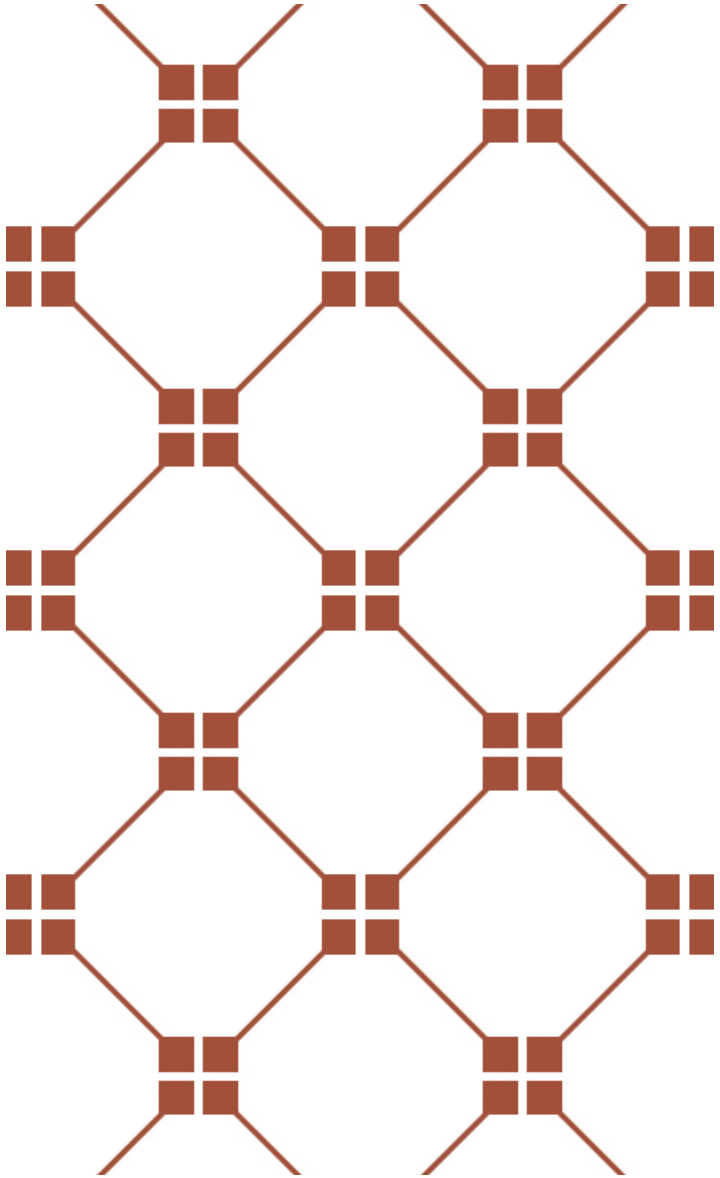
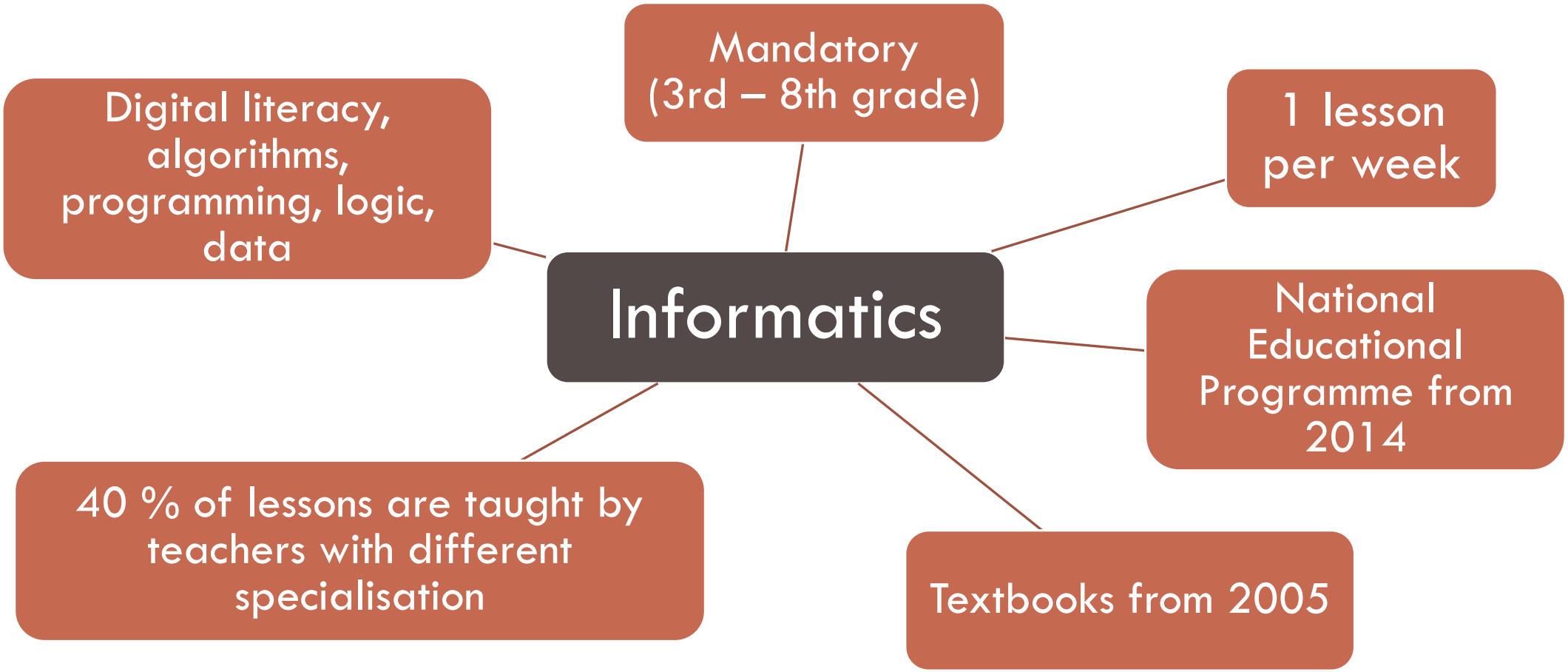


FROM BEBRAS TASKS TO LESSON PLANS – GRAPH DATA STRUCTURES

Lucia Budinská, Karolína Mayerová
Department of Didactics in Mathematics, Physics and Informatics, Comenius University in Bratislava, Slovakia

CONTEXT – SLOVAK INFORMATICS



SLOVAK BEBRAS

From 2nd grade to end of high school

Beaver town

8 categories

iBobor

Archive

89 768 contestants from **1116** schools

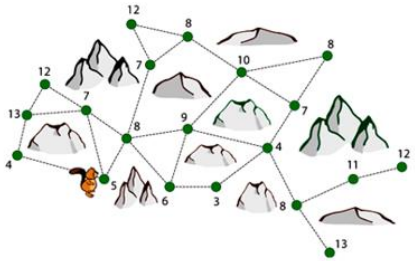
GRAPH DATA STRUCTURES?

