Remote Symbolic Computation of Loci

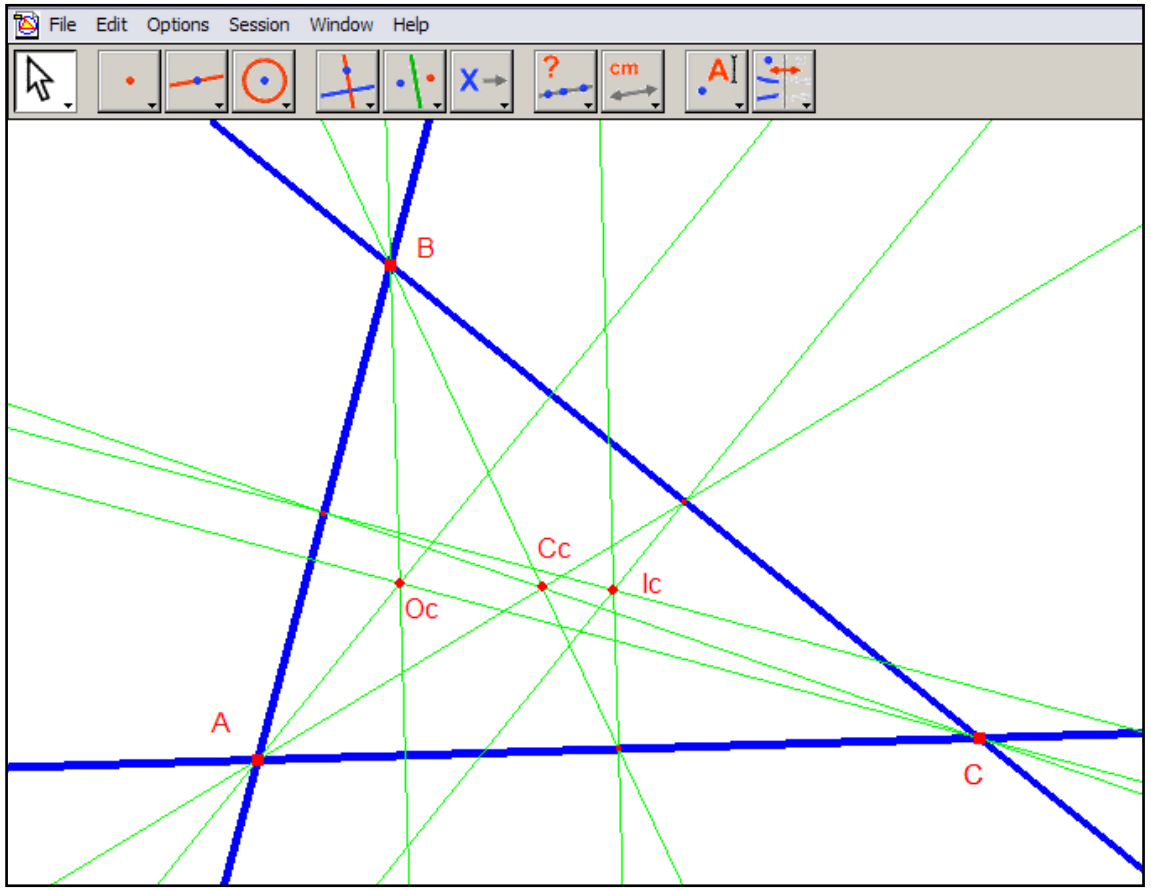
M. A. Abánades, CES Felipe II – UCM, Aranjuez, Spain
J. Escribano, UCM, Madrid, Spain
F. Botana, U. Vigo, Pontevedra, Spain

Structure of the talk

- Introduction
  - Dynamic Geometry and Symbolic Computation
- LADucation
- Examples

