

SNT AND NSI PROGRAMS RELATED TO THE ENVIRONMENT AND DIGITAL TECHNOLOGIES

Authors and date

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INTRODUCTION

As part of the 2019 reform of high school, a new course **Digital Sciences and Technology** is offered to everyone in the *Seconde générale et technologique* class (Y11 in the English school system - K15/K16). Seven themes are studied during the school year with a schedule of 1.5 hours per week:

- Internet
- the Web
- social networks
- Structured data and its processing
- Location, mapping and mobility
- Embedded computing and connected objects
- Digital photography

This program provides students with a digital culture. In addition, some parts can lead to an awareness of the environmental impact of digital technology.

IN THE DIGITAL SCIENCE AND TECHNOLOGY COURSE PROGRAM¹

IN THE PREAMBLE

The teaching of digital sciences and technology in the second year of secondary school aims to allow students to understand the main concepts of digital sciences, but also to allow students, starting from a technological object, to understand the growing importance of digital technology and the stakes that arise from it. The widespread digitization of data, the new methods of processing or storage and the recent development of algorithms for processing very large volumes of digital data constitute a real break in the spread of information and communication technologies. This revolution is changing human practices.

INTERNET

Thanks to its flexibility and universality, the Internet has become the main mean of communication between people and with machines and between machines.

Internet handles two types of information:

- the content sent: text, images, sounds, videos, etc.
- the addresses of the recipient and the sender. Users are mostly familiar with standardized symbolic addresses, such as wikipedia.fr. The DNS (Domain Name System) transforms a symbolic address into a numerical address such as 172.16.254.1 . This is done by a large number of computers distributed over the network and constantly updated.

As a global network, the Internet works with the help of routers, very high speed transmission lines (fiber optics) between routers, cell phone networks, and local networks. Its protocols being software, the Internet can rely on any physical network that implements them: 4G, Ethernet, ADSL, Wi-Fi, Bluetooth, etc.

Its projected traffic for 2021 is 3,300 billion billion bytes (3.3×10^{21} bytes).

THE WEB

The Web (web or network) refers to a system providing access to a set of data (page, image, sound, video) linked by hypertext links and accessible on the Internet. Web pages are written in the HTML (HypertextMarkupLanguage) tag language. Their graphic style is defined in the CSS (Cascading Style Sheets) language.

Search engines allow to find information in pages whose address is not known, or even unknown. The search method called natural referencing is broken down into three main activities, carried out by the search engines:

- (1) the automatic browsing of the Web to collect the visited pages (suction of the Web pages carried out by robots) ;
- (2) the analysis of the content of the pages and their indexation on the words they contain (constitution of a reverse directory which associates to each term the URLs of the pages where it appears);
- (3) the third activity, carried out each time a user makes a request, builds an ordered list of pages (ranking) containing the keywords of the request.

SOCIAL NETWORKS

Social networks are applications based on Web technologies that offer a service for connecting Internet users to develop communities of interest.

All social networking applications use large databases that manage their users, all the data they share, but also the data they agree to provide (without always knowing it), including their personal lives.

All the applications rely on services that connect users with members of the network, relations or common friends: algorithms operating on graphs and databases are at the heart of these services.

STRUCTURED DATA AND ITS PROCESSING

Data is the raw material of any digital activity. In order to allow its reuse, it is necessary to store it in a persistent manner. Structuring it correctly ensures that it can be easily exploited to produce information. However, unstructured data can also be exploited, for example by search engines.

A database is a collection of linked data. For example, a library's database stores data on books, subscribers and loans made. Data files are stored on storage media: internal (hard drive or SSD) or external (disk, USB stick), local or remote (cloud). As these media can be damaged, leading to data corruption or destruction, it is necessary to make backups.

Large databases are often implemented on dedicated servers (powerful machines with a large disk storage capacity). These data centers must be powered and maintained at sufficiently low temperatures to function properly.

Data centers store servers that make data available and applications that use them. Their operation requires resources (fossil resources, fresh water, metals and a large amount of synthetic chemicals) and generates pollution (especially at the stages of metal extraction and recycling when not done properly). Therefore, digital uses must be designed to limit the transformation of ecosystems (especially global warming) and to protect biodiversity and human health.

LOCATION, MAPPING AND MOBILITY

Mapping is essential for many activities: agriculture, urban planning, transportation, leisure, etc. It has been revolutionized by the development of the Internet. It has been revolutionized by the arrival of digital maps accessible from computers, tablets and telephones, which are much more flexible in use than paper maps.

The information on digital maps comes from many sources: government geographic services, photos taken by satellites, planes or cars, data provided by users, etc. Mapping algorithms are mainly concerned with the selective display of various information and the calculation of routes.

The machines used for mapping are mainly computers, tablets and traditional telephones equipped with an ad hoc application. Specialized GPS receivers are still important for marine or air navigation, but those for hiking are disappearing, supplanted by phones.

