Learning Computational Thinking by Bebras Challenge

Gerald Futschek, Austria

Vienna, 18.4.2016

International Challenge on Informatics and Computational Thinking
BEBRAS (Lithuanian word for beaver)

Goals

- to **stimulate** pupils' interest in informatics and information technology

- to **encourage** pupils to *think* deeper while using computers and information technolgies

- to **develop** Computational Thinking

- to **inseminate** concepts of informatics

Participants

All pupils age 8 to 19

Different tasks for 5 age groups:

| Age group			Little Beavers		Benjamins		Cadets		Juniors		Seniors		
Grades	1	2	3	4	5	6	7	8	9	10	11	12	13

Tasks

- pupils have to solve 15-24 tasks within 40 to 60 minutes
- **interactive tasks, open ended, multiple-choice** tasks
- 2 - 4 minutes per task
- easy, medium and hard tasks

Challenge

- performed on PCs, usually during school lectures
- in a week each November
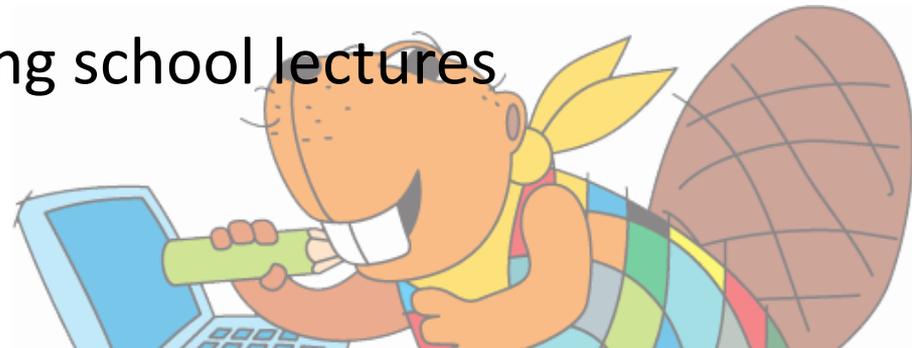
More than 1.3 mln participants in 2015
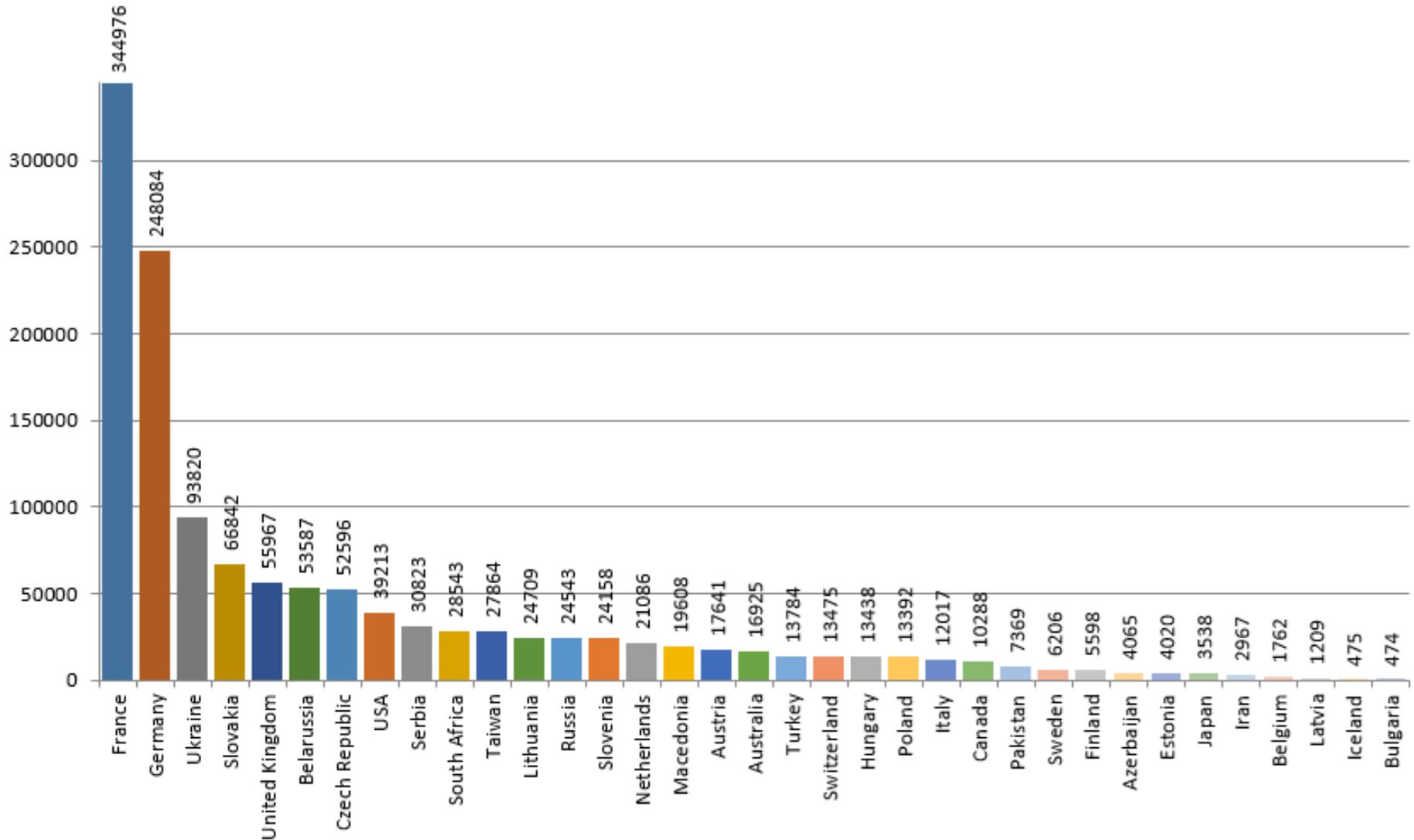
Bebras Contest:
The Challenge of Thinking

