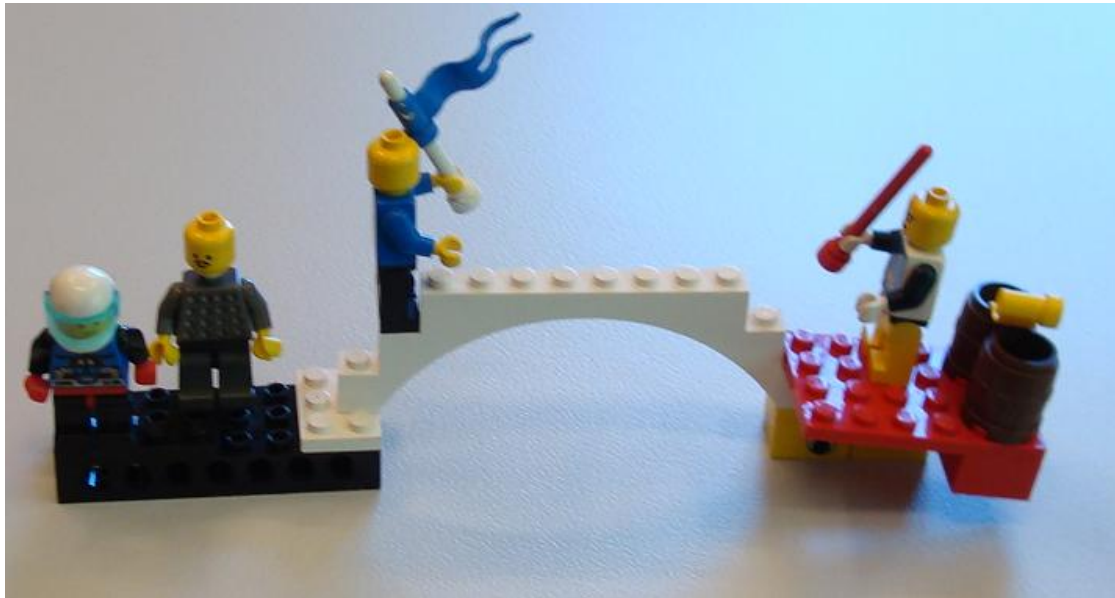


Metaphorical Algorithms

A Source for Bebras Tasks



Michael Weigend, Bebras Team Germany

Outline

1. Introduction
2. Metaphors in Informatics
3. Metaphors in Informatics Education
4. Metaphorical Algorithms and Bebras Tasks
5. Conclusion

1 Introduction



The universe is a
glass of jelly beans



*Bild der Wissenschaft,
April 2010*

Metaphor

glass of jelly beans
95 % black



universe
95 % dark matter
and dark energy

source domain

target domain

Classical Rhetoric: figure of speech, a tropos

Psycholinguistics:

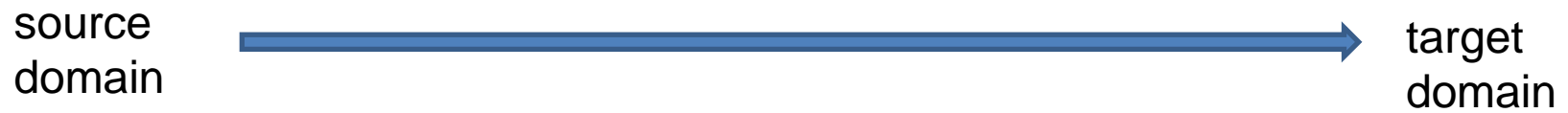
- mapping of concepts (conceptual metaphors)
- prototype of an abstraction

Lakoff 1993, Lakoff & Nunez 1998, Torrealano et al. 2006

Why Do We Use Metaphors?

