FROM THE ALGORITHMIC THINKING TO THE CONCEPT OF PROJECT

- In memory of Walter Zorn1 -

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Abstract: This article presents several important topics that show the importance of algorithms and solving problems in the development of scientific knowledge. In the problem-solving processes require demonstrative thinking, an algorithms thinking. This paper presents a modern approach to the concept of algorithm and explains in detail how it would be seen (by students, teachers, and specialists) algorithm taking into account various aspects that are virtually disregarded the classical approach. The concept of a dynamic evolution algorithm was determined by the competence and experience of IT professionals in the activity of solving problems using computer. Developed and developing algorithms represented the implementation of various projects. Projects in all fields have led to developing society.

Keywords: algorithm, algorithmic thinking, computer science, deduction, project

I. NEW DEFINITION OF THE CONCEPT OF ALGORITHM

Effective use of computer systems and software products requires a continuous training program for specialists, programmers and users. Complexity of the problems requires complex computational processes. This makes use of the concept of algorithm in problem solving activity. Many natural processes, many human activities, can be described in algorithmic form by defining clear and precise of information and action. Every science is based on the theories, theorems (laws) and hypotheses that have been identified, studied and demonstrated by the strengthening, development and evolution in time of sciences. For example, computer science (informatics) is a science that uses new research and results of mathematics, cybernetics, microelectronics, biology, chemistry, psychology. Whole subfields of chemistry, physics, medicine, biology, economics and others are devoted to large-scale computational modelling, simulations and problem solving. In many cases it eliminates the ambiguity in interpretation and bad effects in processing. Algorithmic solution is a fundamental requirement of any problems with the computer. Experience has shown that not every problem can be solved by algorithmic solving, i.e. by describing an algorithm for solving (Vlada and Nica, 2009).

Learning algorithms must be preceded by learning the basics about computer systems to precede the learning of programming, and namely: Computer Systems → Algorithms → Programmings. Taking into account that a program is encoding algorithm in a programming language, the program will be represented as syntax and semantics of the programming language chosen. Reasoning to solve a problem will include methods and techniques for finding effective solutions to the problem are being developed algorithm. Finally encoding algorithm is reasoning. Encoding is given in a language of representation (Vlada, 2003, 2004).

1 Walter Zorn's Famous Web Scripts: Walter Zorn has developed a JavaScript Vector Graphics Library (wz_jsgraphics.js, 2002), Walter Zorn's ToolTip, WZGrapher Function Grapher (wzgrapher_e.zip, 2009); Ref.: http://mvlada.blogspot.com, March 5, 2011
Definition. An algorithm is the virtual system
\[ A = (M, V, P, R, D_i, D_o, M_i, M_o) \],
characterized by the following aspects: development, representation, execution (performance), correctness and analysis. Virtual system \( A \) is consists of the following elements:

- **M** - virtual memory (internal) used for temporary storage of information for the variables from the set of variables \( V \); computing process \( P \) acting on the variables; calculation process with access to memory by reserving memory for variables in set \( V \); initial virtual memory is used for reserving memory for the variables in the set \( V \); then used for writing and reading information in appropriate locations on the variables used in computing process \( P \);
- **V** - set of variables (data structures) defined in the corresponding \( R \) reasoning to solve a problem; reasoning is designed to use the memory \( M \) memory locations for each type of variable \( V \); reserved memory locations of variables in \( V \) are used for calculating the \( P \); execution of instructions that constitute \( P \), exchange values (state) variables corresponding memory locations in accordance with the implementation of reasoning \( R \);
- **P** - calculation process is represented by a collection of instructions (commands) expressed in a language of representation (the most used as pseudo-code); collection of instructions implementing (coding) (using virtual memory \( M \) and the set of variables \( V \)) techniques and methods that are specifically designed for \( R \) reasoning to solve a class of problems; execution of instructions in \( P \) result in a dynamic memory locations corresponding values of \( V \); finally, after the execution of all instructions from \( P \), the solution (solutions) to the problem lies in certain memory locations constituting output data \( D_o \);
- **R** - solving reasoning (the reasoning to solve) expressed by various techniques and methods specific to the part class to solve problems subject (math, physics, chemistry, etc.); they merged with undertakes appropriate programming techniques (logical processes) by using virtual memory \( M \) and the sets of variables \( V \);
- **D_i** - input data representing values of some parameters characterizing the hypotheses (initial state); input values are stored in memory \( M \) by the instructions on read (input) using input environment \( M_i \);
- **D_o** - output data representing values of some parameters characterizing the solution (solutions) of the problem raised by the problem requirements (final states); output data values produced from intermediate values of variables generated by the instructions of the calculation process and finally \( P \) are stored in \( M \), and the transmission (writing) their to the output environment \( M_o \); \( M_o \) is a virtual device for the representation (write) data output graphic or alphanumeric form;
- **M_i** - environmental input is a virtual device input (virtual reading) for reading the input values to be stored in virtual memory \( M \);
- **M_o** - environmental output is an output device (virtual writing) for getting data out of virtual memory \( M \) and were obtained by executing the calculation process \( P \); output data are transmitted (written) as a graphic or alphanumeric virtual media (virtual screen, virtual paper, virtual magnetic disk, etc.).

