



Technical University of Lodz
Institute of Electronics

Algorithms and Data Structures

Introduction for Biomedical Engineering IFE Students

Łódź 2017





General Information

- Lecturers :



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Consultations:

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Consultations: check in the callendar

https://poczta2011.p.lodz.pl/service/user/marek.kocinski@p.lodz.pl/studentenci_2012.html



General Information

- **Lecture/Tutorial:** 30h (15 x 2 hours/week)
- **Venue:** room 413, building B9, Wólczańska 211/215
- **Credits:** 2 ECTS points (1 ECTS point = 25 - 30 h)
- **Self work:** 25 - 30 hours
- **Programming Language:** Python
- **Tools:** Enthought Python Distribution (EPD)



Most popular programming languages (GitHub 2011)

GitHub is a [web-based hosting service](#) for software development projects that use the [Git revision control](#) system. GitHub offers both paid plans for private repositories, and free accounts for open source projects. As of May 2011, GitHub was the most popular open source code repository site.^[3]

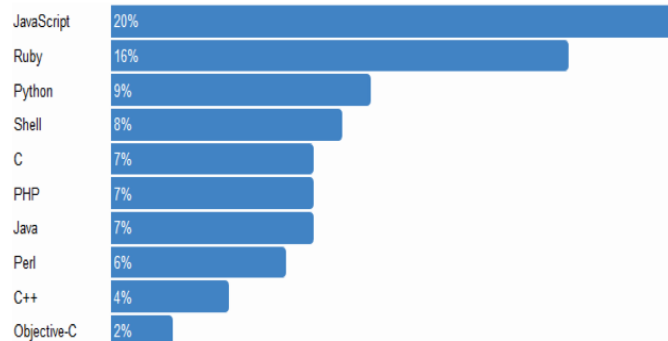
GitHub Inc. was founded in 2008 and is based in San Francisco, California.^[4]

In July 2012, the company received US\$100 Million in [Series A](#) funding, primarily from [Andreessen Horowitz](#).^{[5][6][7]}

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- 4 See also
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GitHub Top Languages 2011