To make intellectual content

(1) ... interesting, funny, beautiful

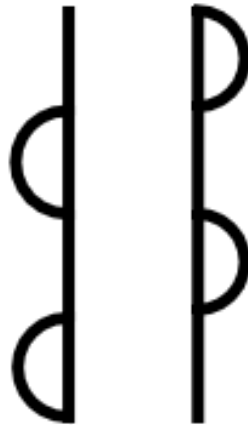


(2) ... comprehensible



Doodles

Surprising Metaphors for Geometric Images

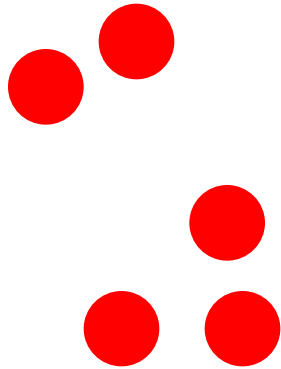


Bear climbing up a tree

Fried egg making a
head stand



Metaphors as Vehicles in Elementary Math Teaching



Collecting Objects



$$2 + 3 = 5$$

Arithmetics

Lakoff & Nunez 1998

2 Metaphors in Informatics

project metaphor

“... this program works like hive of bees, going out for pollen and bringing it back to the hive”

Ron Jeffries 2001

data structures,
class libraries

flow of control

data entities

10011

Metaphor-Related Operations

```
class Thing():
    def __init__(self, name, weight):
        self.name=name
        self.weight=weight

def collectSmallThings (maxWeight, box):
    bag = []
    for thing in box:
        if thing.weight <= maxWeight:
            bag.append(thing)
    return bag
```



creating
meaningful names

switching from one
metaphor to
another

Metaphor-Related Operations

```
class Thing():  
    def __init__(self, name, weight):  
        self.name=name  
        self.weight=weight
```

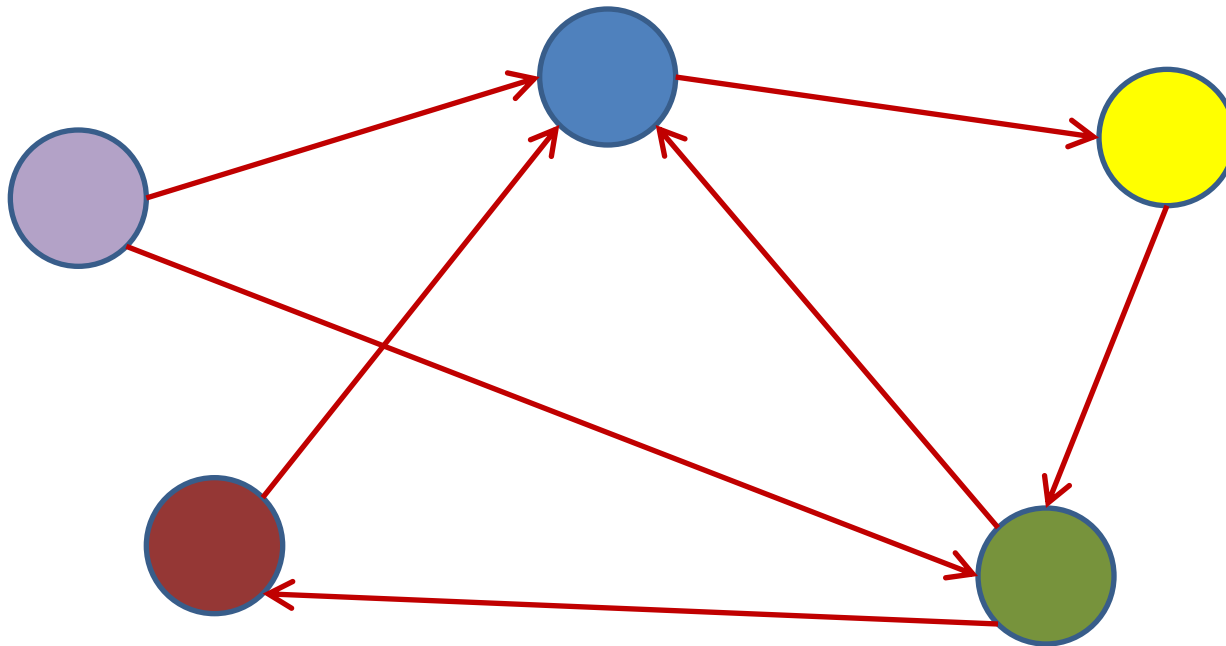
```
class Bag (list):  
    def collect (self,thing):  
        self.append(thing)
```

```
def collectSmallThings (maxWeight, box):  
    bag = Bag()  
    for thing in box:  
        if thing.weight <= maxWeight:  
            bag.collect(thing)  
    return bag
```