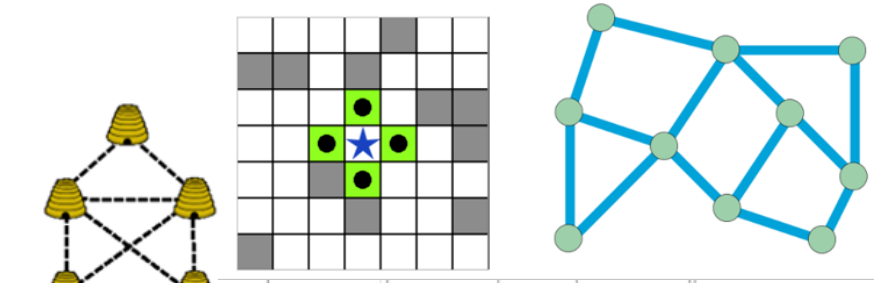
NEP – Representations and tools - Structures

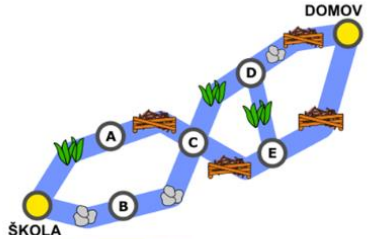
- to orientate in a simple structure (searching and obtaining information from structure based on some criteria);
- to organise information to structures (creating and manipulating with structures with data and simple relations, e. g. tables, graphs, sequences of pictures or numbers);
- to interpret information from structures (deducting existing relations from data in structure, retelling information in structure using own words

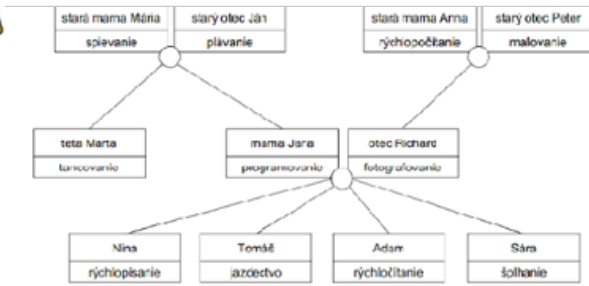
Slovak Bebras

- Previous research
  - Boys and girls differences
  - Categorisation of tasks









PHASES OF RESEARCH

0th

- Analysis of NEP
- Analysis of Bebras tasks suitability

1st

- Quantitative analysis of chosen Bebras tasks
  - Basic statistic
  - Statistical hypothesis tests (chi-square, Pearson standardised residuals)

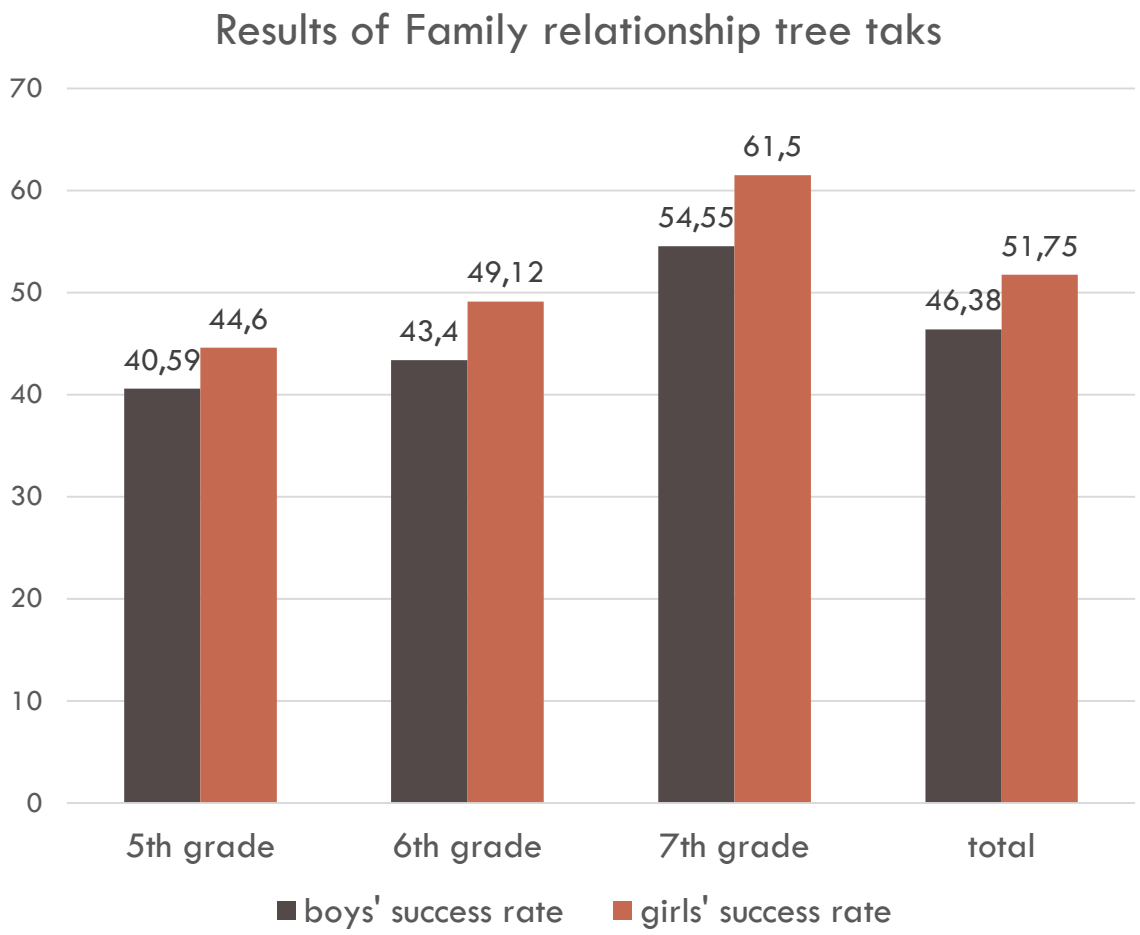
2nd

- Qualitative research (17 participants, 5th-6th grade)
  - Observation
  - Focus group
  - Analysis of pupils worksheets

