# Algebra as a geometric modeling language
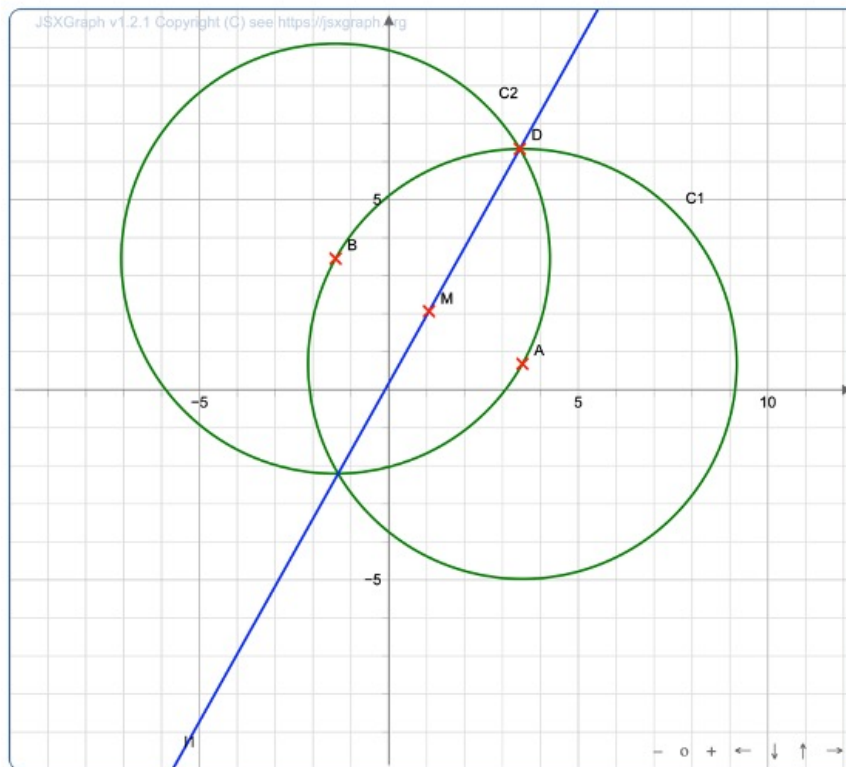
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https://myweb.rz.uni-augsburg.de/~oldenbre/jsfelix/F2d/jxfelix.html

- (Re-)Introduction of FeliX
  - 2002: Prototype, 2021: Web version



First demo: mid points, ellipse , sliding ladder

- Functional vs. Relational thinking
- Functional Thinking: (in)dependent variables, covariation
  - Technical realization
    - Dynamic geometry e.g. Geogebra, Cinderella, GSP
    - Spreadsheets
- Relational Thinking: related variables, mutual connection
  - No technical realization for schools
  - But important in physics, economics, …
- Basic mental model of (in)equations

