The Mathematics Education into the 21ˢᵗ Century Project
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The Decidable and the Undecidable in Mathematics Education
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Java Applets in Education
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Abstract The aim of this paper is to explain and present advantages of the Sun Microsystem's Java language and object-oriented programming in the educational process. Thanks to current boom of Internet and telecommunication technology, common teaching methods may be enriched by so-called e-learning systems, which are mostly based on web pages and the HTML protocol. To improve expressive power of web presentations, dynamic pages are used. Among several techniques for dynamic pages, java applets seem to suite best the e-learning application – java is multi-platform, full-featured object-oriented language with rich graphical capabilities and applets allow real-time interaction with users. This paper presents practical application of java applets in the education of mathematics, physics or chemistry where applets are able to visualize different processes in a way, which is more understandable for students.

Java and Internet

Thanks to the boom of the Internet and telecommunication technology in the past decade lot of new programming and scripting languages emerged. The Internet and especially Web Pages are popularizing in admass. That is the reason why there are lots of technologies and methods for creating its content. One of them is the Java platform.

Nowadays two technologies, Java platform and .Net platform with the C# language compete. Carlos E. Perez writes 101 arguments why Java is better. The most important ones are:

- Java runs on multiple platforms, including smart cards, embedded devices, cell phones, pdas, laptops and desktops (MacOS, Linux, Windows, etc.), servers (Unix bases), Non Stop Servers (Tandem) and Mainframes (IBM).
- Java runs dynamic Languages like Python (JPython), Scheme (JScheme, SISC, Kawa), Ruby (JRuby) or Smalltalk (Bistro). In comparison a commercial development effort to port Python to .NET showed dismal performance. Furthermore, a paper comparing the CLR and the JVM came to similar conclusions.
- Java compiles on one platform and runs on another. Visual Studio.NET and .NET SDK End User License Agreements specifically states that code compiled with it cannot run in non-microsoft platforms.
- Java has smaller runtime (Java Runtime Environment -- JRE) which is about 8 MB large. Contrary .NET runtime is more than twice as large as JRE (i.e. 20 MB).
- Speaking of Java, there are no mandatory upgrades, no subscription fees and no software insurance fees.

The Java programming was developed by Sun Microsystems. It is object-oriented language inspired by the C and C++ languages. Java is an interpreted language, however unlike scripting languages (e.g. JavaScript developed by Netscape Corporation) Java programs are first compiled into so-called byte code. It is the byte code, which is interpreted on target platform, not the program itself. Being an interpreted language, Java requires an interpreter – Java Virtual Machine (JVM).

Java is modern language with features like multithreading, automatic memory deallocation (garbage collection), overflow security, hardware independence, etc.

Java in Education

Today all universities teach at least a little of informatics. Schools oriented at computer science teach object-orientate programming, too. Object-oriented languages are concentrating to data and methods, which work with data. Class is collection – data and methods. Data and methods together interpret object's state and fashion. Classes are organized in hierarchies, so that one class inherits properties of another class.

Object-oriented programming is characterized by these basic terms:

- object
- class
- polymorphism
- encapsulation
- inheritance

Object is a unique, identifiable unit, which keeps operation and data representing its current state. Class is set of objects with identical attributes, behavior and relationship to another objects.

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Encapsulation is the principle about interlacing process and data. Inheritance is joint parent and descendatn class. Polymorphism is the ability of different objects to respond with own form to one account. Java supports all these principles of object-oriented programming.

Java is not only the programming language it is the whole family of related technologies including Java Applets, Java Servlets and JSPs. When we speak of Java and the Internet we mainly speak of these technologies. However to understand these extensions, one has to understand principles of the Java programming language.

The first course content:

- lexical structure (comments, keywords, identificators, constants, operators
- data type (integer types, character type, real types, logical type, array)
- commands (block, if, for, while, shitch,break, continue)
- class (declaration,import, methods, constructor)
- object (new, manipulation, destruction)
- interface
- basic packages and methods from creating aplications (java.lang, java.io, java.util, java.awt, java.swing,…)

The goal of the first course is to achieve the ability to create simple aplications.

Java Applets in Education

Java applets are an interesting alternative to enrich Web pages. Applets are Java programs, which are downloaded and run in the clients' browser.

It may seem dangerous to run foreign programs on client's devices. However Java Applets insist on security and protection and are not allowed to perform dangerous operations. Applets are for example permitted to record sound, redirect to arbitrary WWW pages or call public methods of another applets situated on the same WWW pages. On the other hand applets are forbidden to connect to another servers, write files on the clients' devices and run programs on the home server.

Yet restricted, Java applets have full graphical capabilities and allow real-time interaction with users. Thanks to these features applets are able to visualize processes in a more understandable way, which makes them ideal for education of mathematics, physics or chemistry.

Java and e-learning

Innovation in education is called e-learning. Students with online connection to the school server study at home. Learn program, which runs on the school server consists of some classes, modules, lesson, lectures, courses, etc.

E-learning emphasizes on visualization, because it is easier to understand information presented in visual form. Some systems may use Macromedia Flash or similar technology as a presentation layer, but majority of them use Java applets as most of students learn the java language, not proprietary graphical applications.