The development of Algorithm
Development of algorithm means developing a process demonstration process (computational) will be \( R \) and reasoning to solve that will include methods and effective techniques for finding the solution (solutions) of problem; development of reasoning to solve \( R \) consists of the following:

1. definition of input \( (D_i) \) and output data \( (D_o) \);
2. definition the set of variables \( V \) used in solving;
3. methods and techniques used for solving;
4. reasoning to solve \( R \) encoding in language representation (pseudo-code type) and will be the calculation process \( P \).

The representation of Algorithm
The representation algorithm is understood formalized expression in a language of representation (in general, pseudo-code type) of the link between the memory M, the set of variables V and calculation process P. The general form of an algorithm:

```
algorithm <name_algorithm>
    <declaration_variables>  // section of variables
begin
    <calculation_process_P>  // body of algorithm
end
```

The execution of Algorithm
Algorithms run on the machine are considered abstract / virtual. Characteristics of these abstract machines are "abstracts" on the computing machine / computer systems existing at a given time. Such models of computing machines are:

- Turing machine/ automatic stack (1956-1972, A. Aho, J. Hopcroft, J.D. Ullman, Data structures and algorithms, Addison Wesley publishing Co.,1983);
- MIX machine (Knuth's MIX Language, 1973, Donald Knuth);
- RAM machine (The Random Access Machine, 1974, Aho-Hopcroft-Ullman);
- ASM machine (Abstract State Machines - A Formal Method for Specification and Verification);
- VDM machine (1980, Bjorner and Jones, Vienna Development Method, Prolog-Logic Programming);

With an abstract machine / virtual (to simulate a real machine / computer system) algorithm execution means interpreting virtual representation of the algorithm as a mechanism for dynamic type set of virtual memory (M), process of calculation (P), the input environment (M_i) and output environment (M_o). All these components will be confused with the corresponding virtual machine elements, except the calculation is the "started running" Central Processing Unit (CPU) of the virtual machine. The "started running" of computing process P is understood by the virtual machine CPU performance of all functions (with memory and processor) to simulate all the alleged processing instructions for calculating process P. Algorithm implementation process will mean the generation that will take place over time and will use memory and computing devices and I/O device just as happens with the startup form of an executable program on a computer system / real computer. In this way, the algorithm is the virtual system

\[ A = (M, V, P, R, D_i, D_o, M_i, M_o), \]

can be considered as a virtual "computer system" having the basic components: memory (M), processor (P), input device (M_i), output device (M_o). Taking into account that a program is encoding algorithm in a programming language, the definition of a program is similar to the definition of an algorithm with the difference that is no longer required the presence of reasoning (solving reasoning). In this way the program will be represented as syntax and semantics of the programming language chosen. For both concepts (algorithm and program) "execution" shows the structure of a cybernetic system. A cybernetic system is based on computer system architecture and is a combination of hardware (devices) and software components (programs) that provide user services for execution of program (implement the problem solving). Abstract machine / virtual machine will function as a model of a real computer.

In conclusion, learning algorithms must be preceded by learning the basics about computer systems and to precede the learning of programming, namely: Computer Systems \(\rightarrow\) Algorithms \(\rightarrow\) Programming.

The correctness and analysis of Algorithm
Correctness of algorithm is expressed by partial correctness (the calculation is finished, the running time is finite for any given input from a range of values) and total correctness (for any given input
from a range of values, fair value calculation process carried out according to the purpose / function algorithm). There are various methods for the two components of correctness. Development of computer applications requires testing programs that implement various algorithms for the programmer to make sure the correctness of algorithms designed. Algorithm analysis refers to the memory used and the algorithm execution time (runtime). This analysis is the measurement and description (quantitative) algorithm that allows comparison of various performance algorithmic solutions for the same problem. Typically, the resource while the resource is more critical than memory space, but there are situations in the design and implementation of new algorithms, it is established a compromise between the requirements for memory space and runtime. Analysis of an algorithm includes the following approaches (Brassard and Bratley, 1995)

- establish a calculation mode - this basic model will specify the basic operations) which uses the algorithm and the cost (in units of time) associated with each elementary operations;
- setting time calculation / execution - there are so-called measures of complexity that describe aspects of performance to be measured: execution time in the worst case, if and when amortized average (upper edge in the worst case). These complexity measures depend on the volume of input data set;
- determine the rate of growth - by analyzing the asymptotic growth rate is determined execution time depending on the volume of input data set; Asymptotic analysis expresses increased running time of an algorithm for increasing (to infinity) the volume of input data set.

