CAS: A Tool for Improving Autonomous Work

ALFONSA GARCÍA(*) alfonsa.garcia@eui.upm.es
FRANCISCO GARCÍA(*) gmazario@eui.upm.es
ANGEL MARTIN delrey@usal.es
GERARDO RODRÍGUEZ gerardo@usal.es
AGUSTÍN DE LA VILLA avilla@upcomillas.es

(*) GIEMATIC, Educational Innovation Group UPM

A new scenario (EHEA)

- Student-focused learning and teaching model
- Learning based on specific and generic competences
- Specific competences
- Generic competences: Self-learning
  Critical thinking
  Team work
  Problem solving
  Use of technology

Technology Environment

- CAS for Mathematics in Engineering
- E-learning for autonomous work

Experiences for improving autonomous work

- Small Projects with CAS
- Toolbox
- Competitions
- New assessments models

Small Projects in different environments

- Linear Algebra for Mechanical Engineering (Madrid)
- Calculus for Technical Architecture (Salamanca)
- Calculus for Computer Engineering (Madrid)

Common features

- Small Projects (with low percentage in the final grade)
- Team work
- First year students
- Different problems for different teams
- Use of CAS
- Goals:
  - Applying math concepts for problem-solving
  - Use of mathematical language-for describing procedures

Information to be provided to students

- Clear and concrete learning goals
- A problem for solving with some new mathematical methods or skills
- Clear instructions, including a driving question
- Adequate estimation of autonomous students' work
- Rubric for formative and summative assessment
- Complete planning, including feedback

The use of CAS in a small project allows…

- To solve "real" problems for implementing knowledge and skills
- To analyze different cases, changing the conditions, parameters, etc.
- To promote different ways for the solution
- To experiment and conjecture
- To share the autonomous work

For solving the problem, students needs a good knowledge of :
MATH+ CAS

But there are some risks

- The use of CAS only as a “black box”
- The possibility to miss the critical thinking
- The CAS themselves don´t solve the problem
- The CAS learning can be seen as an additional task

Linear Algebra for Mechanical Engineering

- Specific Goals:
  - Applying Linear Algebra concepts for problem-solving.
- CAS (Maxima)
- Team work with intermediate feedback.

Calculus for Technical Architecture

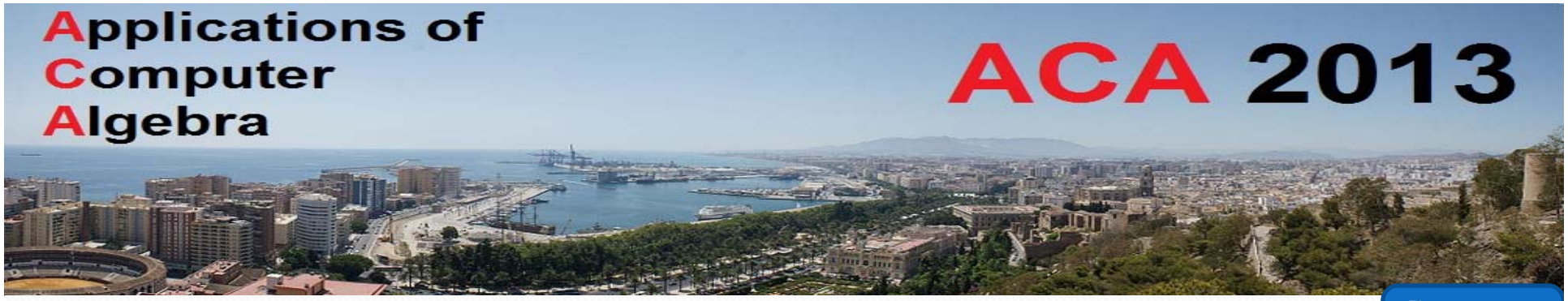
- Specific Goals:
  -Applying ODE concepts for problem-solving
- CAS (*Mathematica*)
- Team work with extra-tutorial activities.

Projects in Calculus for Computer Engineering

- Small team projects (10% of the final grade, 15 hours of autonomous work)
- Goals:
  -Self learning Numerical Methods
  - Applying math concepts for problem-solving
  - Use of mathematical language for describing procedures
- CAS (Maxima)
- Team work → Technical report
- Individual validation test, with computer and tools
- 78 Projects. 180 students

Autonomous Team Work

- Modelling a real problem and formulating a mathematical problem
- Self-learning a numerical algorithm
- Programming the algorithm using Maxima
- Describe a procedure, for solving the mathematical problem, that embeds multiple ideas
- Testing the procedure and solving the real problem
- Writing a technical report

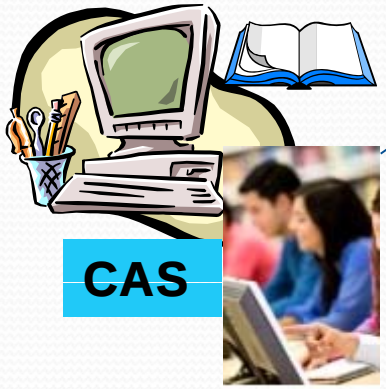


Implementation

Project Instructions

Feedback

Validation test



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TECHNICAL REPORT

Grade

Procedure for solving the mathematical problem

- Rigor (consistent and without mathematical errors)
- Shareability (steps clear to the user)
- Re-usability (can be used in new but similar situations)
- Modifiability (easily modified for using in different situations)

Example

- Real problem: Estimate the number of individuals in a population with height between 1.70 m and 1.90 m, using a normal distribution model
- Mathematical problem: Approximate a definite integral with error less than a preset bound
- Self-learning: Simpson and/or Trapezoidal rule
- Programming with Maxima
- Procedure
- Testing the procedure and solving the problem

Assessment

Team work

- Rubric and feedback for formative assessment of team work.
- The grade for the Report is the same for all students of a team → TG

Validation test (individual)

- Each student must be able to solve a similar problem, using the acquired knowledge, the procedure described and the Maxima functions programmed
- An individual face to face test, using computer and tools →IG

$$\text{Grade} = \min\{10, TG \cdot (0.4 + IG/10)\}$$

Conclusions

- Small projects could contribute towards raising motivation and a more effective learning.
- Application of mathematical concepts, for problem solving.
- Using the CAS the project is not limited to the collection and analysis of information. The CAS allows to solve real problems.

THANK YOU