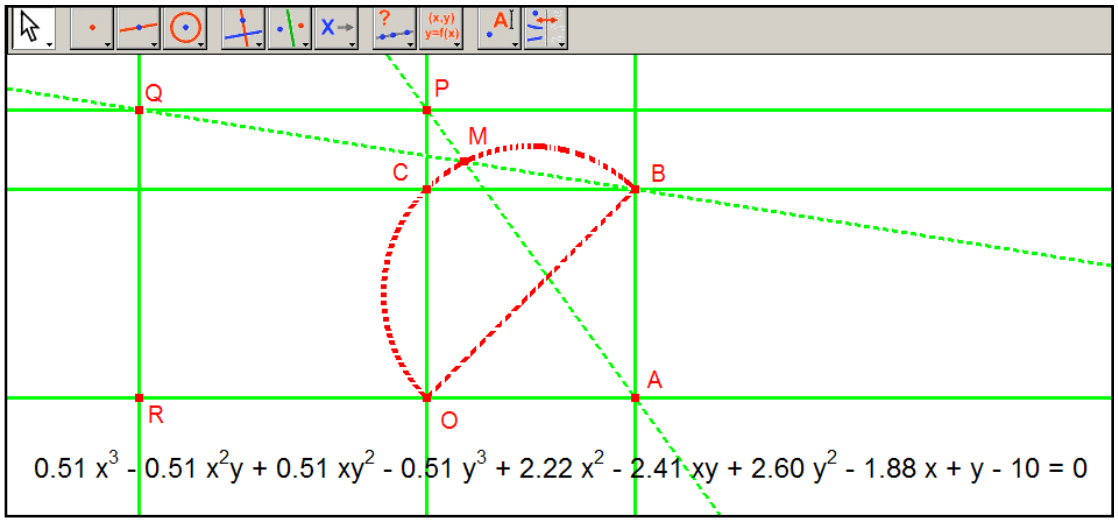
Introduction

- *Visual proof*
- Enough to show that a property is true?

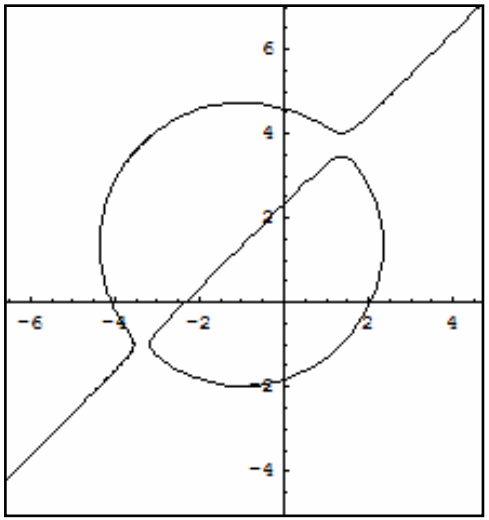


Introduction

- Cabri has a property checker as well as a function to determine equations
- Numerical computations => prone to inaccuracies



Locus = half circle + segment



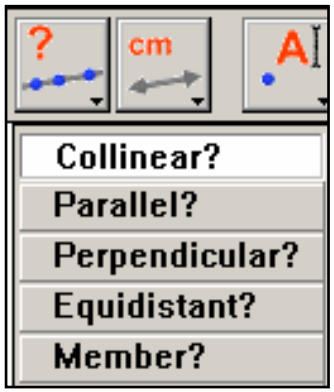
Graph of equation

Introduction

- Solution: symbolic computations
  - Not implemented in general DGS
- (our) Goal: To incorporate mathematically **true** results in the use of DGS
  - Symbolically
  - Remotely (web application)

