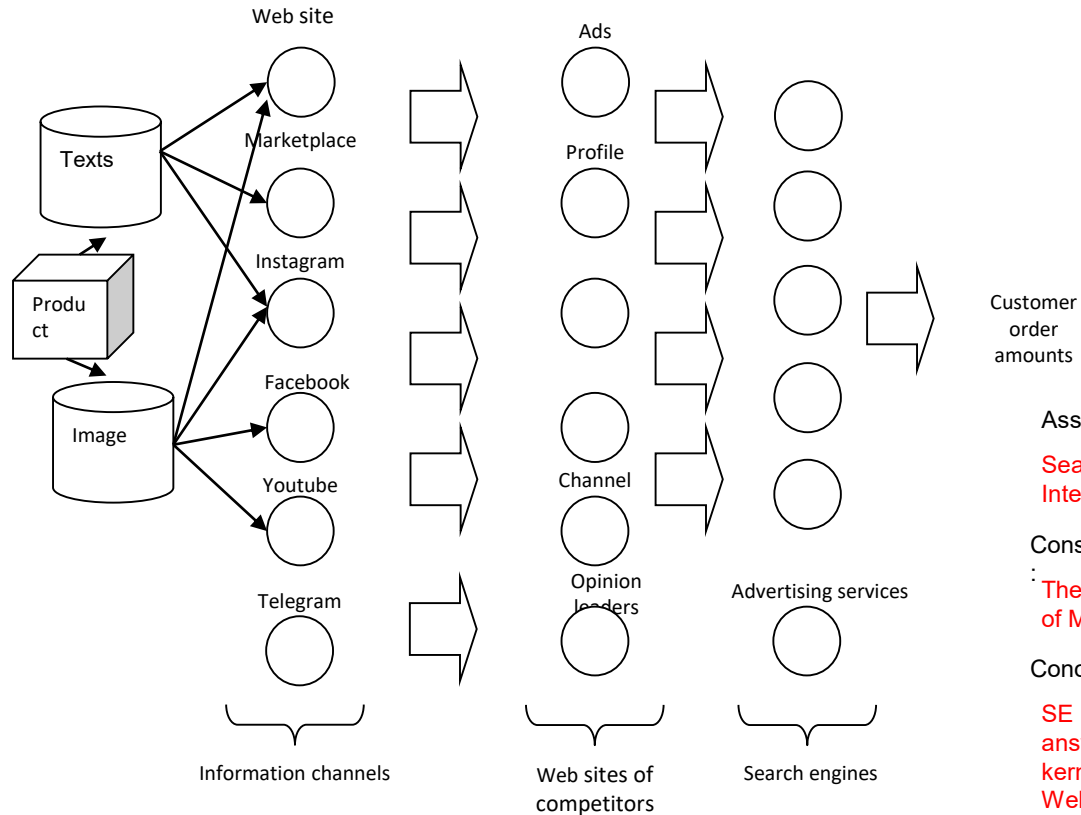


## Trend III – Business needs





# Problem: Be the First



Assumption:

Search Engine is an Intelligent Machine

Consequence

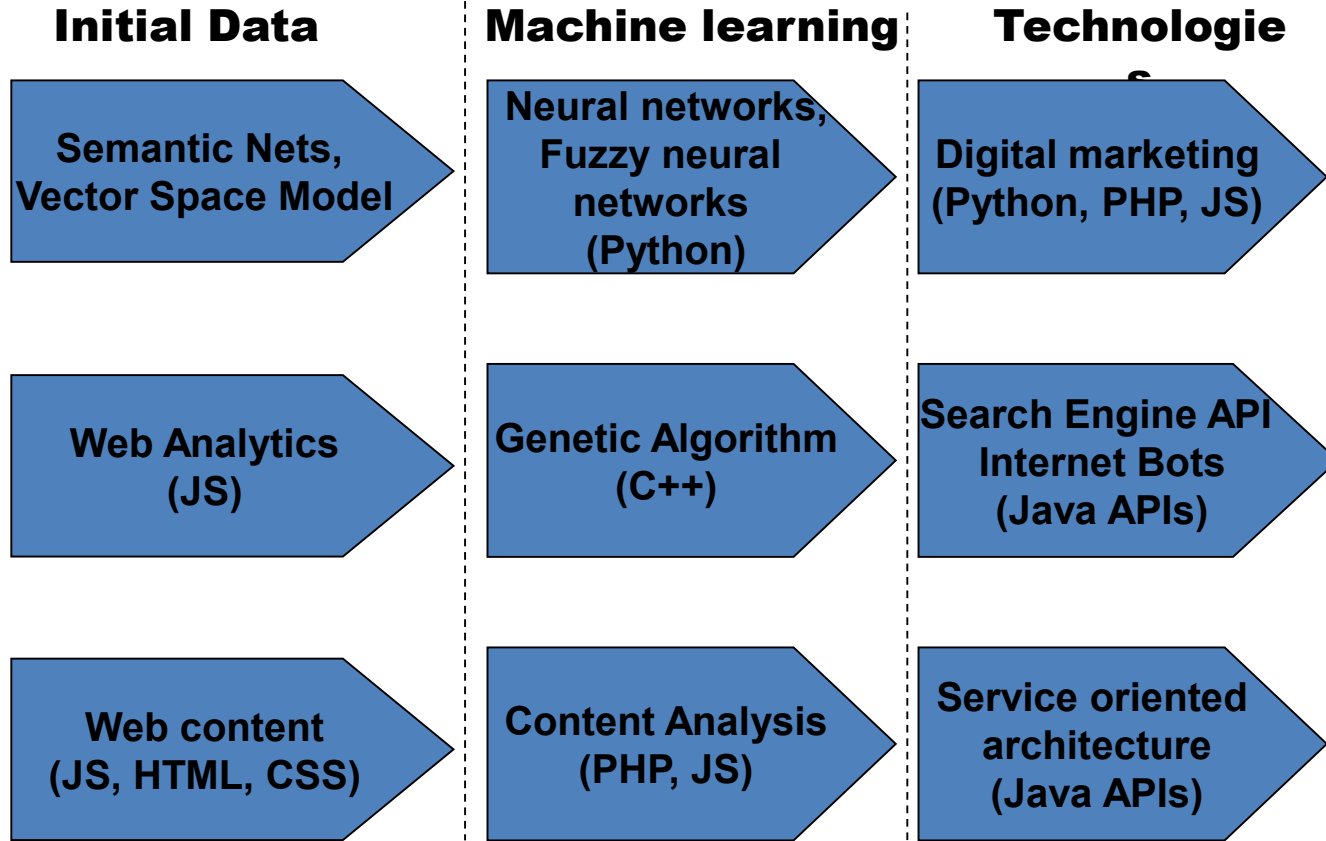
: The task is a problem of Machine Learning

Conclusion:

SE request and answer are semantic kernel of different Web sites content



# Technologies for IT Solution





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**THANK YOU FOR ATTENTION!**