It is no problem to find on the Internet lots of applets dealing with problems of mathematics, physics or chemistry. Common theme is geometry, especially transformation. For example these are applets by Juraj Štugel:
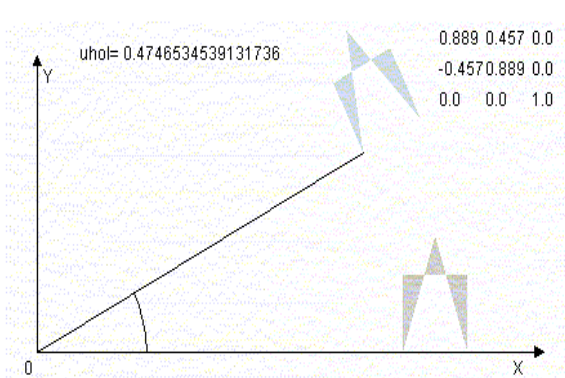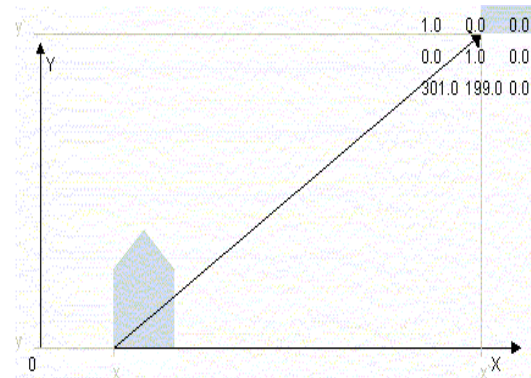

Figure 1. Rotation   Figure 2. Translation

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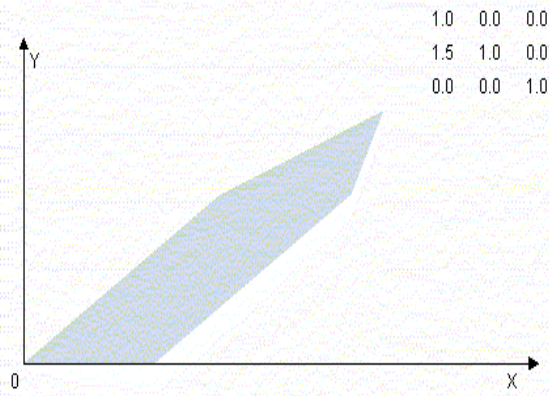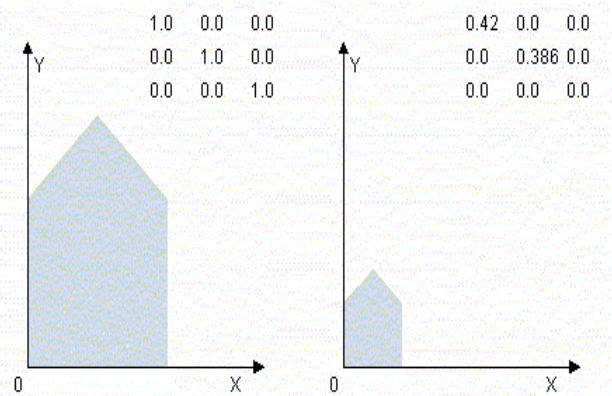**Brno, Czech Republic, September 2003**

Figure 3. Skew   Figure 4. Stretch

He created these applets for his Education of the Computer graphics on Internet.

Another good example of applets concerning mathematics are applets calculating linear system of equations, Pascal's triangle, polynomial equation, quadratic equation, matrix, combination, etc.
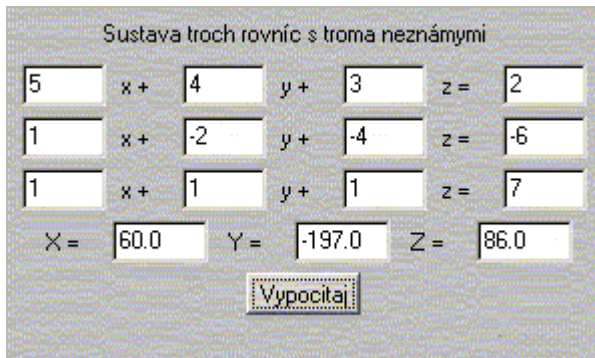

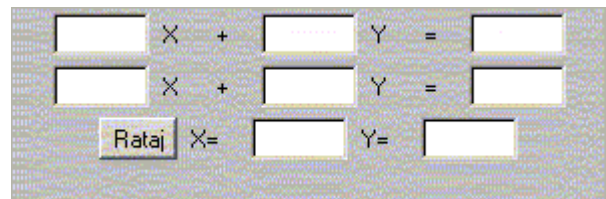Figure 5. Linear system of equations   Figure 6. Linear system of equations

In physics applets that visualize processes in mechanics (Puller system, Lever principle, Newton's laws, Kepler's laws, etc.), electrodynamics (magnetic field, Lorenty force, electromagnetics, etc.), optics, thermodynamics, atoms, nuclear physics and theory of relativity are used.

One can find applets visualizing molecules, periodic tables, chemical formulas, molecular models or chemical kinetics too.

Conclusion

There are many good applets all over the Internet, however lots of them are hidden because they are just forgotten school assignments, people cannot find them or simply does not know of their existence.

I hope, e-learning will rediscover and reuse these fragments and prove that the java platform suite well for this application.

References

1. http://petko.unitra.sk/files/pg/vyucba/
2. http://zive.cz
3. http://java.sun.com