GitHub

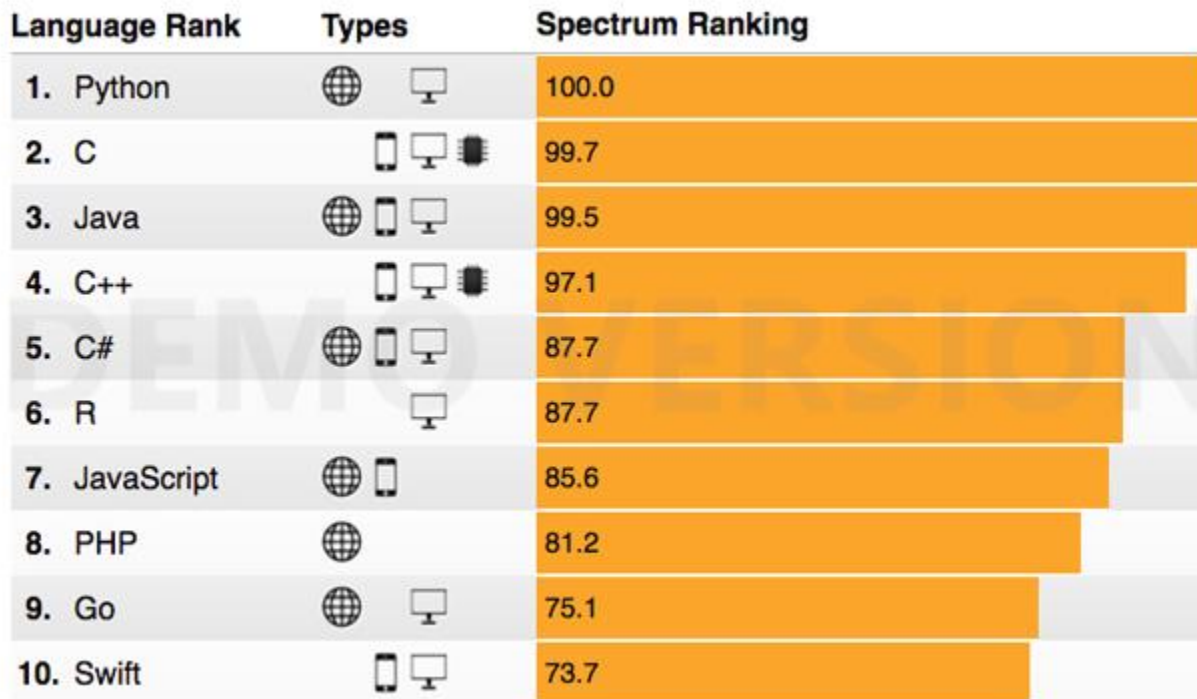
github
SOCIAL CODING

URL	GitHub.com ↗
Slogan	Social Coding (for all)
Commercial?	Yes
Type of site	collaborative revision control
Registration	Required
Available language(s)	English
Owner	GitHub, Inc. ↗
Launched	April 2008 ^[1]
Alexa rank	▼ 317 (September 2012) ^[2]



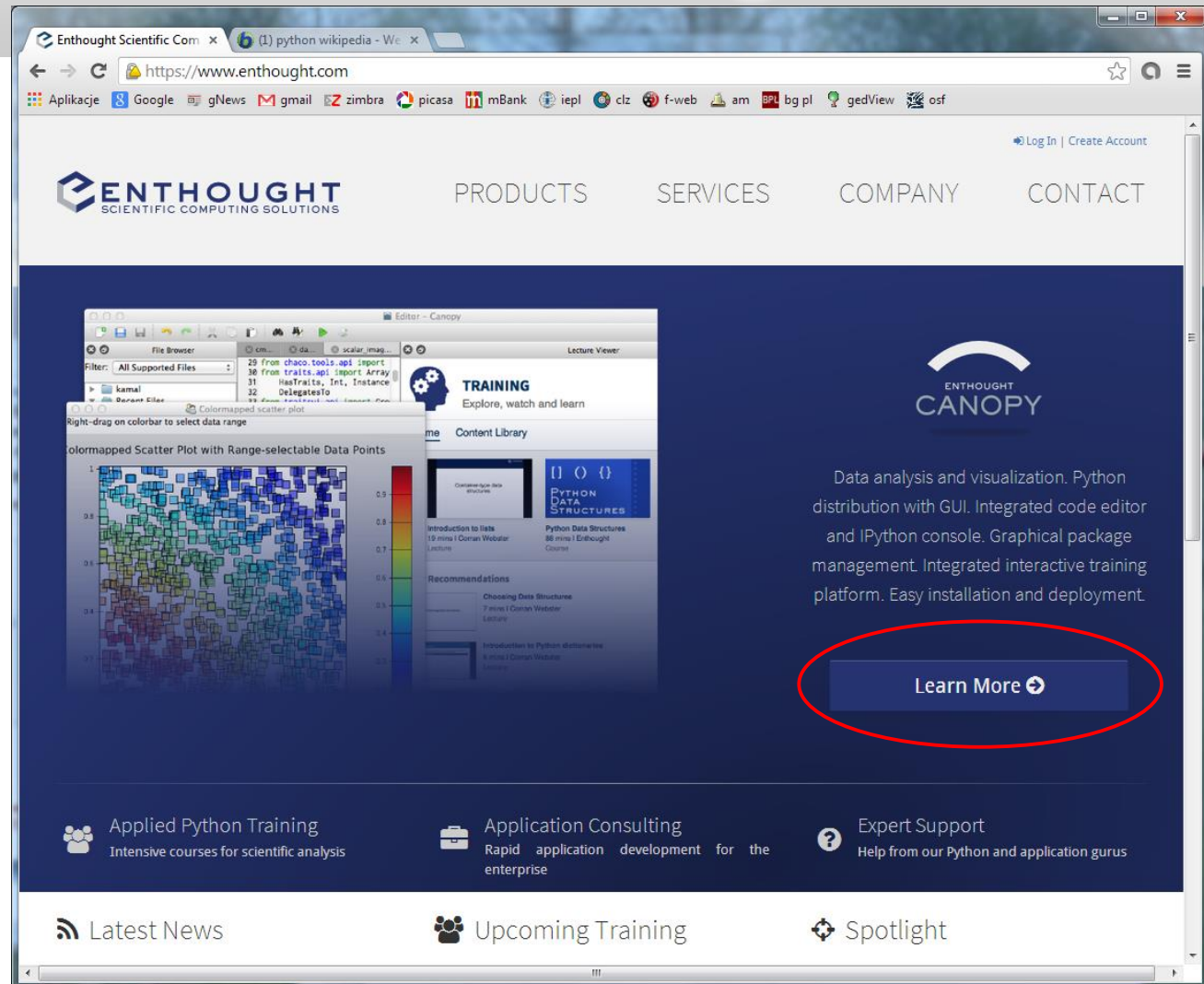
Most popular programming languages (IEEE Spectrum 2017)

