

# Didactic Games For Teaching Information Theory

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# The paper and the talk

- Aim of the paper:  
games to introduce, illustrate and teach  
Information Theory concepts
- Paper content:  
five games and activities for high school students  
(rules, our experience, scientific background)
- This talk: overview and two of the games
- Both games tested in camps for talented students in Slovakia

# Overview

- Games in education: motivation, experience, etc.
- Our approach:
  - children play the game
  - later, they discover a scientific concept
  - parallels with the game bring better understanding
- In accord with many knowledge acquisition theories (e.g. Hejný's Theory of Generic Models):
  - based on the game, child forms a separate model
  - after encountering another separate model in practice, generalization of the concept is easier

# Teaching concepts from Information Theory

Together, our games are related to the following concepts:

- The definition of information
- Measuring information
- Redundancy of natural languages
- Relativity of information
- A transmission channel
- Data coding
- Data compression
- Covert channels

# Soy-Sugar-Glue

## Rules

- two players: *a robot* and *a navigator*
- robot is blindfolded and forbidden to speak
- navigator is only allowed to use three words (e.g.: soy, sugar, glue)
- robot and navigator agree on a way to communicate and practice this communication for a while
- navigator is given a goal the robot is supposed to achieve (usually, multiple pairs compete to achieve the goal first)

# Soy-Sugar-Glue

## Possible goals

**Easy:** Pick up an object. Rotate on the spot.  
Get down on all four.

**Medium:** Touch your nose. Clap hands.  
Score a goal with a football.

**Hard:** Perform a forward roll.  
Pick up a flower and hand it to a non-playing person.  
Find a bottle, open it and drink from it.

**Very hard:** Jump forward.  
Give a non-playing person a kiss on the cheek.

# Soy-Sugar-Glue

## Strategies and practical experience

- good strategies: systematic, easy to remember
- common strategy: two-part commands  
“(body part) (movement)”
- strategies often mimic known computer interfaces  
examples:
  - cursor to select a body part
  - a special “undo” command

# Soy-Sugar-Glue

## Cheating

- commands mapped to letters; goal transmitted as a string
- prevention: goal that interacts with environment
  
- use of intonation, volume, speed of speech, etc.
- changes in voice can indicate how robot is doing
- speed can reflect the amount of robot's movement



# Soy-Sugar-Glue

## Background and insights

### Concepts

- data coding (the process of acquiring the goal)
- transmission channel (environment)
- covert channel (hidden channel used to transmit information)

# Knocking game

## Rules

- two players in adjacent rooms separated by a closed door
- one player is given a sentence that has to be transmitted to the other player
- the transmission is done by knocking on the closed door, no other actions are permitted
- two possible goals:
  - easy: transmit sentence without mistakes
  - hard: minimize the number of knocks in transmission

# Knocking game

## Strategies and practical experiences

- easiest: unary coding (1 knock = A, 26 knocks = Z)
- first optimization: frequent letters = few knocks
- much better: binary coding / Morse code (using knocks and double-knocks)
- another optimization: short/long pauses between knocks instead of double-knocks

Still much room for improvement!

(e.g., Markov model-based or dictionary-based approaches.)

# Knocking game

## Background and insights

### Concepts

- data coding (encoding to the form supported by the channel)
- transmission channel (door with knocking on it)
- data compression (minimizing number of knocks)

## Remaining games in the paper

- Guess the sentence  
Guessing a complete sentence using yes/no questions.  
Defining and measuring information.
- Reconstructing damaged text  
Text comprehension with missing/damaged letters.  
Redundancy of natural languages. Error correction.
- Text message game  
Transmit a message using as few characters as possible.  
Data compression.

Thank you for your attention!