Refactoring:
Adapting
programme code
to metaphors

A Facet of Computational Thinking

Metaphorical thinking =
building bridges between knowledge domains



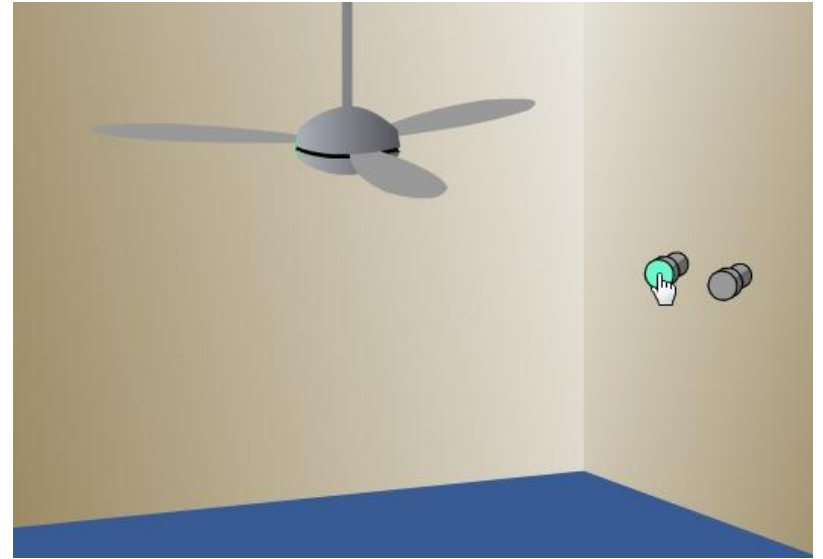
3 Metaphors in Informatics Education

Roleplays

Seminar on game design
Flash and ActionScript 3.0

```
function startFilm (event)
{
    film.play();
}
```

```
startButton.addEventListener("click", startFilm);
```



Visualize the execution in a metaphorical roleplay

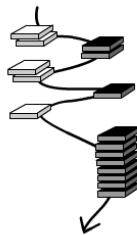
Metaphors and Co-Operative Learning

Rate the
images
(A to F)!

2 2 2 1 1 8 \Rightarrow

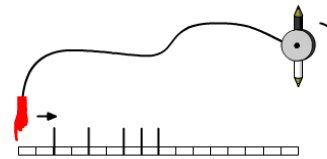


1 A



1 B $2 * \square + 2 * \blacksquare + 2 * \square + 1 * \blacksquare + 1 * \square + 8 * \blacksquare$

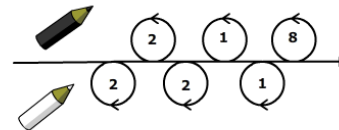
1 C



1 D



1 E



Pick an
image and
explain the
algorithm!

Michael Weigend 2011

The Power of Diversity

Illustration	1 (A)	2 (B)	3 (C)	4 (D)	5 (E)	6 (F)	Avg. (SD)
Walk and lay tiles 1 A	5	17	2	0	1	0	2.00 (0.82)
Sum of products 1 B	14	9	1	1	0	0	1.56 (0.77)
Two-colour-pencil 1C	0	3	4	7	3	8	4.36 (1.41)
Walk on tiles 1D	1	3	6	7	7	1	3.76 (1.23)
Pencils and loops 1E	1	8	8	5	2	1	3.08 (1.19)