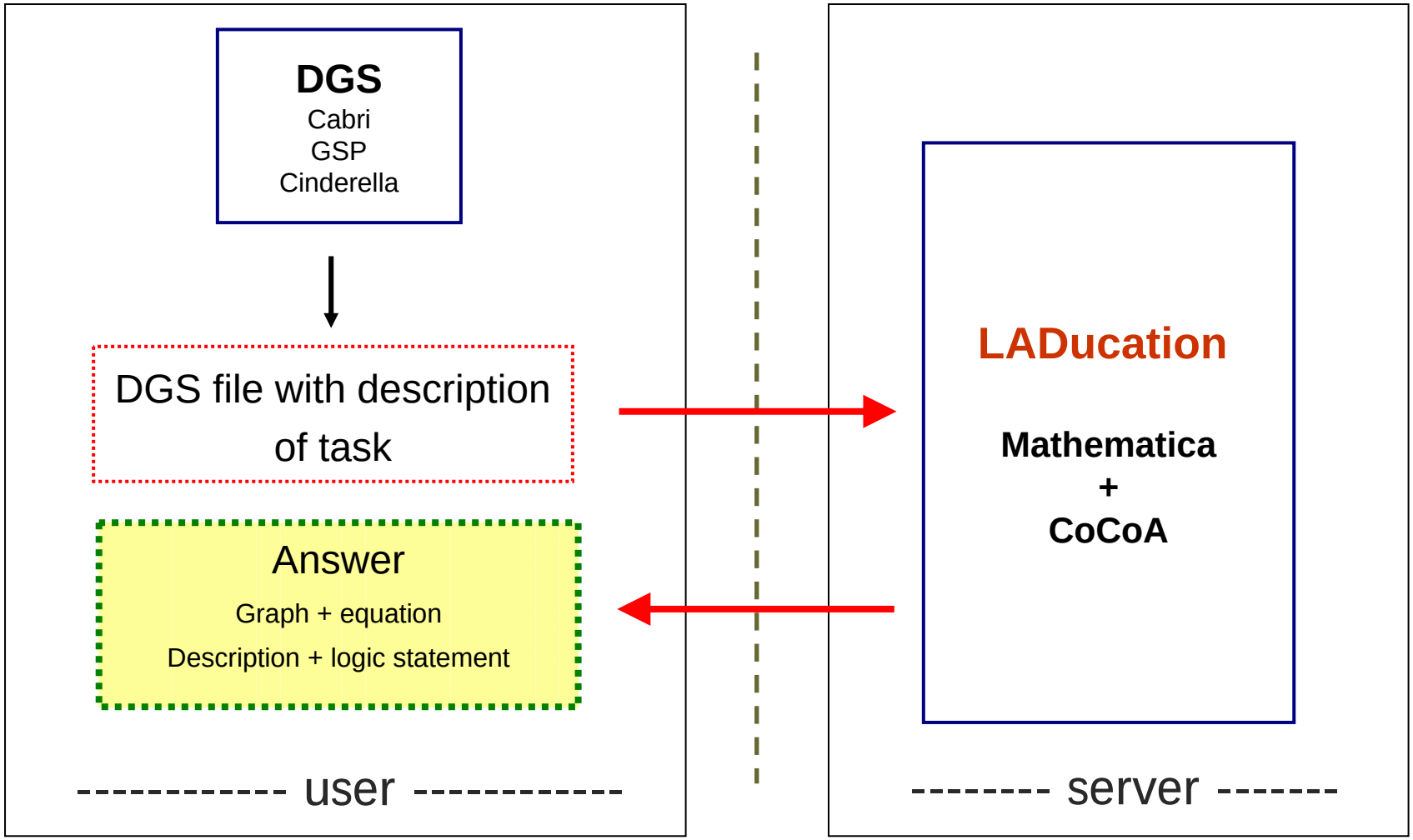
- Introduction
  - Dynamic Geometry
- LADucation
- Examples

LADucation



- LADucation is a *remote add-on* for:
  - Cabri, Geometer's Sketchpad, Cinderella
- LADucation gives
  - Equations and graphs of geometric loci
  - *Certified* answers to the five questions included in the Cabri property checker
- Sound results based on computations using symbolic algebraic techniques from the field of Automated Deduction (Gröbner Bases)

LADucation


DGS
Cabri
GSP
Cinderella
DGS file with description of task
Answer
Graph + equation
Description + logic statement
---------- user ----------
LADucation
Mathematica
+
CoCoA
-------- server -------