II. THE CONCEPT OF PROJECT

Computer systems (modern computer) is an example of appropriate and to understand diversity and evolution of the concept of the project. In particular, operating systems on which work computer can be considered the result of projects. Not incidentally, Cybernetics (systems science) emerged and developed along with computers and informatics development. As the concept of algorithm (which has revolutionized the thinking and computer science) concept of project was spectacular development and even greater impact on all human activities. For example, Google’s project may be considered the biggest project in the past 50 years, if not the last 100 years, having regarded to vision, impact and implementation of this grand project. To understand the philosophy of this project must be studied more steps and results to make comparisons and express many different changes and structures. It is clear that the descriptions of definitions are completely outdated of different realities that are found in our world. Also, specialists and experts can not separate the concept of Project at Management, and effective and appropriate management can not be done without technologies and without performance computers. Therefore, it is explained that the development projects and their management was done after 1950 (middle 20th Century) when the expanded use of computers in many fields.

Definition. "A project is a group of activities to be carried out in a logical sequence to achieve a set of predetermined objectives, from the customer." (European Commission).

If we consider the new definition for the concept of algorithm, we can say that the same approach can be applied to the concepts of project, system, program, and languages. We have the following equivalent scheme:

PROJECT vs. SYSTEM vs. PROGRAM vs. LANGUAGES vs. ALGORITHM

Developing, creating and implementing a project.

Steps:
Start → Definition → Design → Development → Implementation → Testing/Conclusion.

Project management is the set of activities for planning, organizing, and managing resources to ensure successful completion of specific project objectives. It is sometimes confused with program management, however, from a technical standpoint is actually a construction of higher level:
coordination of all relations in the project. *Management functions:* Planning, Organization, Leadership, Control.

**Chronology, historical landmarks:**

- Henry Gantt (1861-1919) - founder of project management (also called the father of planning and control techniques), studied the work order of operations is known for "Gantt chart" basic technical project management;
- 1950 years- Project Management early modern era (before the 1950s, projects were coordinated using Gantt charts and various informal techniques and tools);
- 1955 year- probabilistic method PERT (Program Evaluation and Review Technique) by Booz-Allen & Hamilton for the U.S. Navy under Project Polaris (Polaris is a ballistic missile launch from the submarine);
- 1957 - "Critical Path Method (CPM)" developed by DuPont in cooperation with Remington Rand Corporation to coordinate plant maintenance projects;
- 1967 - the rise in the U.S., the Project Management Institute (Project Management Institute - PMI). The premise of this institute is that techniques and tools used by project management are the same regardless of the industry in which they are used;
- 1967 - was established in Europe, International Association for Project Management (The International Project Management Association - IPMA);

We define in a few words the basics on the classification of projects and management functions. Classification of projects:

1. *After scale objectives:* organizational, local, regional, national, international;
2. *After the nature of projects:* social projects, cultural projects, economic projects (construction projects, engineering, research and development activities.), art projects, environmental projects, management projects.

Other important projects in history:

- Human Genome Project that deciphered the human genome and mapped;
- Manhattan Project that developed the first nuclear weapon;
- Polaris missile project, which has developed an ICBM control system;
- Project Apollo, which made people landing on the moon;
- Atomic bomb project conducted by Russia;
- Projects and programs for space.

**Comments:**

1. As a result of a "project" for military research, scientist John von Neumann devised an electronic computer architecture (von Neumann architecture in 1945, research report) that is still valid today. With this adventure began building modern computers:
   a) basic components of a computer: memory, processor, system input / output;
   b) programming languages and operating systems;
   c) algorithms and software applications.
2. make a competition between the hardware (the technology) and software component (the logic) of computers. The evolution and development can be understood only if it highlights the concept of algorithm development and inventing a new approach to understanding human activity in the venture to the evolution and development: planning, organization, activities, monitoring, verification, all of which are activities Human-based projects. 1950 - invented the "Gantt chart" developed by Henry Gantt - founder and considered the father of project management planning and control techniques.

In fact, it can be concluded that the appearance of software products (software engineering) is due to various local or global projects.
Definition.
A software product is a result / product obtained from a human creative process, being an object / instrument utility individually identifiable as part virtual / logical and physically available in electronic format on a magnetic storage medium / FD type optical (floppy disk), HD (hard disk), CD (compact disk) or Memory Stick. The electronic format of the product can be: a program to solve certain problems, an operating system, compiler, an interpreter, a converter program, a utility, an operating environment, a programming environment, an environment for solving a platform A procedure, a program editor, a program generator, a program ativirus, an HTML / PHP / ASP / Java code, e-mail program, browser, etc.