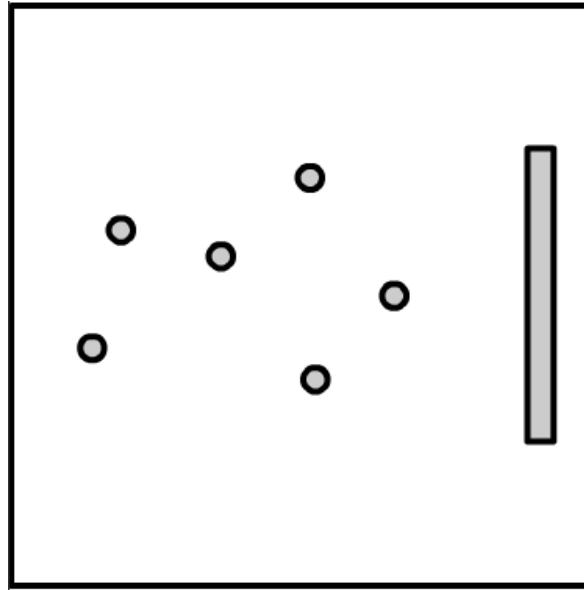
Michael Weigend 2011

Different persons understand
metaphors differently well

“studies on the quality of peer-to-peer dialogue have found that the extent to which students gain from group work depends on the depth and the quality of the dialogue they engage in”

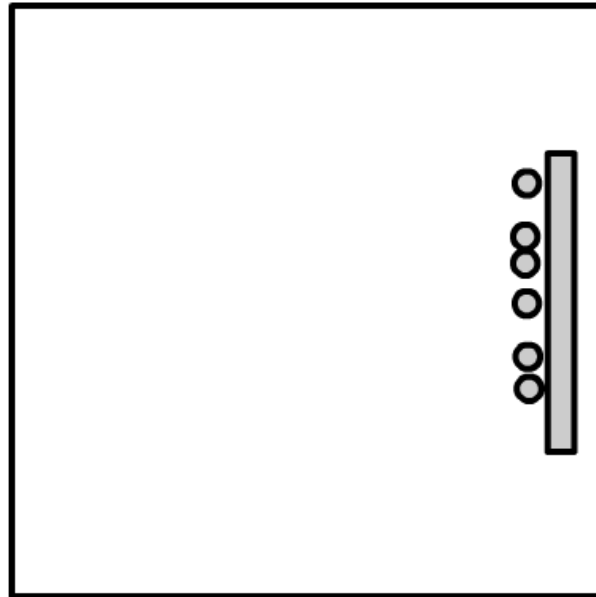
Asterhan et al. 2010, p. 211

Metaphorical Algorithms - a Challenge to Creativity



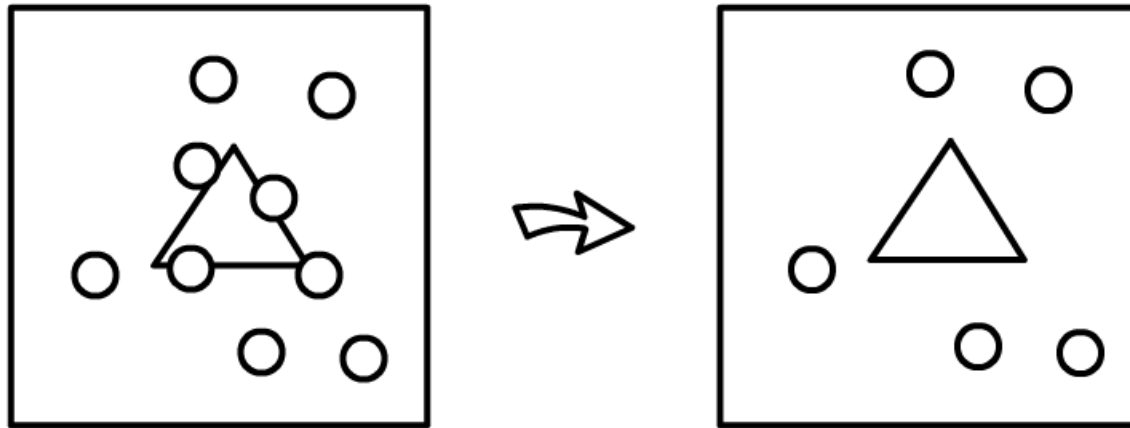
There are six horses standing on the meadow and an empty feeding trough. Someone puts feed into the feeding trough. Immediately the horses walk to the trough on the shortest way and start to eat.

