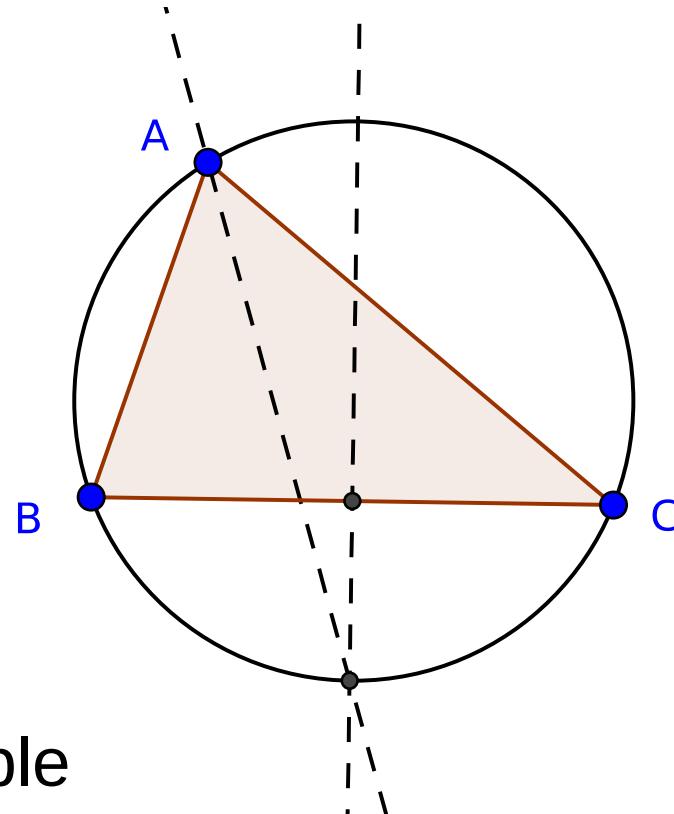


# Who cares about Euclidean geometry?

Miroslav Olšák

# Euclidean geometry

- Points, lines and circles in the plane

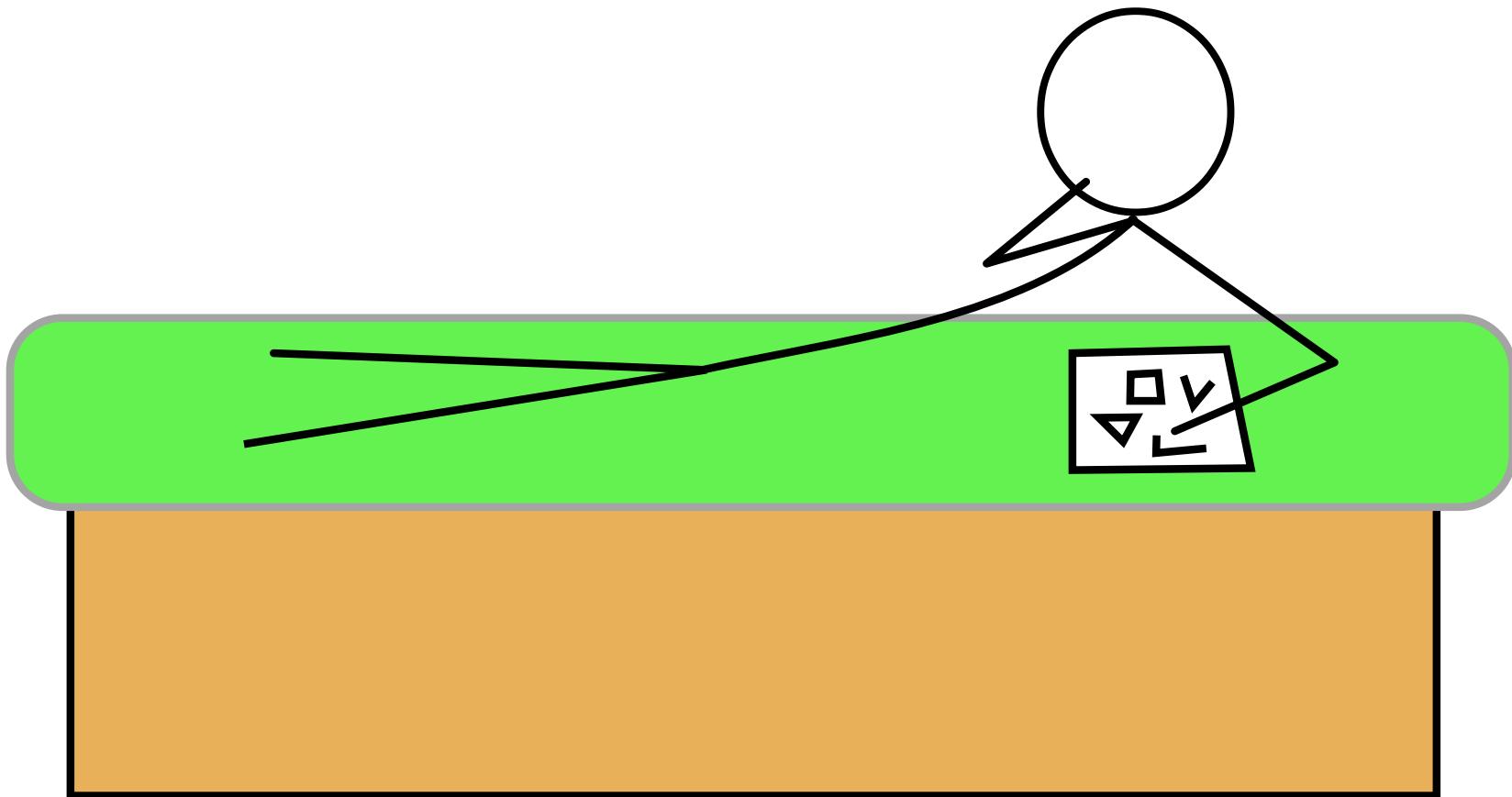


- Nice but...
  - Without applications