Major Projects.

- The launching of the Japanese Project in 1981 for building the 5th generation computer at the beginning of the 90’s; this foresaw a revolution in the field of computers through the so called Knowledge Information Processing Systems (KIPS);
- The project had a deep impact worldwide; Artificial Intelligence begins to be taught as a discipline of Computer Science in higher education;

Example 2. European R & D Projects (1990-2013)
- Global Information Society – initiative launched in 1997; in 1995, at the Conference for an Information Society in Brussels it was analyzed the implementation of an international competitive informational infrastructure;
- Global Tera byte Recherche Network (GTREN) – action program launched in 2002 for the development of the communication infrastructures and of a faster, safer and more efficient Internet network;
- eEurope 2005 – launched in 2002, the action program “An Information Society for All” has two major objectives: to stimulate services, applications and the content of electronic information and to development wideband infrastructure and to increase the information and network security;
- Sixth Framework Programme (FP6) (2002-2006) - European Union Framework Programme 6 (http://ec.europa.eu/research/fp6/), launched in 2002 is one of the most complex research programs, development and innovation.

Example 3. Google Project
- The idea of search technologies in the field of Web on the Internet, was crystallized in 1996 when two students (PhD candidates) from Stanford University in California working on a research project. It's Larry Page (U.S.) and Sergey Brin (Russia) who designed the so-called algorithm / technology "PageRank";
- Products and services - search engine, Google Page Creator, Google Blog, Advertising, Google Search Appliance, Google Books, Google Maps, Google Earth, Google Translate;
- In addition to standard Web search services, Google has released over the years a series of online productivity tools. Gmail, a free webmail service from Google, was launched as a beta program invitation in 2004, and became available to the public in 2007.
Example 4. Linux Project

Linux is an operating system that was initially created as a hobby by a young student, Linus Torvalds, at the University of Helsinki, Finland. Linus had an interest in Minix, a small UNIX-derived operating system, and decided to develop a system to exceed the Minix standards. He began work in 1991, when he released version 0.02 and worked steadily until 1994, when version 1.0 of the Linux kernel was released.

- Linus Torvalds: The 100 Most Influential Inventors of All Time as one of the most important and influential inventors.
- 1991: Linus Torvalds versus professor Andrew Tanenbaum + open source.
- Software Projects (The Apache Software Foundation Projects).

Linux operating system emerged from the desire of a Finnish student, Linus Torvalds, to write a multitasking operating system for Intel 386 microprocessor. That was the summer of 1991 when buying their first computer microprocessor 386 and had to transfer some files over the network and MS-DOS system was not quite got to the operation environment (Vlada, 2010).

The basis for the development of Linux is the UNIX operating system which offers many facilities for computer networks. Linux took over these facilities and added new ones. Another great idea in the development of Linux was that the development was made possible by contributions from thousands of developers worldwide who has used the Internet environment to talk through newsgroups (newsgroups) year to transmit information and results. This was a world first in developing a project. An important role Linux plays in developing the Internet system, without which Linux miracle was possible. Permanent communication and cooperation between programmers allow quick enthusiasts who were dedicated to the project initiated by Linus Torvalds.

The original plan (Linux Kernel) project was:
- writing a driver disk
- design a file system to read and write files to the central system Minix (Unix-like system created by Andrew Tannenbaum, Netherlands);
- writing drivers for various peripherals.

Note 1: "The Apache Software Foundation provides support for the Apache community of open-source software projects. The Apache projects are characterized by a collaborative, consensus based development process, an open and pragmatic software license, and a desire to create high quality software that leads the way in its field". (www.apache.org).

Note 2: The Apache HTTP Server Project is a collaborative software development effort aimed at creating a robust, commercial-grade, feature, and freely-available source code implementation of an
HTTP (Web) server. In February of 1995, the most popular server software on the Web was the public domain HTTP daemon developed by Rob McCool at the National Center for Supercomputing Applications, University of Illinois, Urbana-Champaign. However, development of that had stalled after Rob left NCSA in mid-1994, and many webmasters had developed their own extensions and bug fixes that were in need of a common distribution. - http://httpd.apache.org.

III. Conclusions

Representing knowledge by inventing science led to the use of scientific language that had a major impact on the evolution of all sciences. Concepts and terms in various sciences have changed along with changes in the field of knowledge. The invention of the concept of an algorithm for making calculations and operations conducted to obtain better solutions and actions specified purposes. Transmission of these operations to the computer is due algorithm and language concepts.

References