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## SYMBOLIC COMPUTATION TECHNIQUES

**ABSTRACT**

Symbolic Computation Techniques use computers to manipulate mathematical equations and expressions in symbolic and numeric forms, and visualizations [1 ... 5].

The main idea of symbolic algebra computation is explained. Introduction of some symbolic computation systems, MAPLE and MAXIMA has been given [6 ... 13 ] and some important examples are given.

**Symbolic Algebraic Computation (SAC)**

**1. What is symbolic computation?**

Symbolic computation deals with mathematical computations on numbers, symbols, expressions, and formulas, in an exact manner, as opposed to numeric computation that deals only with floating-point numbers (and therefore approximations).

Typical operations include symbolic differentiation, integration, polynomial etc...

**2. What languages are used?**

Some of used computer languages are: **MAPLE, MAXIMA (MACSYMA) , AXIOM, REDUCE, MATHEMATICA and ....**

The location of Tools for symbolic computation is illustrated in Figure 1.

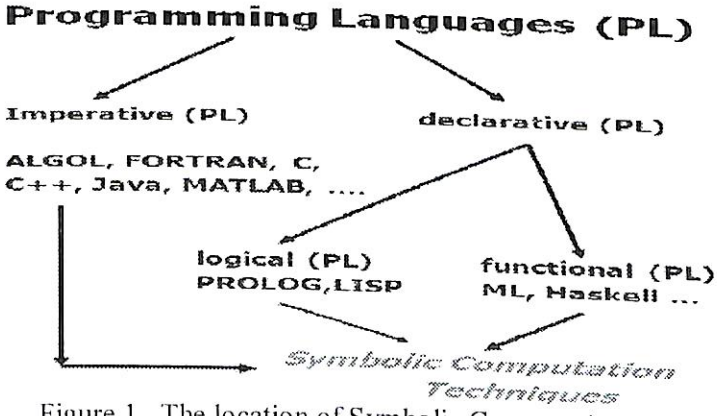



Figure 1. The location of Symbolic Computation Techniques

**3. What machines do SAC systems run on?**
**UNIX Workstations, PC's and MAC's**
**4. MAPLE**

MAPLE is a computer algebra system (CAS). There is extensive support for symbolic computation, as well as numeric computations and visualization. Table 1 shows some properties of Maple.

Table 1. Some properties of Maple

| | |
|---|---|
| **Developer** | **Waterloo Maple inc. (Maplesoft)** |
| **Release** | **14.01/Oct. 28, 2010** |
| **Written in** | **C, Java, Maple language** |
| **Type** | **Computer Algebra System (CAS)** |
| **License** | **Proprietary** |
| **WEBsite** | **www.maplesoft.com/products/maple/** |

**Some examples for Maple :**

**1. Symbolic Integration**

After starting maple the following input is typed:

- **> int(cos(x/a),x);**

The Maple system gives the following response:

- **a sin(x/a)**

**2. Polynomial expressions:**

**> s := (a^x)^2 + exp(ln(x)+2);**

$$s := (a^x)^2 + e^{(\ln(x)+2)}$$

**> simplify(s, power);**

$$a^{(2x)} + x\,e^2$$

**> simplify(s, exp);**

$$(a^x)^2 + x\,e^2$$

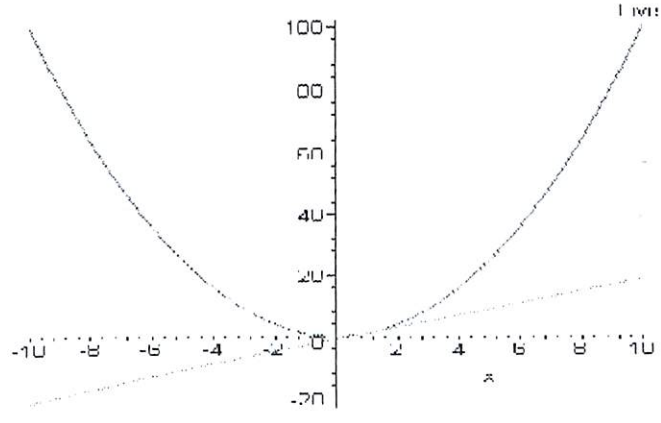
**3. Plots**

**> restart:**

**> x^2-x;**

$$x^2 - x$$

**> smartplot(x^2, 2*x-1);**




**5. MAXIMA**

MAXIMA is a Computer Algebra System based on a 1982 version of MACSYMA. MAXIMA is a full-featured CAS that specializes in symbolic operations but it also offers numerical capabilities and visualization. Table 2 shows some properties of MAXIMA.

Table 2. Some properties of Maxima

| | |
|---|---|
| **Developer** | **Macsyma group** |
| **Release** | **January 17, 2011** |
| **Written in** | **Common Lisp** |
| **Type** | **Computer Algebra System (CAS), Mathematical Software** |
| **License** | **GPL** |
| **WEBsite** | **Maxima.sourceforge.net** |

**Some examples for MAXIMA :**

**1. Symbolic Integration**

After starting maple the following input is typed:

- **integrate(1/x, x);**

The MAXIMA system gives the following response:

- **=> log(x)**

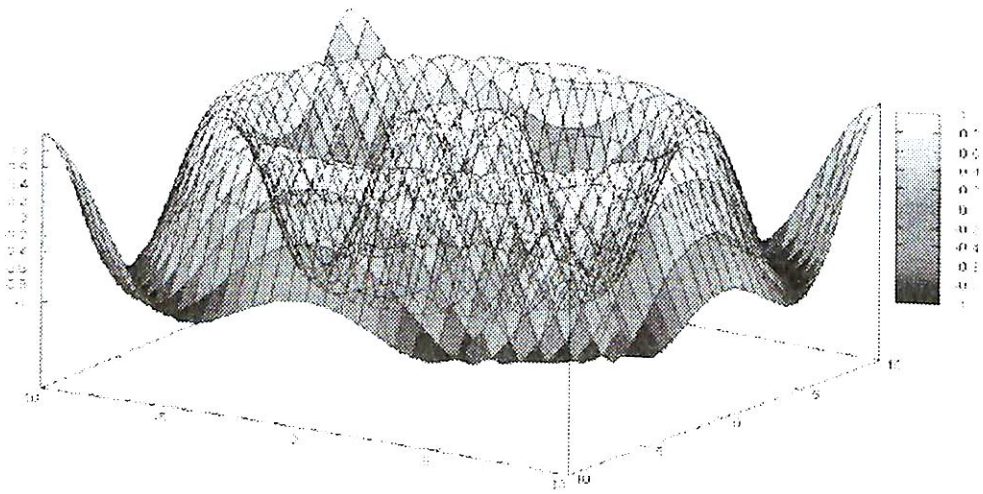
**2. Given the following function:**

h(x,y):=sin(sqrt(x^2+x^2));

To plot h(x,y) using plot3d:

plot3d(h(x,y):=sin(sqrt(x^2+x^2)), [x,-5,5], [y,-5,5])$

The result is:



**3. Given the following differential equation. Solve this differential equation using ode2().**

```
(%i14)  eq : 'diff(f,t,2) + f*'diff(f,t)^3=0;
```

$$(\%o14)\quad \frac{d^2}{dt^2} f + f\left(\frac{d}{dt} f\right)^3 = 0$$

```
(%i15)  ode2(eq, f, t);
```