  - Algorithmically decidable

# AITP

- Automated theorem proving
- Machine learning

# Me

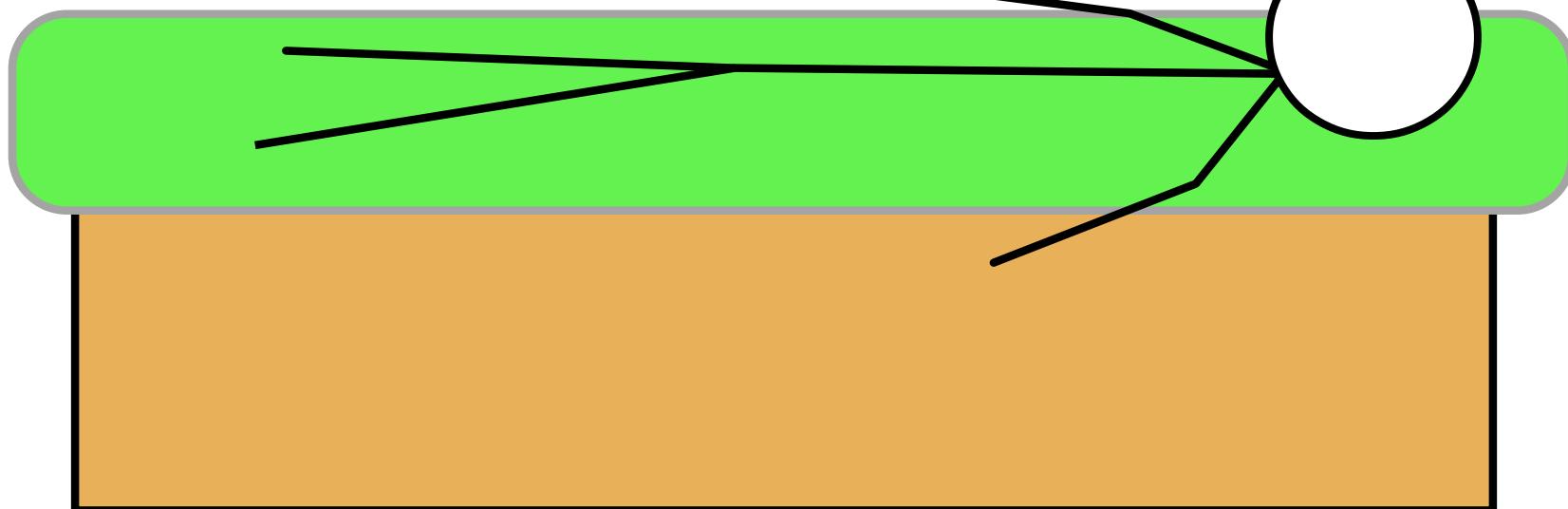


**Breaking news!**

A computer program exceeded  
world best mathematicians

Problem solving solved, what next?  
Computer programming!