- To solve the tasks one has to **think**

- Already learned knowledge is not asked

- Pupils have to find solving strategies

- They have to find and understand structures

- They have to find arguments for or against given alternatives

Developing Problem Solving Skills

- Solving Bebras tasks educates in „Computational Thinking"

- Computer science (CS) like thinking is done while solving the tasks

- Each task involves a CS concept that needs specific thinking qualities

Kind of Bebras Tasks

Multiple Choice

usually one out of four

Interactive

move objects to create solution

Value

input of number or short text

Computational Thinking
operational definition for K-12 education

Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:

- **Formulating** problems in a way that enables us to use a computer and other tools to help solve them

- Logically **organizing** and **analyzing** data

- **Representing** data through abstractions such as models and simulations

- **Automating** solutions through algorithmic thinking (a series of ordered steps)

- **Identifying**, **analyzing**, and **implementing** possible solutions with the goal of achieving the most efficient and effective combination of steps and resources

- **Generalizing** and **transferring** this problem solving process to a wide variety of problems

ISTE and CSTA, 2011

Planting Flowers

2012-DE-05, cadetts

A big beaver and a little beaver are planting flowers in the garden. The little beaver has smaller arms and smaller legs than the big beaver. Little beaver's steps are therefore shorter and it plants the flowers at positions closer to its body.
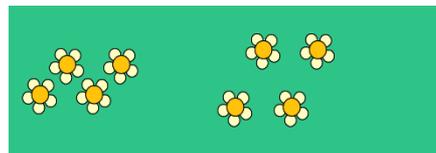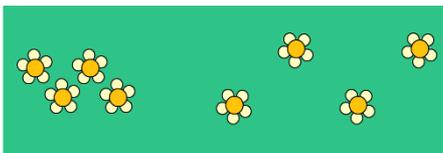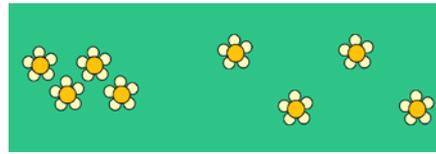
At the beginning, they stand on the lawn back to back looking in opposite directions. Then both move according to these instructions:

```
repeat twice:
    plant a flower on your right hand side
    move one step forward
    plant a flower on your left hand side
    move one step forward.
```

How does the lawn look like afterwards?

Missing piece (Senior)

2012-CH-10

Beaver John has received a secret message. Unfortunately a part of the message has been destroyed by a spill of red colour.
This case was foreseen and there are additional squares in the message. Each square in the rightmost column (column 6) or the lowest row (row 6) is coloured such that the number of black squares in a row, respectively in a column is *even*.
John considers there are sixteen different possible messages. Only two of them make sense to him.

What is a valid pattern of the red piece?
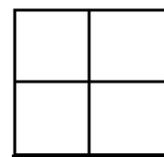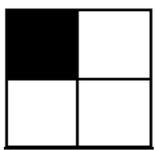
Which Foto do you want?

Johnny has 8 photos. He would like to give one of them to Bella. He asks her some questions to find out which photo she wants:

"Do you want a photo with a beach umbrella?" "Yes."