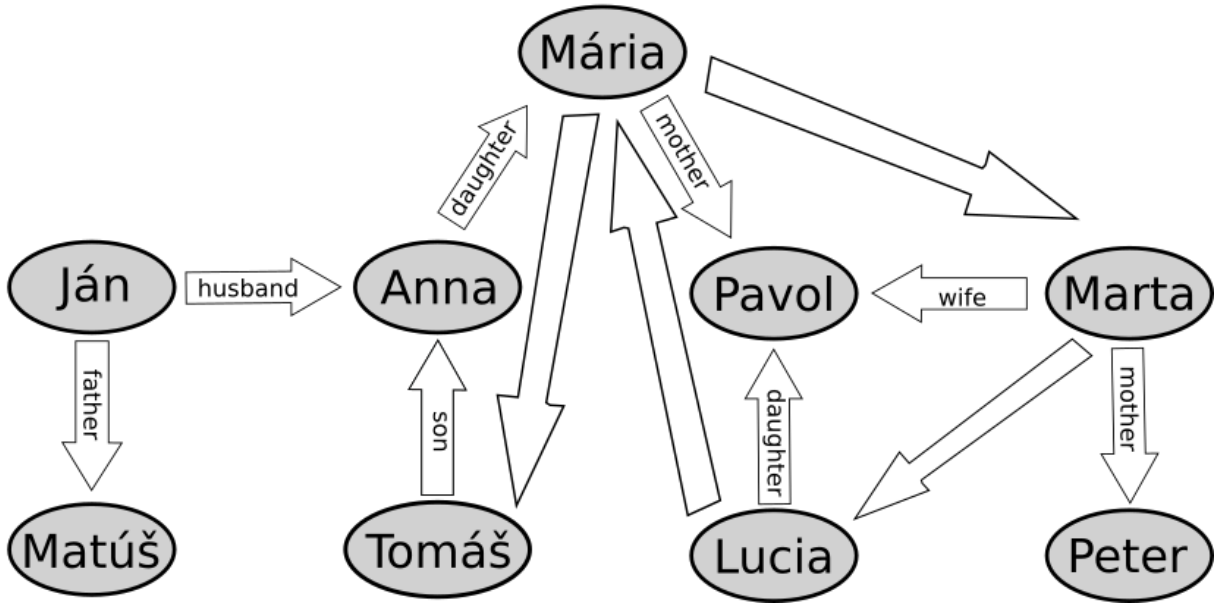
3rd

- Worksheet creation for each task
  - Addressing problems found in previous phases
- Analysis of pupils works (18 participants, 5th-6th grade)

FAMILY RELATIONSHIP TREE



Task 1 - Family relationships tree
In the picture you can see members of the Awesome family and some relationships between them. Choose the arrow which represents the relation **grandmother**.



FAMILY RELATIONSHIP TREE – 2ND PHASE

- boys: less time, choosing name not arrow

- girls: thinking about relations

Main problems of this task:

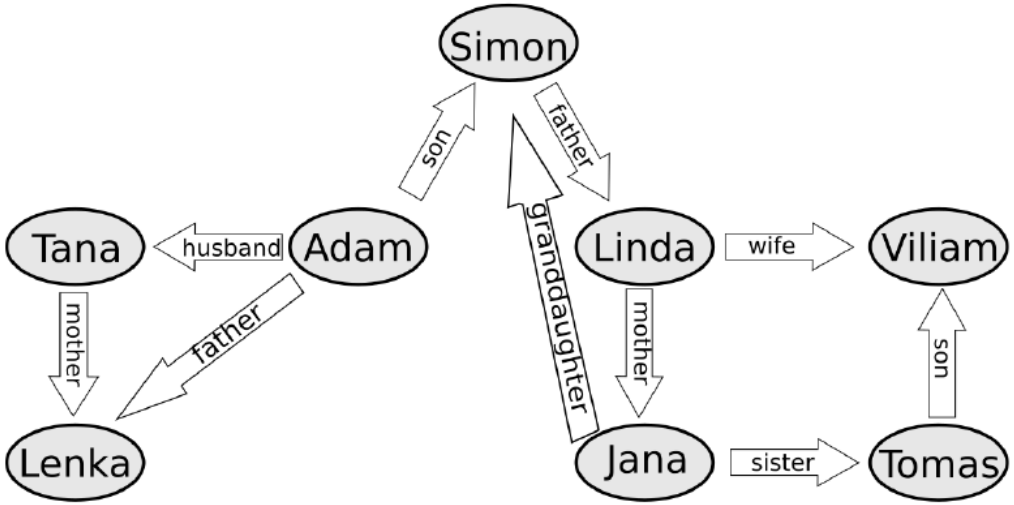
1. the meaning of arrows is **ambiguous**

2. some pupils could have problems with **naming relationships** in family

3. pupils **intuitively understand** relationships in the picture, but they did not pay attention to the direction of arrows

FAMILY RELATIONSHIP TREE – 3RD PHASE

1. **In the picture you can see family relationships in one family. For example, we can find out that *Adam is Simon's* son, or that *Jana is Tomas's sister.***



Fill in:

- Simon is Linda's ……
- Adam is Simon's ……
- Tana is Lenka's ……
- Tomas is son of ……
- Adam is Tana's ……
- Jane is granddaughter of ……

2. **Get these relationships from the picture:**
   - Linda's daughter name is ……
   - Adam's daughter name is ……
   - Linda is Adam's ……
   - Tana is Adam's ……
   - Simon is Jane's ……
   - Viliam is Tomas' ……

3. **What does the direction of the arrow symbolise?**

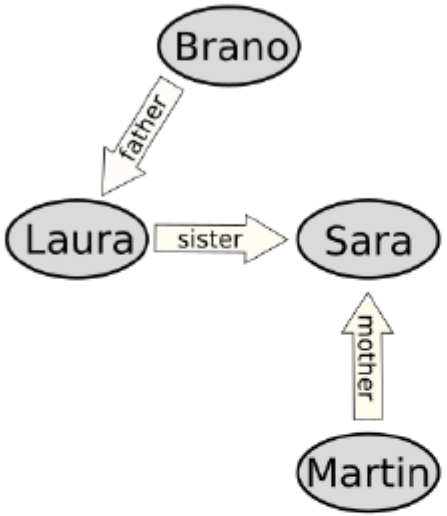
   For example, what you can say if arrow with *son* in it goes from Adam to Simon?

   Adam is …… Adam has ……

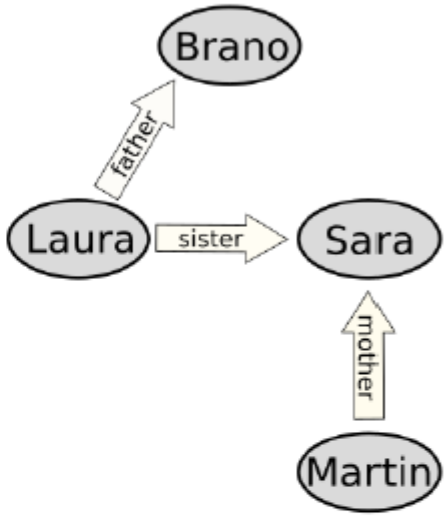
   Simon is …… Simon has ……

4. **Add ellipses with names and appropriate arrows to the picture above representing relationships:**
   - *Hana is Simon's wife.*
   - *Lenka has a brother named Albert.*
   - Can you find any other relationship which is not drawn? Add it into the picture.