How does it look like?



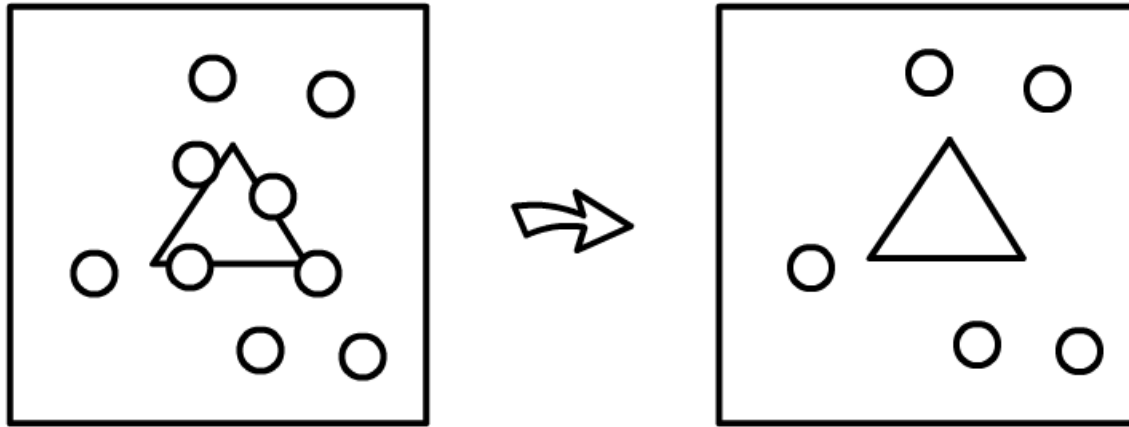
Most kids in the age of 10 find a similar solution.

Complete the Story



There are bubbles floating around a cactus...
The bubbles that touch the cactus burst.

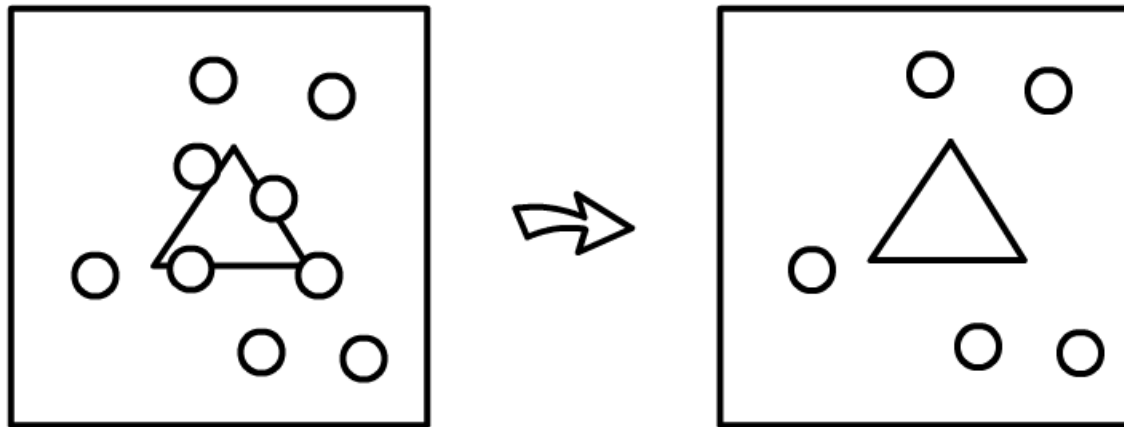
Create a Story (1)



There are nine billard balls, which are supposed to be potted into a triangular hole. But Luis manages to pot just four of the balls with two strikes. How does it look like?