Riemann hypothesis  
solved by a computer



# Mathematics

- Abstraction
- Reasoning
- Problem solving

# Abstraction

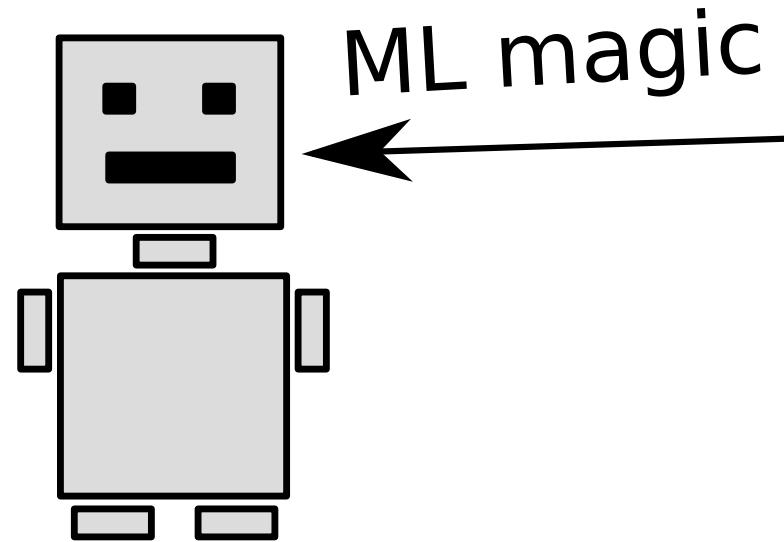
A conceptual process where general rules and concepts are derived from the usage and classification of specific examples, literal ("real" or "concrete") signifiers, first principles, or other methods. (Wikipedia)

# Abstraction – Logician's approach

- Replacing constants with variables
- Construction of lambda function (HOL)
- ...

$$\int_{\varphi(a)}^{\varphi(b)} f(x) dx = \int_a^b f(\varphi(t))\varphi'(t) dt$$