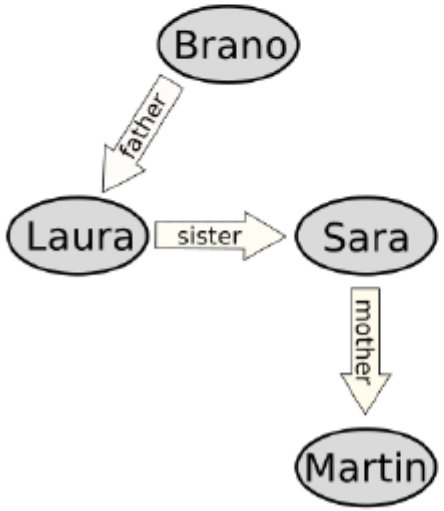
5. **Which picture represents family described below?**
   - *Sara has a sister named Laura.*
   - *Sara is Martin's mother.*
   - *Brano is Laura's father.*



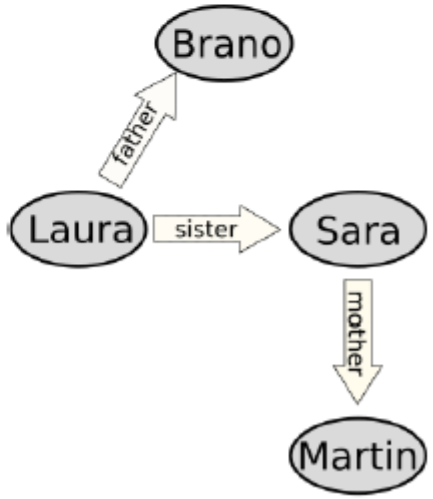
A)



B)



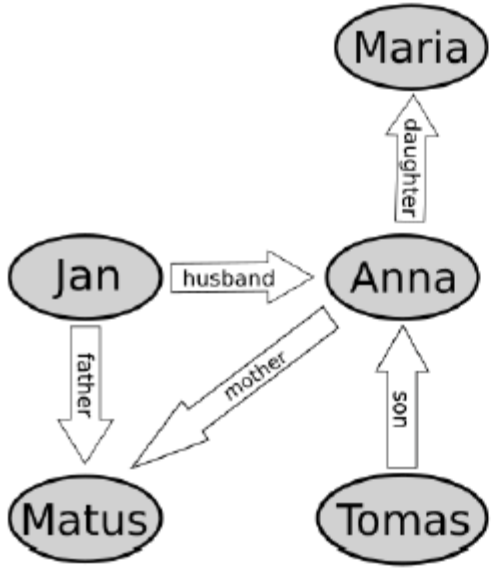
C)



D)

6. **Draw a picture (like in previous tasks) of a family described below:**
   - *Tomas has, together with his wife Simona, a son named Albert.*
   - *Albert is a father of Martina and Kristof.*
   - *Kristof's mother is named Patricia.*

7. **In the picture you can see relationships in another family.**



Fill in:

- Anna is Maria's ……..
- Maria is Tomas's ……..
- Anna´s husband is named ……..
- Matus grandmother is named …….
- Matus is Jan's ……
- Tomas's mother is named ……

8. **Read a description of a family.**
   - Juraj is a husband of Lujza and a father of Dano.
   - Lujza is mother of Dano and a daughter of Emilia.
   - Samo is Lujza's son.

   Fill in:

   a) Dano is Juraj's ……
   b) Samo's mother is named ……..
   c) Lujza is Emilia's ……..
   d) Emilia je Samo's ……..
   e) Lujza's husband is named ……..
   f) Dano's grandmother is named …….

9. **Which of these tasks was easier for you? 7th or 8th? Write a number ……..**

   Why it was easier?

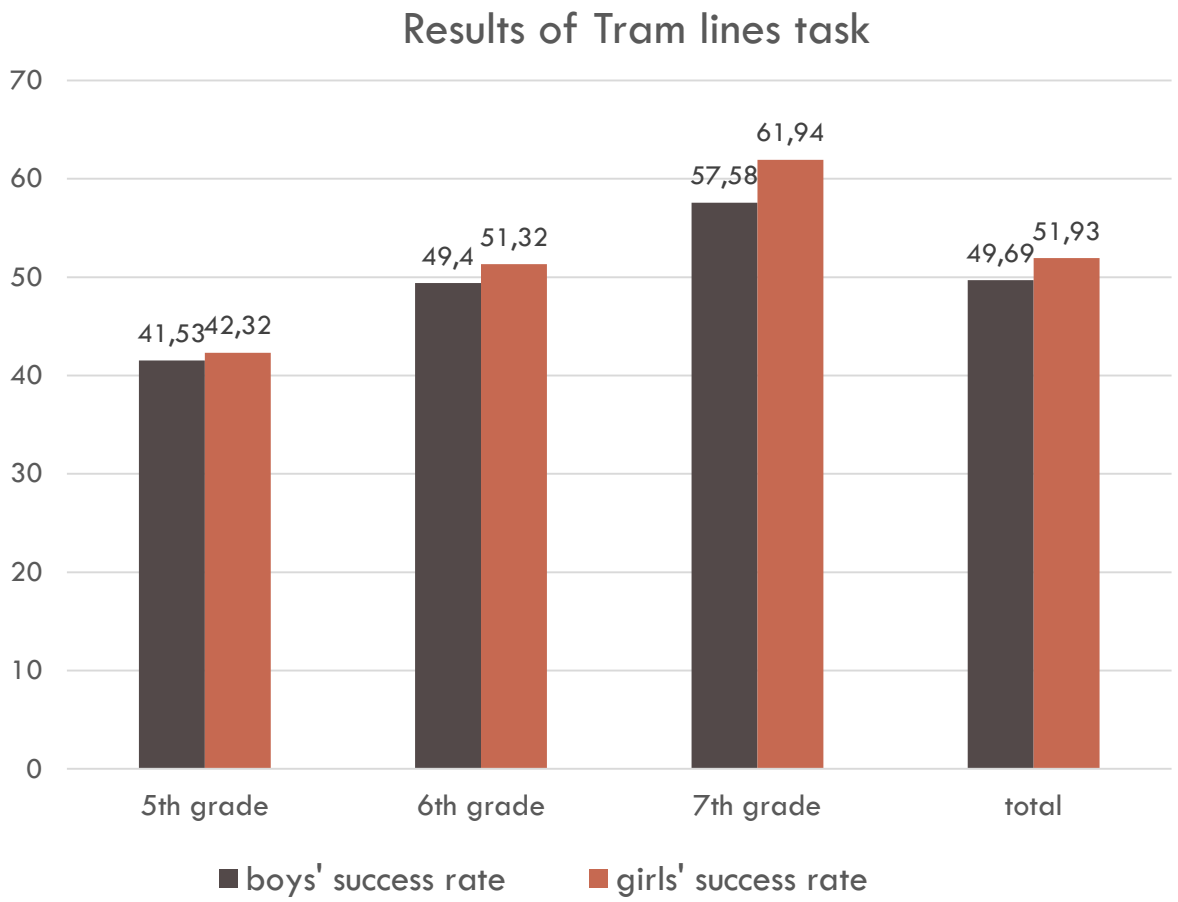
   Try to explain when picture is better than text.