Boy, 11 years old

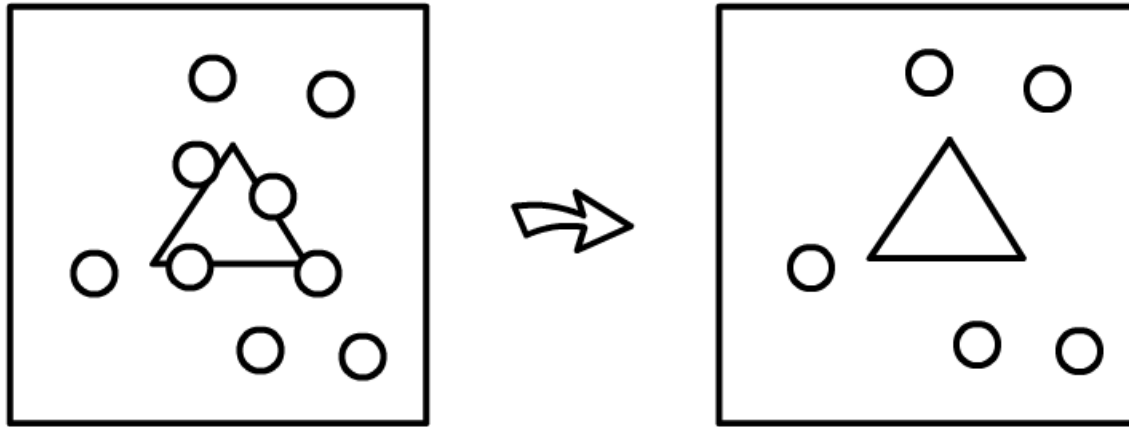
Create a Story (2)



There are people standing at a pyramide. Then something flows out of the pyramide and they run away.

Boy, 10 years old

Create a Story (3)

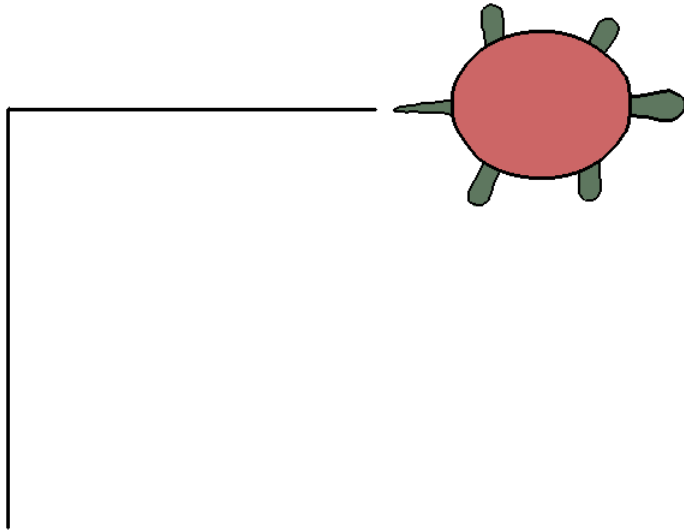


Mrs Müller puts washing powder into the basin. The bacteria are diminished. How does it look like?

Boy, 9 years old

4 Metaphorical Algorithms and Bebras Tasks

A Classic: The LOGO-Turtle



```
forward (50)  
right(90)  
forward (50)
```

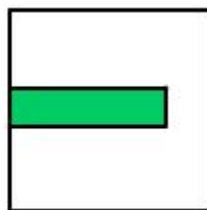
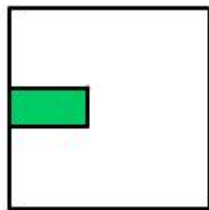
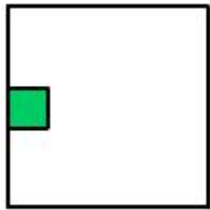
The Turtle Is Not A Turtle

soldier

bipedal walker

weathercock

A Proposal: Plant Life



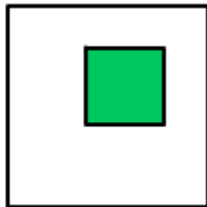
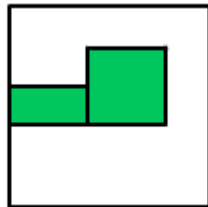
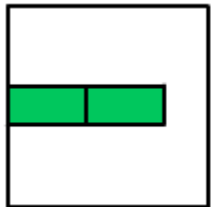
`a.grow(east); a.grow(east);`

Methods:

`grow (direction)`

`split()`

`die()`



`b,c = a.split(); c.grow(north); b.die();`

5 Conclusion

Bebras tasks involving metaphorical algorithms...