"Do you want a photo where I have something on my head?" "No."

"Do you want a photo where you can see the sea?" "Yes."

Which photo should Johnny give to Bella?

A)	B)	C)	D)
E)	F)	G)	H)

Graph of a map

- Maps can be easily pictured as graphs. In such a graph every node is a country and the lines between the nodes mean that they border each other. The picture shows a graph of a map with seven countries.

- **Indicate the map that fits the given graph**

Dice

2013-SK-09, Junior

We have three commands **draw-1**, **draw-2a** and **draw-2b** that draw dots like this:

draw-1   draw-2a   draw-2b

The command **turn90** turns the pattern 90 degree.

For example the command sequence

draw-1,draw-2a,turn90 draws

Which sequence of commands draws this?

A) **draw-2b, turn90 , draw-2a, draw-1**

B) **draw-2b, draw-2a, turn90 , draw-2a**

C) **draw-2a, draw-2b, turn90 , draw-2a**

D) **draw-2a, turn90 , draw-2a, draw-2b**

Bookshelf (Junior medium)

2010-EE-03

The librarian wants to order the volumes of an encyclopaedia with as few steps as possible.

For doing one step he takes a volume out of the shelf, shifts some of the remaining ones to left or right and puts the volume in his hand to the new free space.

The following example sorts 5 volumes using just one step:

Now he wants to order the following 9 volumes:
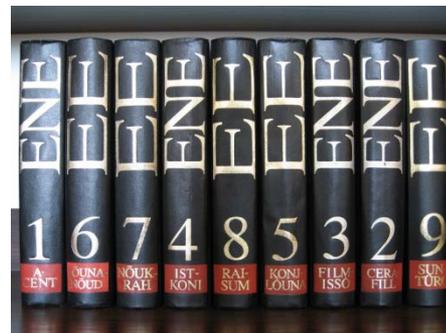
This is computational thinking
A largest increasing subsequence remains untouched in the optimal solution. To find substructures that remain invariant is a key competence of computational thinking.

What is the smallest number of steps to order all 9 volumes?

Loading Lisas

2014-DE-08, Benjamin to Junior

The fishermen Falke and Folke own two boats, named "Lisa 1" and "Lisa 2" – the two Lisas. The maximum load for each boat is 300 kilo.
Falke and Folke should carry some barrels filled with different kinds of fish. They are paid per kilo transported.

220	130	120	100	90	90	60

Lisa 1   Lisa 2
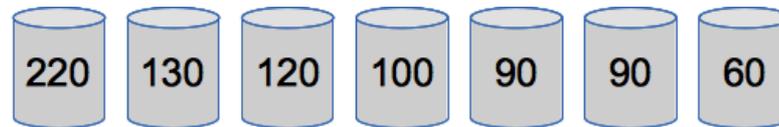
Put barrels onto the boats such that each boat gets loaded with as many kilos of fish as possible.
The barrels have their weight (in kilos) printed on them.

How tasks are created

3 Phases:

1. **Task Proposals**: developed in each of the Bebras countries

2. **International Task Pool**: Composed and developed during the yearly international Bebras Task Workshop (one week in May)

3. **National Task Sets**: Subset of the Int. Task Pool, translation and adoptions to national needs and policies

Effects on learning and teaching

- Students learn
  - a wide range of CS concepts
  - that CS is interesting and challenging
  - how to think computational
  - how Computational Thinking may be applied in daily life

- Teachers learn
  - how students can be introduced to even advanced CS concepts

Use of Bebras tasks beside the contest

At school

       - during the {CS, English, Maths} lecture

       - as extra activity for all

       - as motivation to learn a concept

       - as test tasks

References

- V. Dagiene, G. Futschek: *Bebras International Contest on Informatics and Computer Literacy: Criteria for Good Tasks*, LNCS 5090, pp 19-30 (2008).

- G. Futschek, V. Dagiene: *A Contest on Informatics and Computer Fluency Attracts School Students to Learn Basic Technology Concepts*, Proceedings 9th WCCE 2009, paper No. 120.

- V. Dagiene, G. Futschek: *Introducing informatics concepts through a contest*. IFIP Working Conference: New Developments in ICT and Education, Amiens; June 2010 - 30.06.2010; Paper-Nr. 07, 15 pages.

- Dagienė, V., Stupurienė, G., Pėlikis, E. (2015). Introducing Computational Thinking through a Contest on Informatics: Problem-solving and Gender Issues. Informacijos mokslai, ISSN 1392-0561, Vol. 73.

International website

www.bebras.org