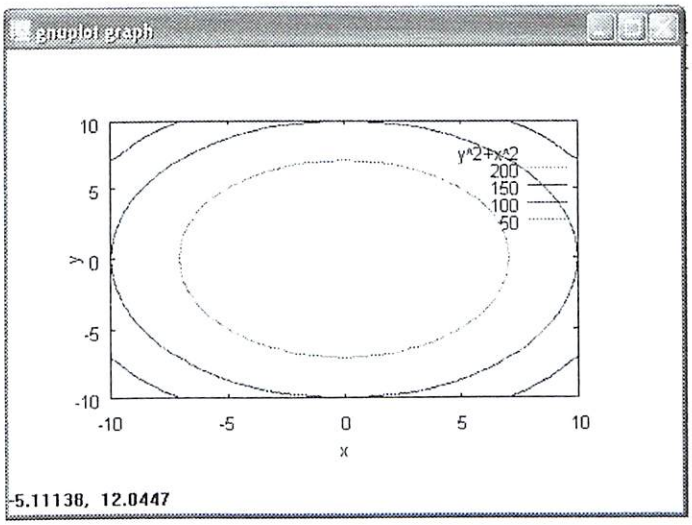
$$(\%o15)\quad \frac{f^3 + 6\,\%k1\,f}{6} = t + \%k2$$

**4. Contourplot**

Given the function x^2 + y^2, plot its contour between -10 and +10.

**(%i1) contour_plot (x^2 + y^2, [x, -10, 10], [y, -10, 10]);**

**The result is:**




**6. CONCLUSION**

This short paper gives important informations to symbolic computations and gives 2 examples of such systems, i.e. MAPLE and MAXIMA. The results of symbolic computations are exact and generic. But symbolic computation methods have several limitations. In some cases, symbolic computation methods need very long time and resources to solve a problem. Some problems cannot be solved symbolically, for example higher degree polynomial, some systems of differential equations. For such cases, numerical computation methods could be used, which are approximate solutions.

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**Түйін**

Мақалада символдық есептеулер туралы мәліметтер берілген. MAPLE и MAXIMA сияқты есептеу құралдары қарастырылған. Кейбір типтік мысалдар келтірілген. Символдық есептеулер дәл және әмбебап болса да кейбір шектемелер бар. Кейбір мәселелерді шешуде символдық еспетеулер көптеген уақыт пен ресурстарды қажет етеді. Егер көпмүшеліктің дәрежесі өте үлкен болса немесе кейбір дифференциалдық теңдеулер үшін символдық еспетеулер қажетті нәтижені бермейді. Мұндай жағдайлар үшін жуықтап шешу мақсатында сандық әдістер қолданылады.

**Резюме**

В статье дана важная информация о символьных вычислениях. Приведены символические инструменты вычисления MAPLE и MAXIMA. Рассмотрены некоторые типичные примеры. Результаты символьных вычислений являются точными и универсальными, но эти методы имеют ряд ограничений. Для решения проблем, в некоторых случаях, символические методы вычисления нужно очень много времени и ресурсов. Некоторые проблемы не могут быть решены символически, например, когда имеется более высокая степень многочлена, некоторые системы дифференциальных уравнений. Для таких случаев, как приближенные решения используются численные методы решения.

**Özet**

Bu makale sembolik hesaplamalar için önemli bilgiler verir. Kullanılan sembolik hesaplama araçları MAPLE ve MAXIMA vardır. Uygulamalar gibi bazı tipik örnekler verilmiştir. Sembolik hesaplamaların sonuçları kesin ve genel. Ama sembolik hesaplama yöntemleri çeşitli sınırlamaları vardır. Bazı durumlarda, sembolik hesaplama yöntemleri, bir sorunu çözmek için çok uzun zaman ve kaynak gerekiyor. Bazı sorunlar örneğin yüksek dereceli polinom, diferansiyel denklemlerin bazı sistemler için, sembolik olarak çözülemez. Böyle durumlarda, sayısal hesaplama yöntemleri yaklaşık çözümler olduğu, kullanılabilir

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## УПРАВЛЕНИЕ ОБРАБОТКОЙ СИГНАЛОВ В ДИСКРЕТНЫХ СЛЕДЯЩИХ СИСТЕМАХ

В системах автоматического управления передача, обработка и преобразование информации осуществляются только в определенные моменты времени. В этом случае в системах действуют сигналы, являющиеся некоторой последовательностью импульсов, и такие системы называются дискретными [1].

Создание дискретных систем может быть вызвано многими причинами.