<https://spectrum.ieee.org/computing/software/the-2017-top-programming-languages>



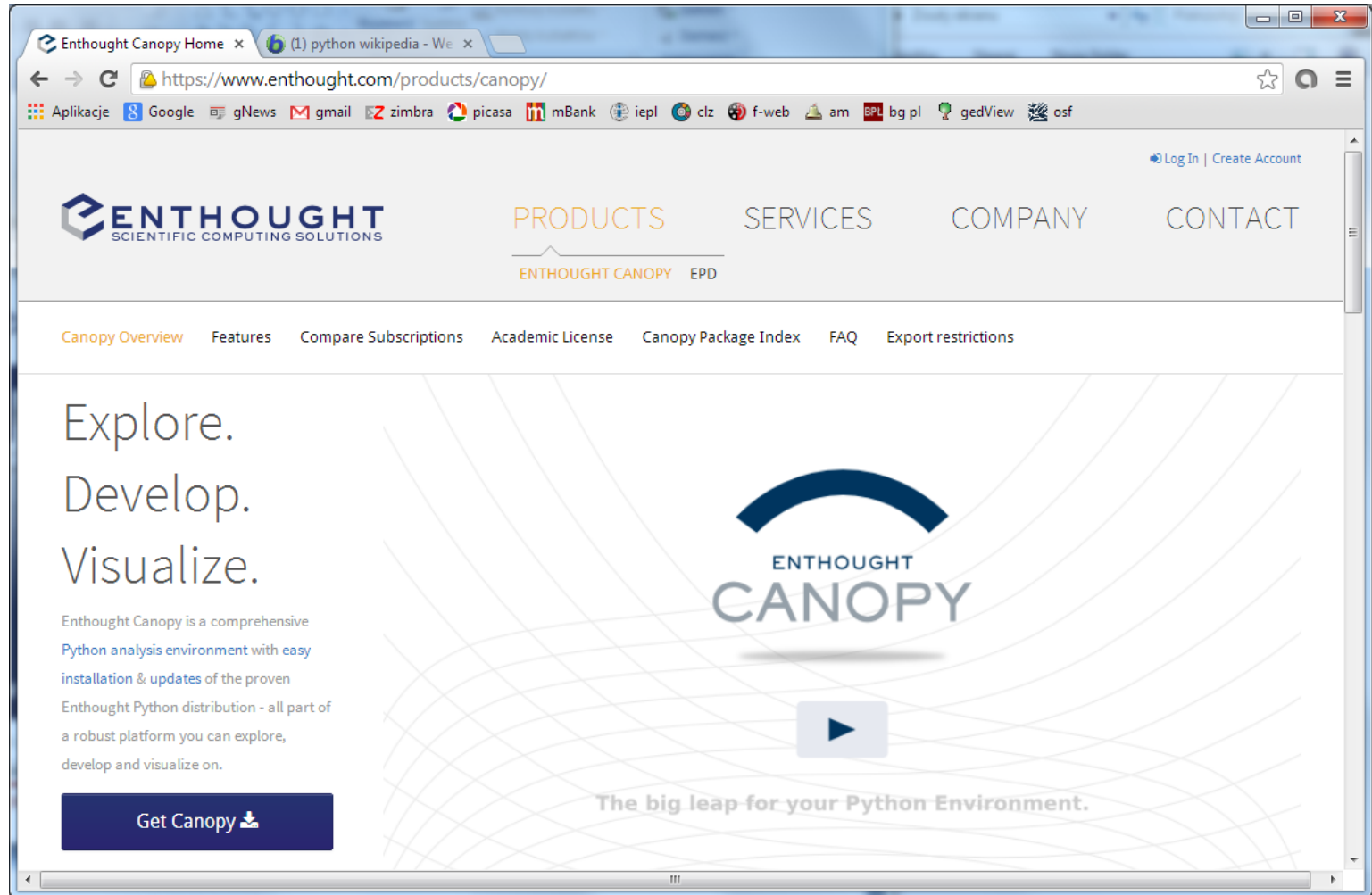


www.enthought.com





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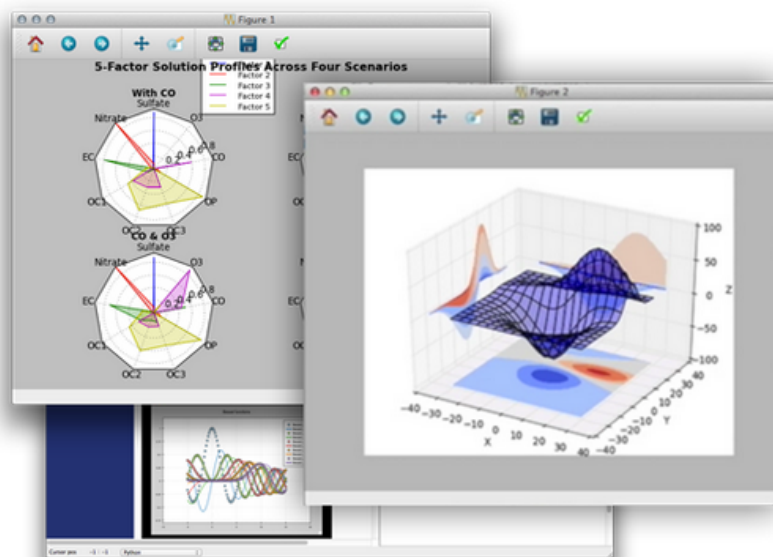




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What's in it for you?



Scientists and Engineers

A comprehensive, Python-based analysis desktop & Python distribution, Canopy provides an open and intuitive environment for scientific and analytic computing. Since it's Python, your algorithms, scripts and programs will never be locked into a proprietary language. And with the analysis desktop, data analysis, scripting and plotting are more straightforward.

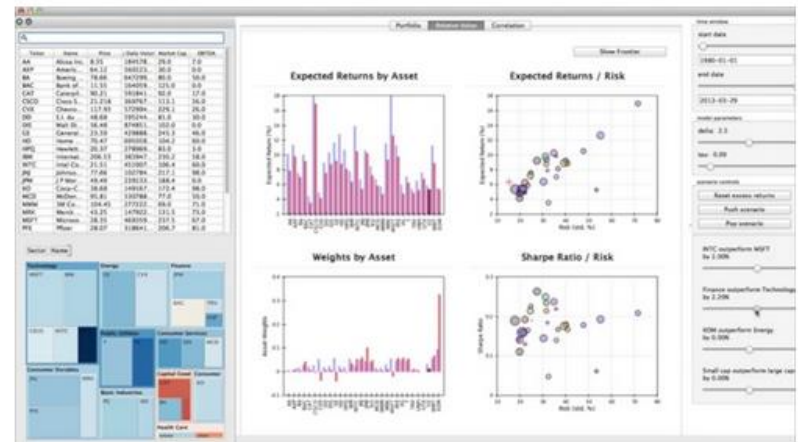


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Quantitative and Data Analysts

Python spans from algorithm development and testing on the desktop to teams developing web-server applications. With the Canopy desktop and Python distribution, data ingestion, manipulation and analysis are simplified, and algorithm prototyping and testing are streamlined.





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Portable Power

NORTHROP GRUMMAN



Enterprise

As a comprehensive Python-based analysis environment, Canopy puts powerful, yet very cost-effective, tools in the hands of analysts, scientists and engineers. As a robust application platform, it streamlines technical computing application development and deployment for your organization and for your customers.

With the popular, intuitive Python language and the comprehensive Canopy application platform, your organization can deploy new applications, algorithms and analysis tools much faster than with standard software languages and platforms. Users, especially "power" users, can extend and innovate with scripting and open platform APIs, driving the creation and sharing of innovative techniques and tools.



Who uses Python?

python™

NASA

python™

CENTRAL INTELLIGENCE AGENCY
UNITED STATES OF AMERICA

Jan Koprowski <jan.koprowski@gmail.com> Politechnika Gdańska, FTIMS – Informatyka Stosowana 5



Who uses Python?