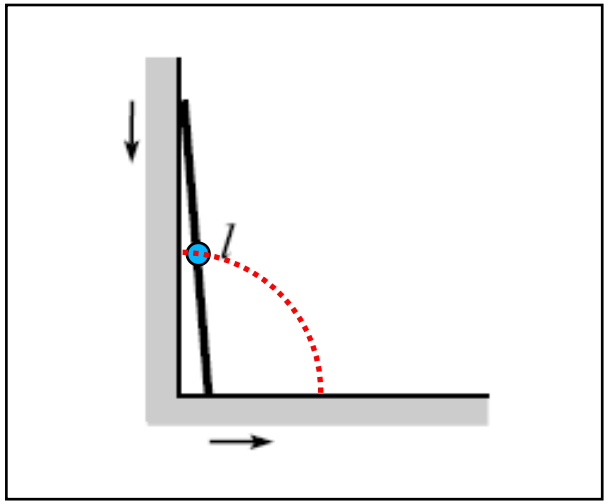
LADucation

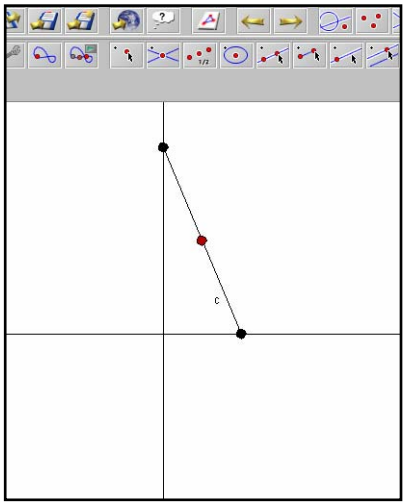
- No CAS or special software required on the user's system
- **http://nash.sip.ucm.es/LAD/LADucation.html**
- LADucation = educational version of LAD
  - Symbolic proccess of **L**ocus, **A**ssertion and **D**iscovery tasks

- Introduction
  - Dynamic Geometry
- LADucation
- Examples

Examples

- Checking conjectures: The *sliding ladder problem*
  - find the shape of the curve described by the center of a ladder when sliding to the floor from its position leaning against a vertical wall.