   Try to explain when text is better than picture.

10. **Try to draw a picture as in previous tasks for your own family.**
    - **Draw at least 5 people and 7 arrows with relationships.**
    - Explain at least two relationships with words (for example: "My mother is Ema.").

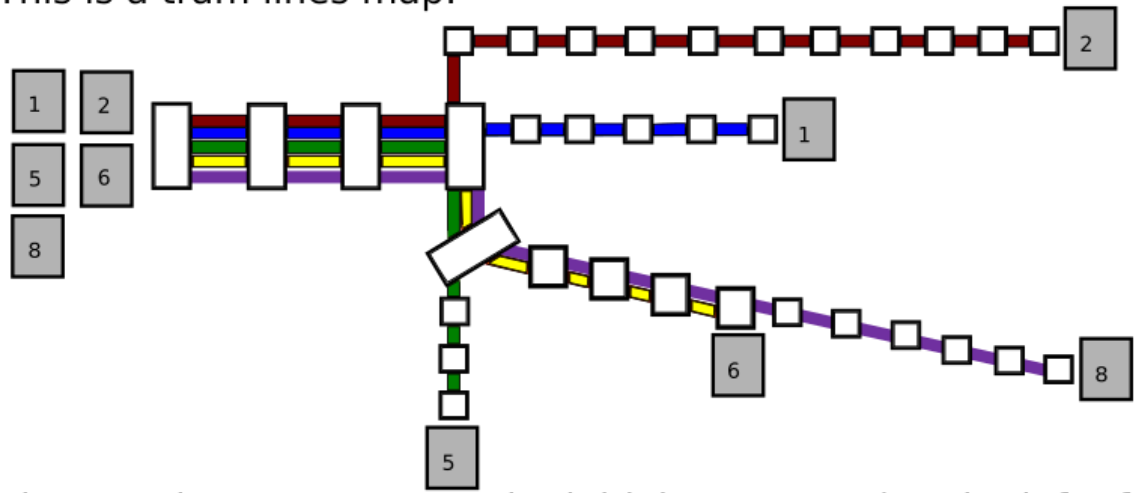
11. *** Can you create your own way how to visualise family relationships? Draw it and describe how it works.**

TRAM LINES



Task 2 - Tram lines

This is a tram lines map:



Adam get into one tram at the initial tram stop (on the left of the map). On the third stop, tram turned and on the next stop it turned again. On the next fourth stop it had its final stop. What **number** did the Adam's tram have?

A) 2 B) 5 C) 6 D) 8

2015/16 Benjamin category (10-12 years old)

TRAM LINES – 2ND PHASE

- boys were more likely to guess

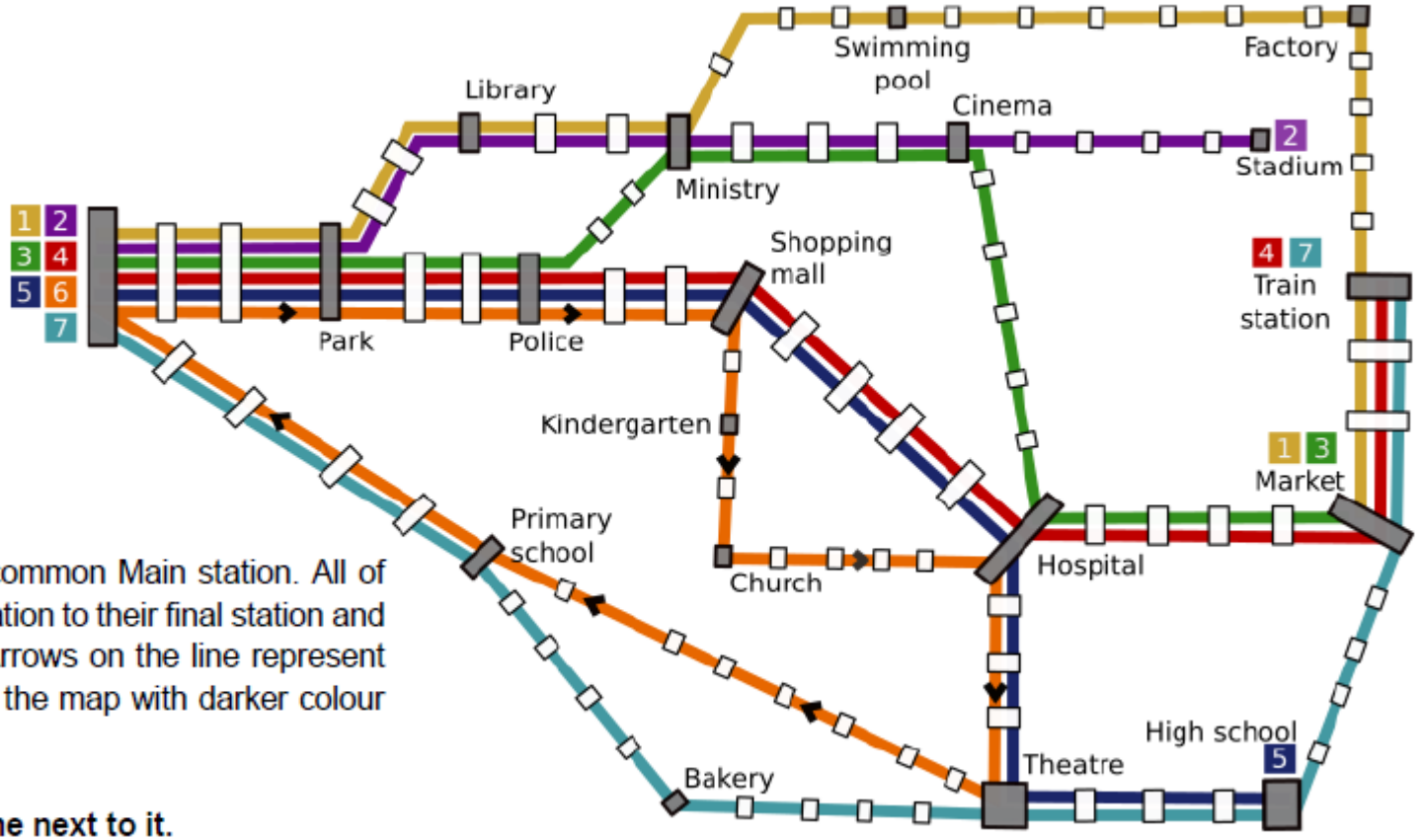
- common questions - What is represented by square?
  - Should we count the first stop?