# FeliX: Didactical theory
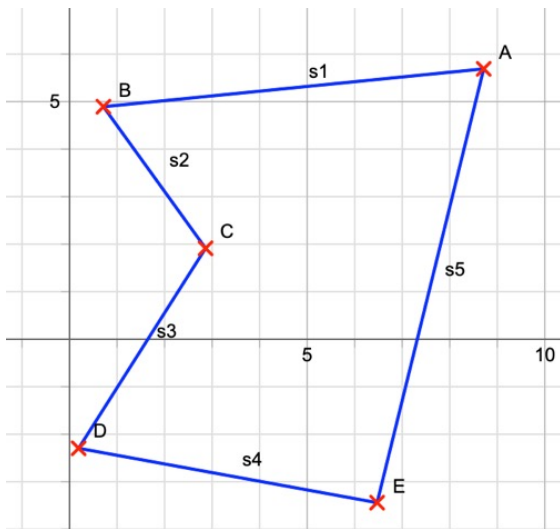
- Sound and simple logical basis



**Sets** of objects and propositions

Variable-Value assignment: **Interpretation**
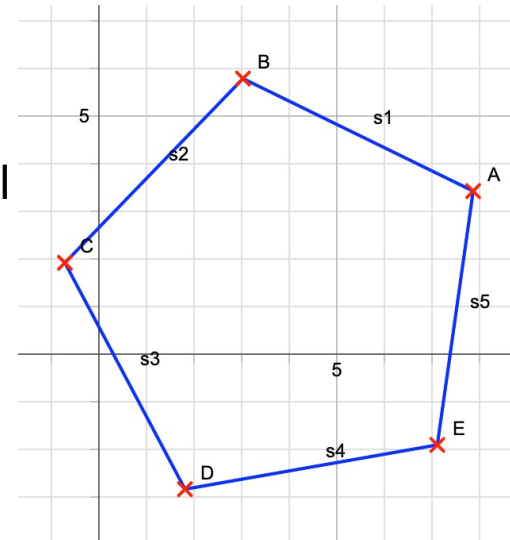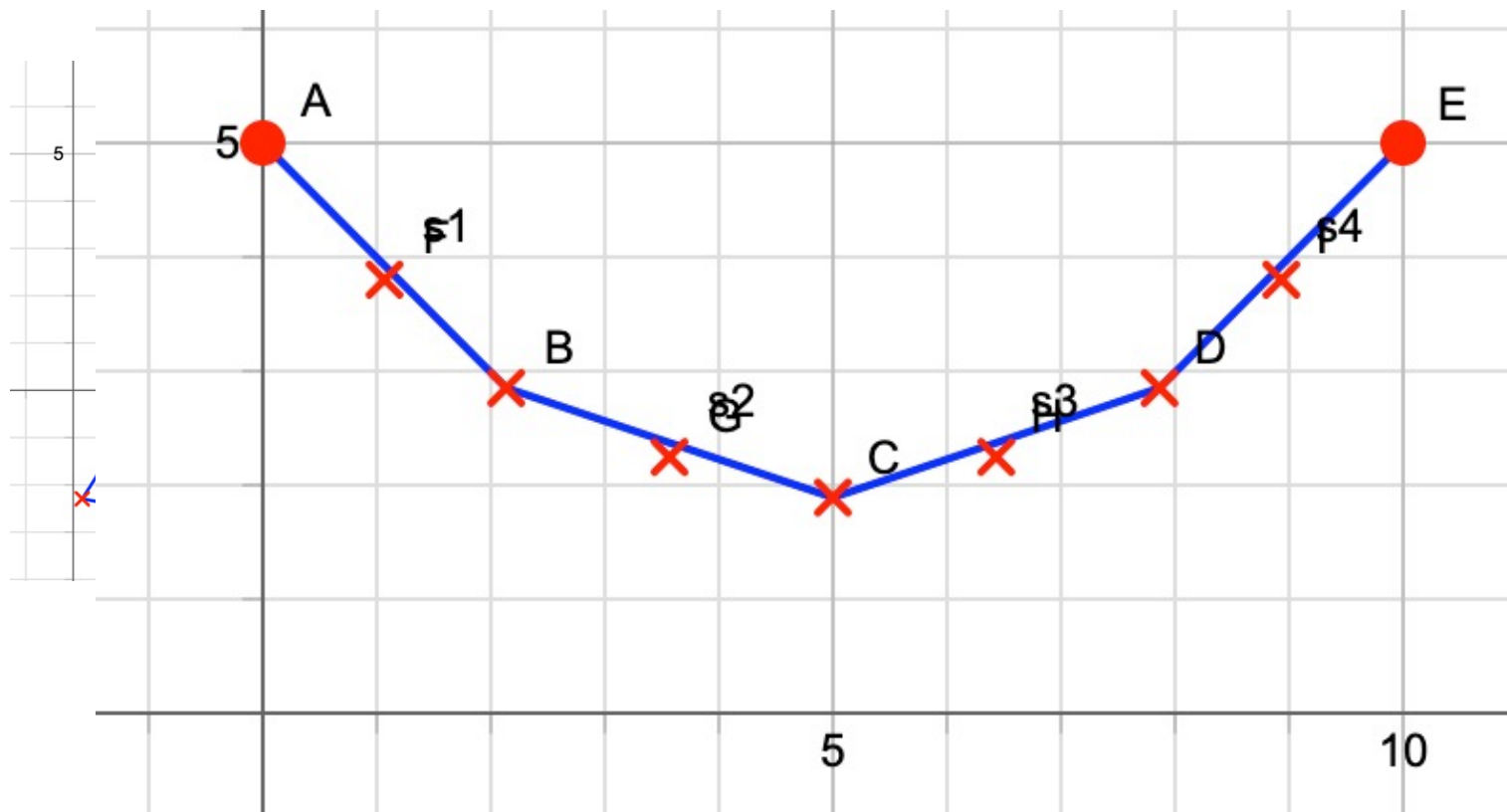
Propositions

Automatic search for a **model**

- Inequalities
- Expressions → Optimization
  - Fermat-Torricelli point in triangle



Circ.=const
Area→maximal

- Inequalities
- Expressions → Optimization
  - Fermat-Torricelli point in triangle

- Implementation: JSXGraph for UI, plotting,….., giac for expression manipulation, Groebner bases and numerical constraint optimization

- How it works

  - Geometric Constraints $\rightarrow$ Set(!) $S$ of algebraic (in)equations; sum of valid expressions $F$

  - **Move** Point $(x, y)$ with coordinates to $(x_0, y_0)$: minimize $(x - x_0)^2 + (y - y_0)^2 + F$ subject to $S$

  - **Relax**: Minimize $\sum_{(s=0) \in S} s^2 + F$

  - **Calculate orbit**: Point $(x, y)$ : $eliminate(S, vars\_of\_non\_fix\_objs \setminus \{x, y\})$
    factorize off irrelevant factors

- Euclidean or projective geometry?
- How much damping?
- Purely symbolic version?
- Probability
- Regions (e.g. $A_x^2 + A_y^2 < 1 \wedge A_y < 0$)
- User interface
  - Improved handling: Change colors, redo/undo, save/load/export, equation editor
  - Non-algebraic model mode: Tool to represent knowledge $\rightarrow$ Modelling in school
- Development of tasks