# Machine learning approach

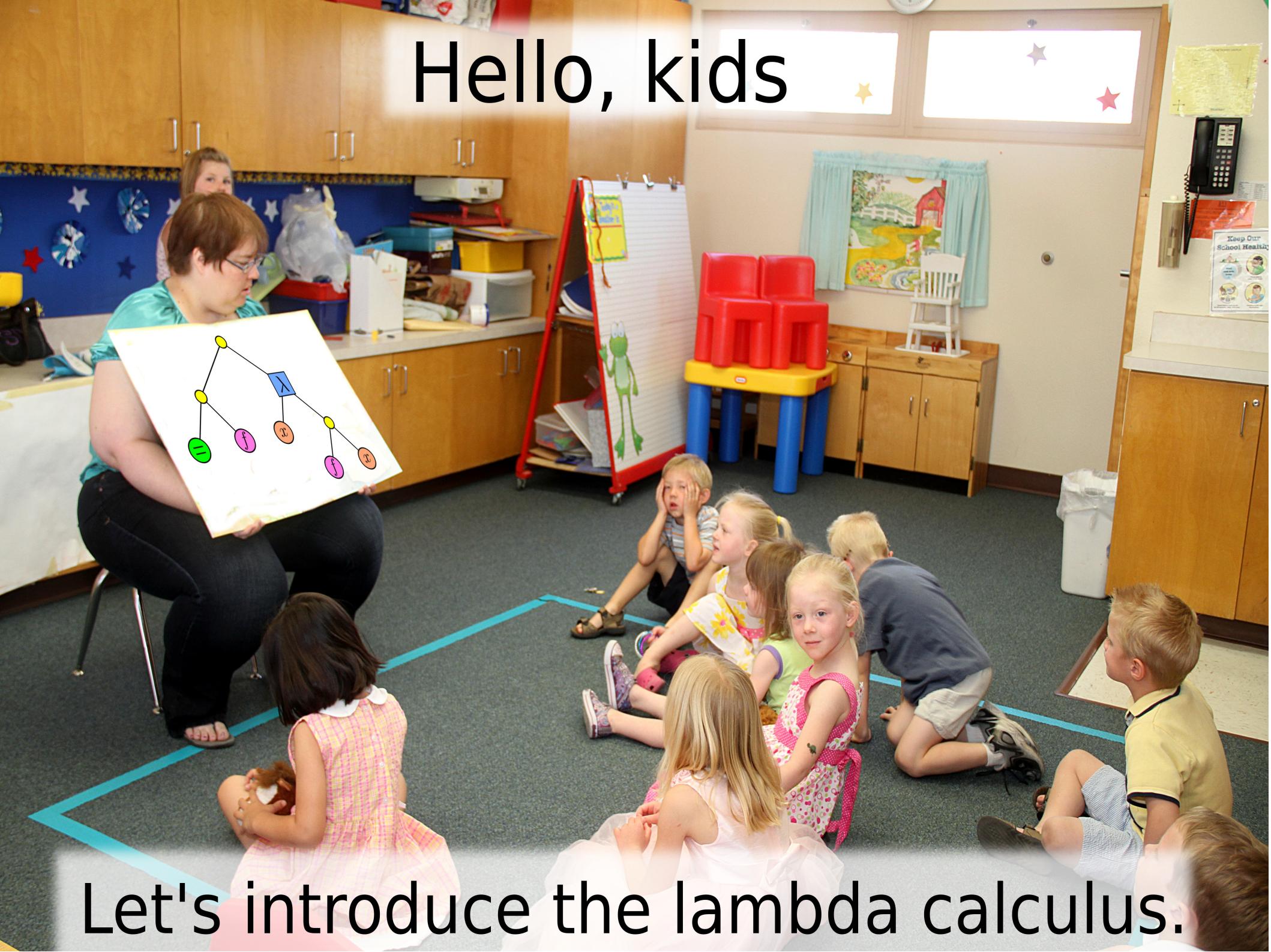


Now I have an idea  
what a "dog" means

These are dogs



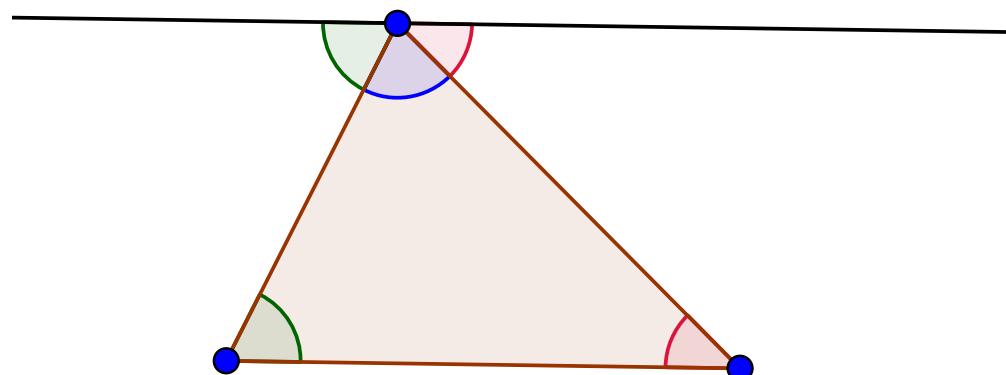
# Hello, kids



Let's introduce the lambda calculus.

# Elementary school

- Arithmetic
- Word problems
- Euclidean geometry
  - One abstraction level
  - Teaches reasoning



# Problem solving – benchmark



# International Mathematical Olympiad (IMO)

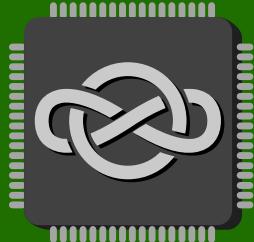
- Prestigious competition for high school students
- 4 “domains”
  - Algebra
  - Number theory
  - Combinatorics
  - Euclidean geometry
- National rounds
  - Plenty of problems of various difficulty
    - Thousands for geometry

# One more point

- People at IMO are really clever

# One more point

- People at IMO are really clever
- The plan
  - 1) Solve geometry
  - 2) Get AI generated problems to competitions
  - 3) Get attention of talented people
  - 4) Invite them into a project of solving entire IMO



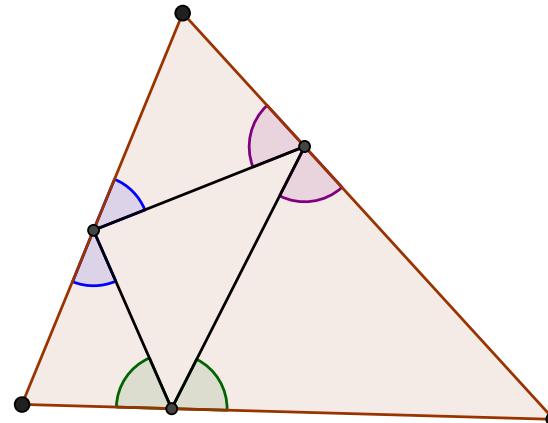
Let's solve the problem solving

# Euclidean geometry

- Problems from elementary school to IMO
- Relatively simple → suitable for experiments
- Concrete → suitable for image processing
- We can attract IMO people
- Without applications?
  - Not the ultimate goal
- Algorithmically decidable?
  - Ignorable

# Suggestions

- Data collection
  - Prasolov, Chan, 106, 107, AOPS, ...
  - ...
- Reinforcement learning
  - Guide by image / structure
  - Problems to prove
  - Constructional problems
  - ...
- ...



# What do you think?