Main problems of this task:

1. pupils were not able to understand the graph structure **quickly**
2. some **wording** could be **ambiguous**
3. younger pupils were not looking for **more than one answer**

TRAM LINES – 3RD PHASE

worksheet



In the picture there is a map of tram lines. All the lines start at common Main station. All of them except one are bidirectional (they are going from the Main station to their final station and back). One-directional line starts and ends at the Main station. Arrows on the line represent the direction of the line. The most used stops are represented in the map with darker colour and names based on what is close to them.

1. **Look at the picture, find the *Main* station and write the name next to it.**
   a. Which line is one-directional? .....
   b. How many stops does the line **1** have? .....
   c. How many stops does the line **7** have? .....
   d. What does the numbers next to some stops represent? .....

2. **Write down all number of lines which we can take (without transferring) from the *Main station* to:**
   a. the *stadium* .....
   b. the *kindergarten* .....
   c. the *hospital* .....
   d. the *market* .....

3. **Decide which line we should take if we want to go through the lowest number of stops. We are going:**
   a. from the *shopping mall* to *theatre* and we are choosing between lines **5** and **6**.

      The line ..... is better, because .....

   b. from the *ministry* to the *main station* and we are choosing between lines **2** and **3.**

      The line ..... is better, because .....

   c. from the *main station* to the *primary school* and we are choosing between lines **6** and **7.**

      The line ..... is better, because .....

   d. from the *train station* to the *main station* and we are choosing between lines **1**, **4**, and **7**.

      The line ..... is better, because .....

4. **Fill in:**
   a. Filip took on the line ..... at the *Main station*, he rode around the *library* and he took off seven stops after it next to the *cinema*.

   b. Hana, after shopping at the *shopping mall*, took on line **5**. She rode it for four stops. Next, at the fifth stop (called .....) line turned and Hana took off after more ..... stops next to the *theatre*.

5. **Find a good combination of lines and stop where to transfer if:**

   a. The teacher wants to bring her pupils from the *primary school* to the *swimming pool* and she doesn´t want to transfer too much.

      .....

   b. The line 5 is not working and Linda needs to quickly go from the *high school* to the *park*.

      .....

   c. Tomas came by train on the *train station* and he wants to go to the *cinema*. He would like to avoid the stop next to the *hospital* because there are always many ill people.

      .....

   d. Mum get Ema from the *kindergarten* and they want to go to the *park* and to the *library*, in no strict order, but they don't want to spend a lot of time in the trams.

      .....

   e. Jane goes from the *primary school* and needs to bring her brother from the *kindergarten* and to buy a bread in the *bakery*.

      .....

6. **Fill in:**
   a. After the training at the *stadium,* Simon was riding **5** stops to the ....., there he transferred to the line ..... . He took it, with two turns, for ..... stops to the final stop, where he transferred to the line ..... and three stops later he took off at the *train station*.

   b. Ivan took the line .... from the *church*, he lost time reading the newspapers and forgot to transfer to the line **4** at the stop ..... so he rode four more stops to the ..... There he transferred to the line ..... which he rode to the *train station* where he transferred to the line **1** and five stops later he took off next to ..... .

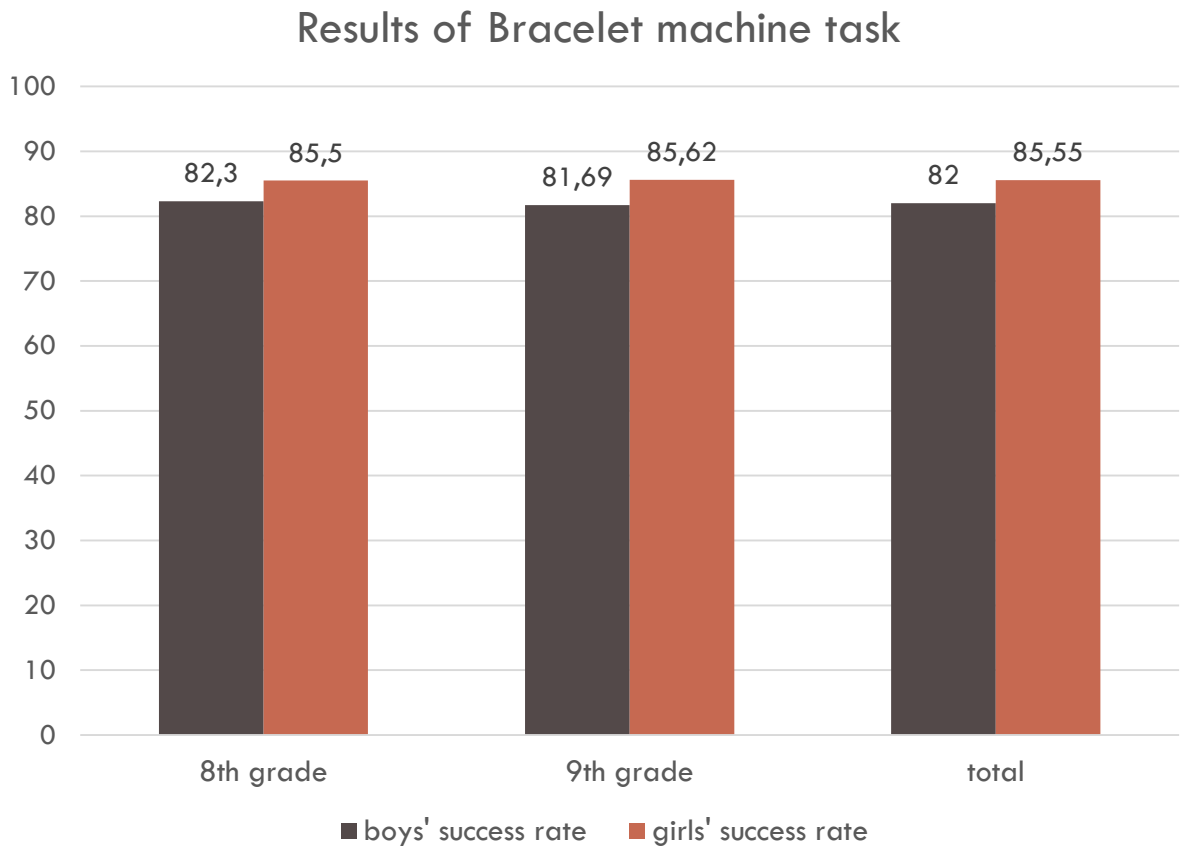
7. **This town plans to build new neighbourhood. Design new line which will connect neighbourhood with kindergarten, primary school and high school with maximum of one transit.**
   a. Draw and number the line.
   b. Describe how it will be possible to get from the neighbourhood:
      to the kindergarten .....
      to the primary school .....
      to the high school .....
   c. What is more important to you – if you don´t need to transfer at your way or that the way is quicker (the line doesn´t stop at many stops)?

      .....

      Why?