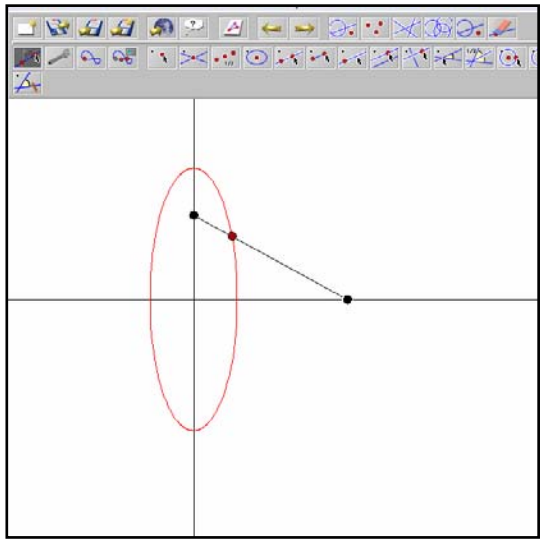


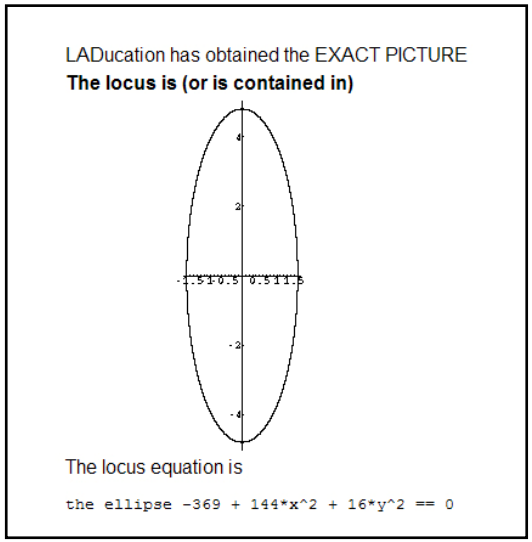


--- LADucation ---

Examples

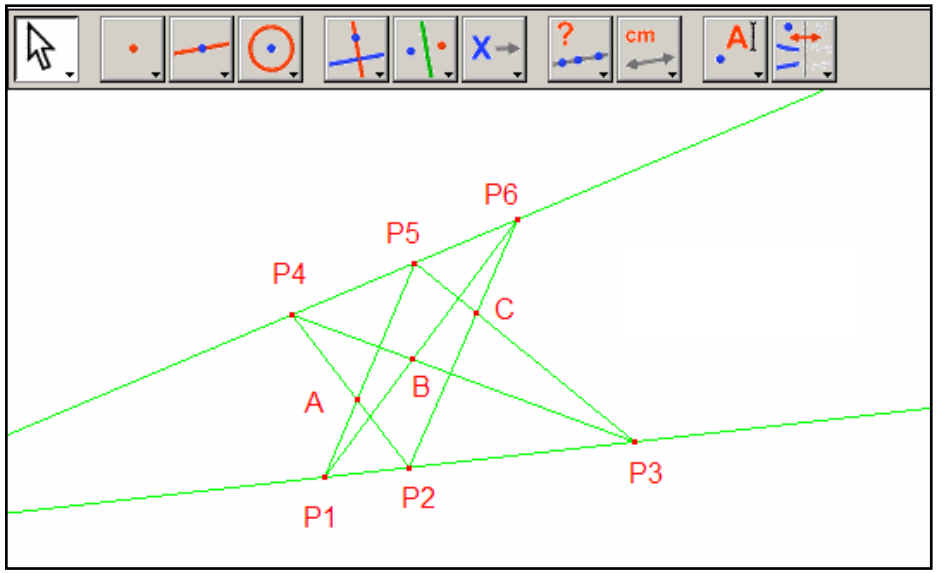
- The *sliding ladder problem* 2
  - shape of the curve described by any point in a ladder when sliding to the floor from its position leaning against a vertical wall.





Examples

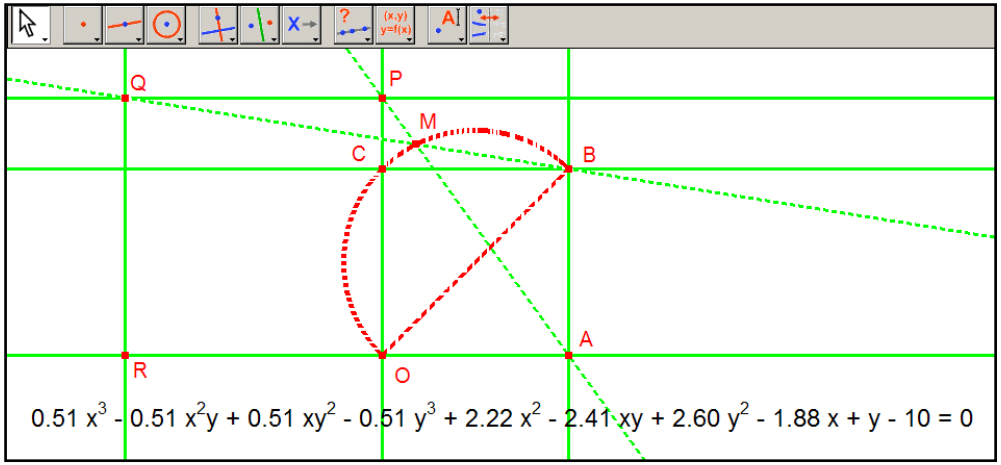
- Testing classic theorems with Cabri: Pappus' theorem
  - two straight lines with points P1 to P6

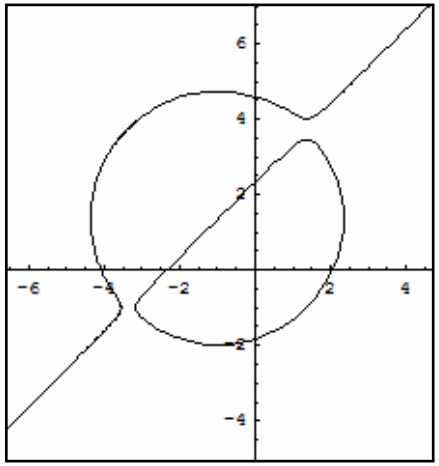


--- LADucation ---

  - Claim: A,B,C lie on a straight line.

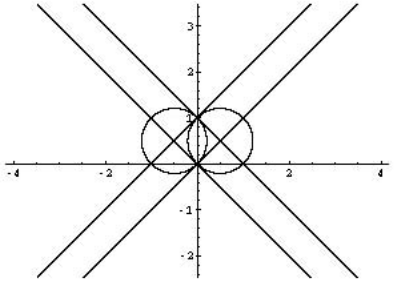
Examples





LADucation has obtained the EXACT PICTURE

The locus is (or is contained in)



The locus equation is

```
the line x - y == 0
the line 1 + x - y == 0
the line -1 + x + y == 0
the line x + y == 0
the circle -x + x^2 - y + y^2 == 0
the circle x + x^2 - y + y^2 == 0
```

Thank you

Gracias

Danke