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SFOPDES: A stepwise tutorial for teaching Partial Differential Equations using a CAS

José Luis Galán-García[1]***, Gabriel Aguilera-Venegas***[1]***, Pedro Rodríguez-Cielos***[1]***, Yolanda Padilla-Domínguez***[1]***, María Ángeles Galán-García***[1]***, Ricardo Rodríguez-Cielos***[2] [jlgalan@uma.es]

[1] University of Málaga, Málaga, Spain
[2] Technical University of Madrid, Madrid, Spain

Partial Differential Equations (PDE) are one of the most difficult topics that Engineering and Sciences students have to study in the different Math subjects in their degree.

In this talk we introduce `SFOPDES` (Stepwise First Order Partial Differential Equations Solver) aimed to be used as a tutorial for helping both the teacher and the students in the teaching and learning process of PDE.

The type of problems that `SFOPDES` solves can be grouped in the following three blocks:

1. **Pfaff Differential Equations**, which consists on finding the general solution for:

$$P(x,y,z)\,\mathrm{d}x + Q(x,y,z)\,\mathrm{d}y + R(x,y,z)\,\mathrm{d}z = 0$$

   (a) General method.
   (b) Particular cases:
      i. Separable equations.
      ii. Exact Pfaff equations.
      iii. One-separated variable equations.

2. **Quasi-linear Partial Differential Equations**, which consists on finding the general solution for: $P(x,y,x)\,p + Q(x,y,z)\,q = R(x,y,z)$ where $p = \dfrac{\partial\, z}{\partial\, x}$ and $q = \dfrac{\partial\, z}{\partial\, y}$.

   (a) General method.
   (b) Particular solution which contents a given curve Γ.

3. Using **Lagrange-Charpit Method** for finding a *complete integral* for a given general first order partial differential equation: $F(x,y,z,p,q) = 0$.

(a) General method.

(b) Particular cases:

i. $F(p,q)=0$

ii. $g_1(x,p)=g_2(y,q)$

iii. $z=px+qy+g(p,q)$

In [1], a talk given at ACA 2018 conference, we introduced the first version of this tutorial where the general methods for each type of the above PDE were considered. In this talk we extend that work introducing new programs which solve the particular cases of Pfaff equations and general first order PDE using Lagrange-Charpit method.

We have used the CAS DERIVE to develop this tutorial since Engineering students at the University of Málaga are still using this software in the computer lectures in different topics. The way of using this CAS in teaching has been shown in previous ACA conferences and in published papers as [2] or [3].

Nevertheless, since DERIVE is discontinued, we are migrating this tutorial to a free and multi-platform environment as PYTHON programming language using SYMPY which is a CAS extension for PYTHON. This way, the tutorial will be available for any user without the need of a proprietary software as DERIVE. In this talk, we will also show the advances (with the advantages and disadvantages) in this migration. In addition, this migration to PYTHON will allow it uses in the SAGEMATH since this free CAS can deals with the PYTHON library SYMPY.

Keywords
PDE, Stepwise tutorial, CAS, DERIVE, SYMPY, PYTHON, SAGEMATH

References

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