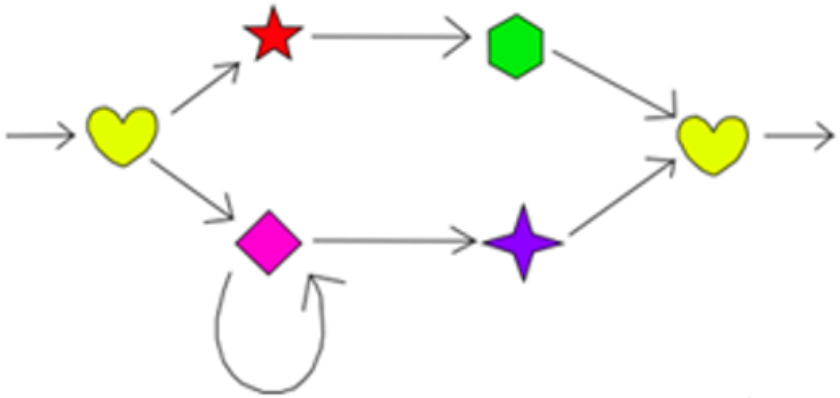
      .....

BRACELET MACHINE

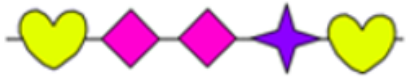


Task 3 – Bracelet machine

Sara wants to create a bracelet for her mother.
In the picture there are the rules how to string the beads.



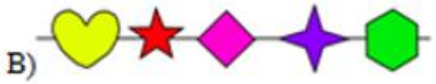
Sara made this bracelet:



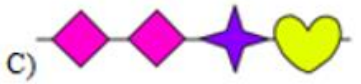
Which of the following bracelets could she make using the rules in the picture?

A)

B)



C)



D)

2013/14 Cadets category (13-14 years old)

BRACELET MACHINE – 2ND PHASE

- only intuitive understanding of graph and rules
- what is bracelet – bracelet is circular so the picture (automaton) looks like it too
- method of exclusion

Main problems with this task:

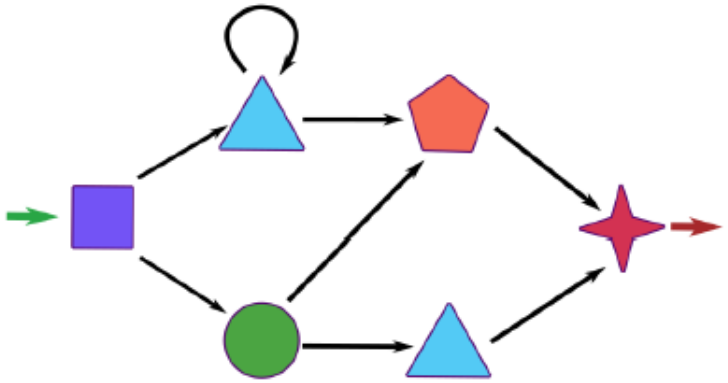
1. more difficult **comprehension of rules** from graph for this age group
2. not clear understanding what the **loop** means

BRACELET MACHINE – 3RD PHASE

1. In the picture you can see rules based on which our automaton creates bracelets. It always begins to create a bracelet from a green arrow and it ends with a red arrow .

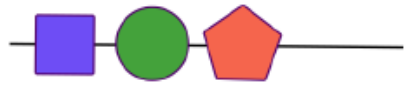
This automaton created this bracelet:

Draw a way how the automaton was creating this bracelet.



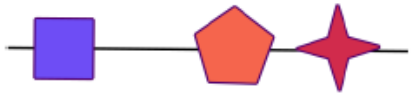
2. These bracelets were made also by our automaton based on the rules in the picture above. There is one bead missing from each bracelet. Draw them.

a.



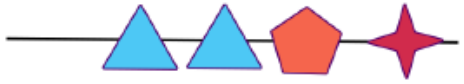
b.

c.

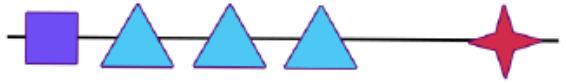


d.

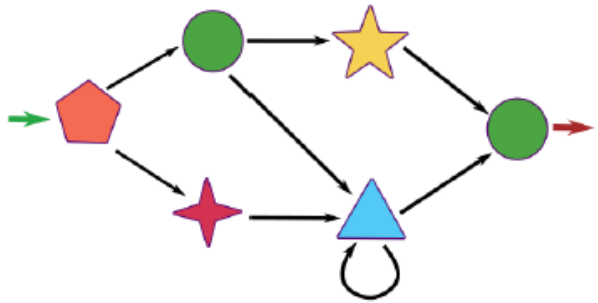
e.



f.



3. **In the picture there are other rules for an automaton. Choose the bracelets which it could create.**



A.

B.

C.

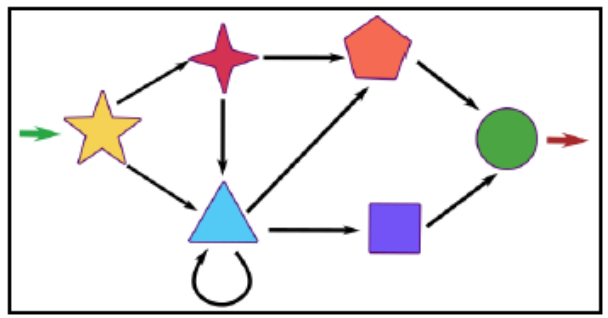
D.

E.

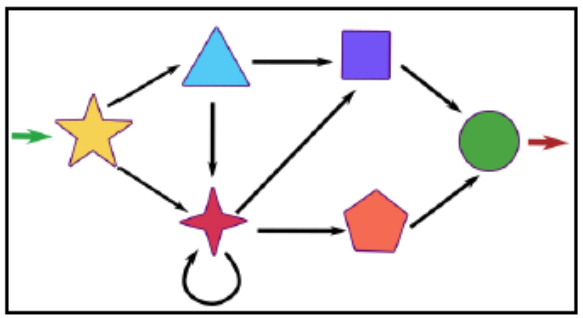
F.

4. **In the pictures there are two set of rules for two automata. For each bracelet write which automaton it was created by.**

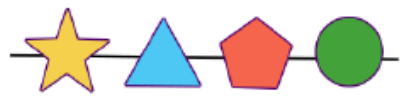
automaton Zetor



automaton Xavi

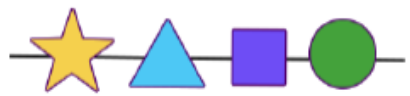


a.



.....

b.



.....

c.

.....

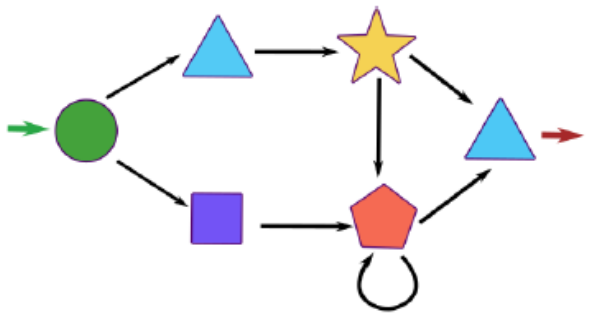
d.