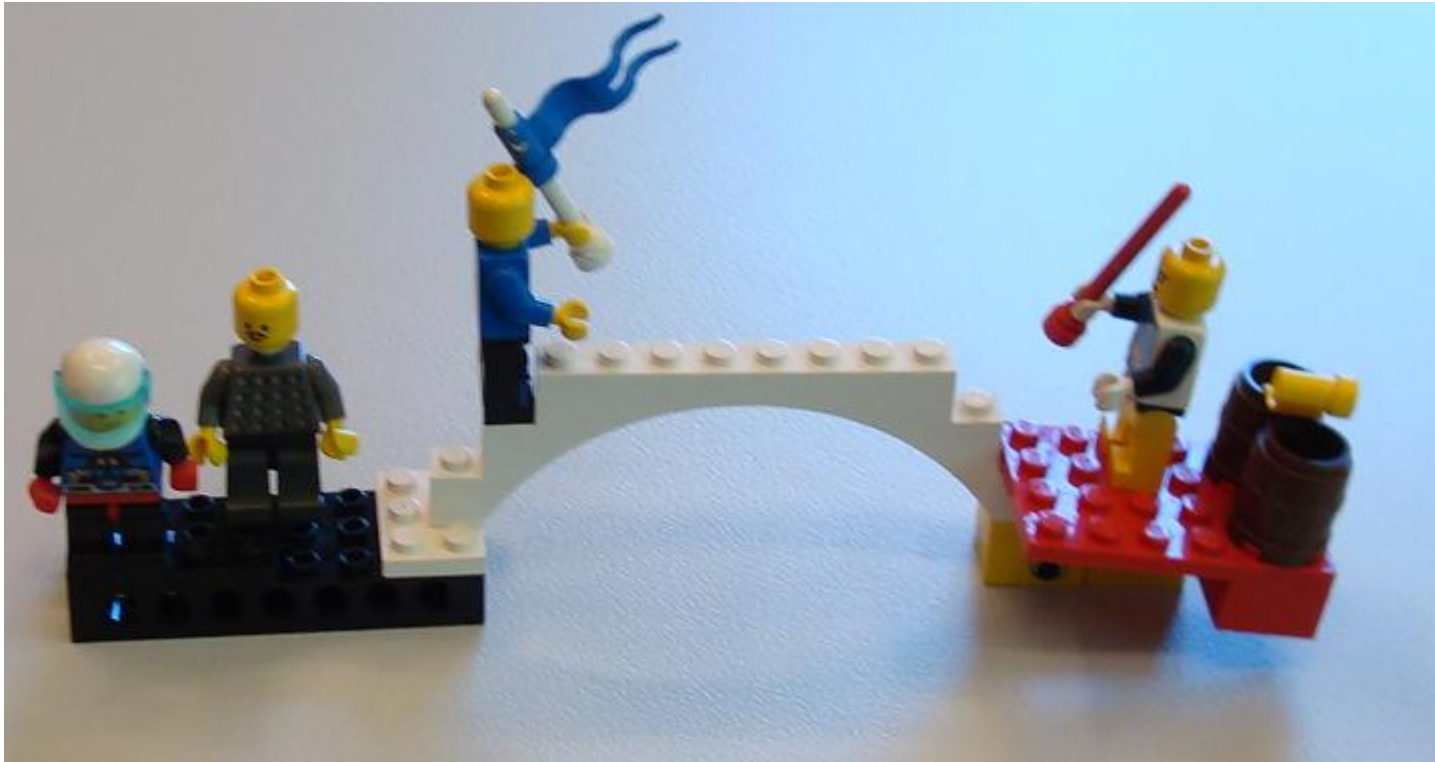
(1)... may be interesting, beautiful and funny

(2)... do not require special knowledge

(3) ... inspire algorithmic creativity

(4) ... represent a fundamental facet of computational thinking

And Finally...What Is This?



(A) defragmentation of a HD
(C) USB memory stick

(B) Optical mouse
(D) Digital camera

References

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