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New rules for improving CAS capabilities when computing improper integrals. Applications in Math Education

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In many Engineering applications the computation of improper integrals is a need. In [1] we pointed out the lack of some CAS when computing some types of improper integrals. Even more, the work developed showed that some improper integrals can not be computed with CAS using their build-in procedures.

In this talk we will develop new rules to improve CAS capabilities in order to compute improper integrals such as:

1. $\displaystyle\int_0^{\infty} f(x)\, g(x)\, \mathrm{d}x \quad ; \quad \int_{-\infty}^{0} f(x)\, g(x)\, \mathrm{d}x \quad \text{and} \quad \int_{-\infty}^{\infty} f(x)\, g(x)\, \mathrm{d}x$

   where $g(x) = 1$ or $g(x) = \sin(ax)$ or $g(x) = \cos(ax)$ and $f(x) = \dfrac{p(x)}{q(x)}$ with degree of $p(x)$ smaller than degree of $q(x)$ and $q(x)$ with no real roots of order greater than 1.

2. $\displaystyle\int_0^{\infty} x^{\alpha}\, f(x)\, \mathrm{d}x \quad \text{where } \alpha \in \mathbb{R} \setminus \mathbb{Z} \quad \text{or} \quad -1 < \alpha < 0$

We will show some examples of improper integrals that CAS as MATHEMATICA, MAPLE, DERIVE or MAXIMA can not compute. Using advance techniques as Laplace and Fourier transforms or Residue Theorem in Complex Analysis, we will be able to develop new rules schemes for these improper integrals.

We will also describe the conclusions obtained after using these new rules with our Engineering students when teaching Advanced Calculus.

Keywords: Improper Integrals, Rules Development, CAS, Engineering

References

[1] José L.Galán-García, Gabriel Aguilera-Venegas, María Á. Galán-García, Pedro Rodríguez-Cielos, Iván Atencia-Mc.Killop. Improving CAS capabilities: New rules for computing improper integrals. Applied Mathematics and Computation. Volume 316, 1 January 2018, Pages 525-540.

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