EMBEDDED COMPUTING AND CONNECTED OBJECTS

Embedding computing in objects sometimes allows to: simplify their operation, give them more possibilities of use and safety, and allow them to integrate new possibilities with constant hardware by simply modifying their software.

Microprocessors are much more numerous in objects than in computers and telephones, but they are often smaller, cheaper and slower. Sensors and actuators rely on a variety of physical and electronic technologies, sometimes moving towards power electronics. A key issue is the reduction of power consumption, especially for battery-powered devices.

DIGITAL PHOTOGRAPHY

Digital photography has an easy and immediate diffusion through the internet: every day, billions of pictures are taken and shared. As the algorithms for taking and developing pictures require a lot of calculation, the cameras have several processors, general or specialized.

GENERAL DIGITAL AND COMPUTER SCIENCE SPECIALTY PROGRAM ²

IN THE PREAMBLE

The specialization in digital and computer sciences in the final year of the general education cycle aims to provide students with the fundamentals of computer science in order to prepare them for further studies in higher education, by training them in the practice of a scientific approach and by developing their appetite for research activities. The objective of this general education is the appropriation of the concepts and methods that underlie computer science, in its scientific and technical dimensions. It is based on the universality of four fundamental concepts and the variety of their interactions:

- **data**, which represent in a unified digital form very diverse information: texts, images, sounds, physical measurements, sums of money, etc. ;
- the **algorithms**, which specify in an abstract and precise way the treatments to be carried out on the data from elementary operations;
- the **languages**, which allow to translate the abstract algorithms into textual or graphical programs so that they can be executed by machines;
- the **machines**, and their operating systems, which make it possible to execute programs by chaining a large number of simple instructions, ensure the persistence of the data by their storage and manage the communications. It includes **connected objects** and **networks**.

In addition to these concepts, there is a transversal element: the **interfaces** that allow communication, data collection and system control.

PROGRAM ELEMENTS

Human-machine interactions on the Web When browsing the Web, Internet users interact with their machines through Web pages. The Human-Machine Interface (HMI) is based on the management of events associated with graphic elements equipped with algorithmic methods. The understanding of the client-server dialogue already covered in the second grade is consolidated, on simple examples, by identifying the client's requests, the

calculations and then the server's responses processed by the client. A form of a Web page can be constructed to analyze its operation.

Hardware architectures and operating systems The purpose of expressing an algorithm in a programming language is to make it executable by a machine in a given context. The discovery of the architecture of machines and their operating systems is an important step. Electronic circuits are at the heart of all computing machines. Networks allow the transmission of information between machines. Operating systems manage and optimize all the functions of the machine, from the execution of programs to input-output and energy management. We can show the role of the different components of the local network of the establishment.

Languages and programming Without introducing this terminology, the aim is to show that there are many programming languages, different in style (imperative, functional, object, logic, event-driven, etc.), as well as formalized description or query languages that are not programming languages. The importance of specification, documentation and testing is to be presented, as well as the interest of modularization which allows the reuse of programs and the availability of libraries.

DIGITAL AND COMPUTER SCIENCE SPECIALTY PROGRAM FOR THE GENERAL TERMINAL ³

IN THE PREAMBLE

The specialization in digital and computer sciences in the final year of the general education cycle aims to provide students with the fundamentals of computer science in order to prepare them for further studies in higher education, by training them in the practice of a scientific approach and by developing their appetite for research activities. The objective of this general education is the appropriation of the concepts and methods that underlie computer science, in its scientific and technical dimensions. It is based on the universality of four fundamental concepts and the variety of their interactions:

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PROGRAM ELEMENTS

Databases The development of computer processing requires the manipulation of more and more data. The organization and storage of this data is an essential performance issue. The use of relational databases is a widespread solution today. These databases make it possible to organize, store, update and query voluminous structured data used simultaneously by different programs or different users. This is impossible with the tabular representations studied in the first grade. Very large (petabyte-sized) database management systems (DBMS) are at the center of many information collection, storage, and production systems.

Hardware architectures, operating systems and networks The reduction in size of electronic circuit elements has led to the advent of Systems on Chips (SoCs), which combine in a single circuit many of the functions previously performed by separate circuits assembled on an electronic board. Such a system-on-chip is designed and developed in a software way, its electronic bricks are accessible through APIs, as for software libraries. Every machine is equipped with an operating system whose function is to load programs from mass memory and to launch their execution by creating processes for them, to manage all the resources, to handle interrupts as well as input/output and finally to ensure the global security of the system. In a network, routers play an essential role in the transmission of packets on the Internet: packets are routed individually by algorithms.

SOURCES

1. Programme de sciences numériques et technologie de seconde. To download from eduscol.education.fr ←
2. Programme de numérique et sciences informatiques de première générale. To download from eduscol.education.fr ←
3. Programme de numérique et sciences informatiques de terminale générale. To download from eduscol.education.fr ←