.....

e.

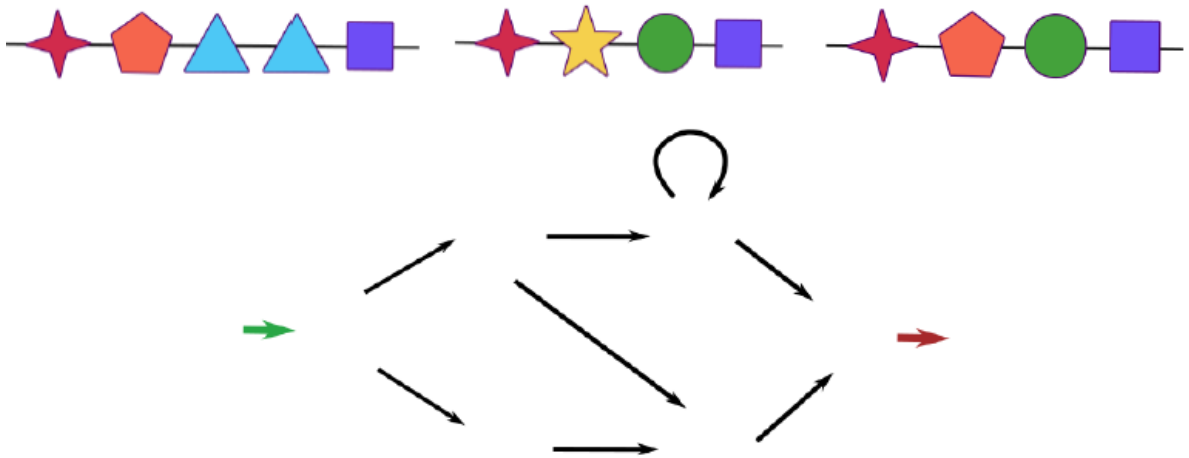
.....

5. **Draw at least three different bracelets which could be made by an automaton working with rules in the picture.**



6. **Write down, what we know about bracelets which are made with automaton in previous task:**
   a. The bracelets start with bead: .....
   b. The bracelets end with bead: .....
   c. Could some bead be repeated in the bracelet?.....
      If yes, which one? .....
      And how many times?.....
   d. How long is the shortest bracelet made by automaton?.....
   e. How long is the longest bracelet made by automaton? .....
      Why? . .....

7. **Fill in missing beads into rules for automaton if you know that these three bracelets were made by it.**

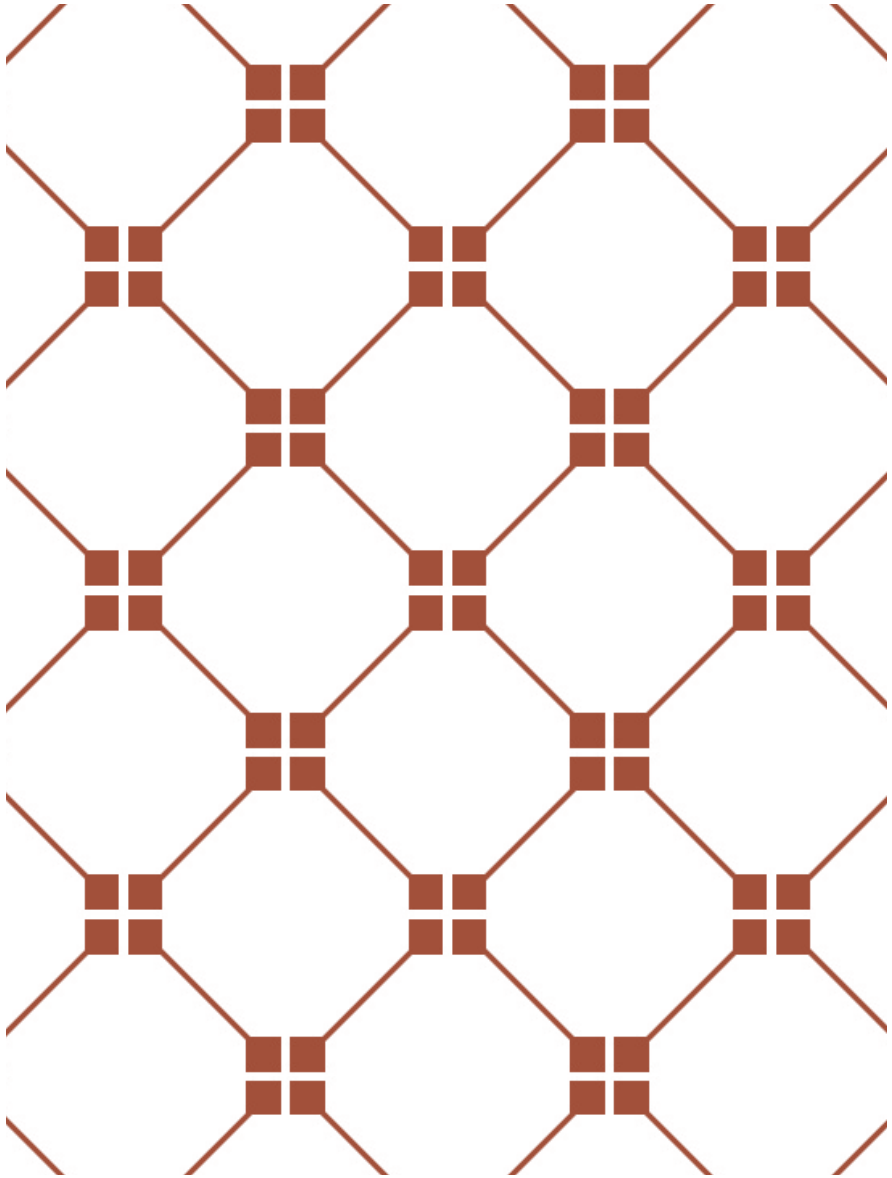


8. **Try to create your own rules (as in previous tasks) for automaton. It can create bracelets, necklaces, words...**
   - **Draw at least two final „products“.**
   - **Explain how your automaton works.**

CONCLUSION & DISCUSSION

- we are aware of the small sample
- therefore we wanted to get the feedback from teachers:
  - *„It is not easy for us to use Bebras tasks in lesson if we don‘t have a good understanding of informatics concept behind it.“*
  - *„We don‘t have time to look for suitable tasks and creating materials.“*
  - different ways how to use worksheets
- new schools, new rounds of testing
  - seems like a motivation of the task is important in girls/boys success (or their predicted success)

This appears like a good way how to bring graph data structures to school informatics.



THANK YOU FOR YOUR ATTENTION

Lucia Budinská, lucia.budinska@fmph.uniba.sk