NOKIA
CONNECTING PEOPLE





Who uses Python?

python™

YAHOO! GROUPS

YAHOO! MAPS INDIA BETA

YAHOO! OUR CITY INDIA BETA

ZOPE Corporation

real

RealNetworks

Python logo (orange hand)

WALT DISNEY FEATURE ANIMATION

COREL Paint Shop Pro PHOTO XI

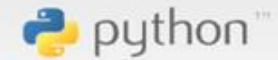
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Jan Koprowski <jan.koprowski@gmail.com> Politechnika Gdańska, FTIMS – Informatyka Stosowana

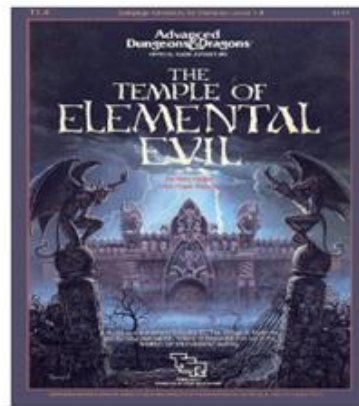
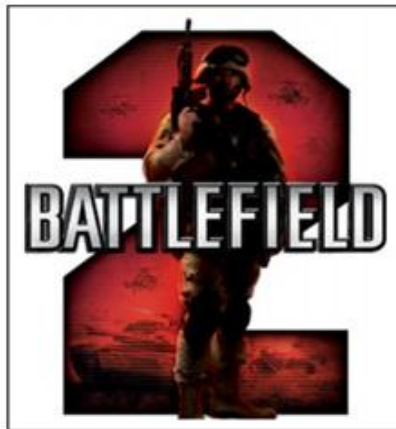
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Who uses Python?



SID MEIER'S
CIVILIZATION IV





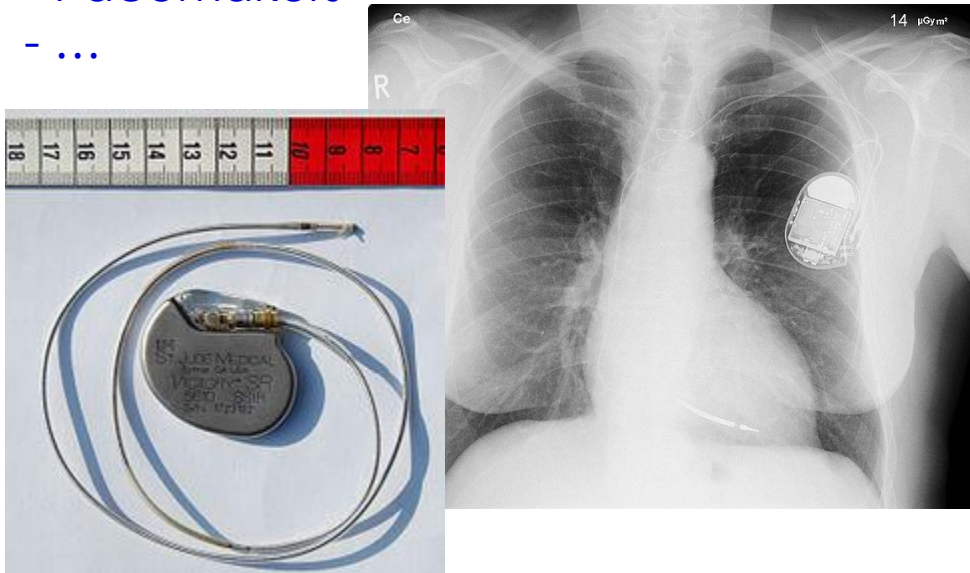
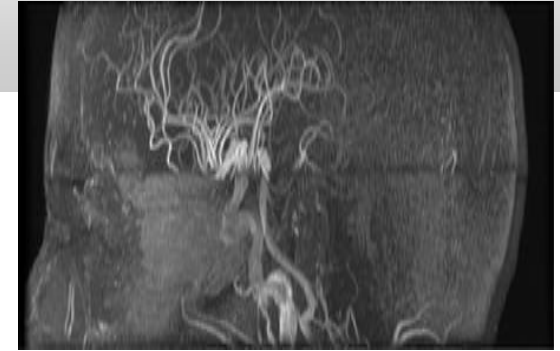
Python and other languages





Computers in Medicine

- HealthCare IT Systems
- Medical Imaging (CT, MRI,...)
- Image Analysis/Segmentation
- Medical Signal Analysis
- Surgery Navigation Aids
- Pacemakers
- ...



http://en.wikipedia.org/wiki/Artificial_cardiac_pacemaker



Computers in Medicine



Laptops, Netbooks and Tablets



Desktops and Workstations



Servers, Storage and Networking



Software and Peripherals

- HealthCare IT Systems
- Medical Imaging (CT, MRI,...)
- Image Analysis/Segmentation
- Medical Signal Analysis
- Surgery Navigation Aids
- Pacemakers
- ...

<http://content.dell.com/us/en/healthcare/healthcare-solutions>



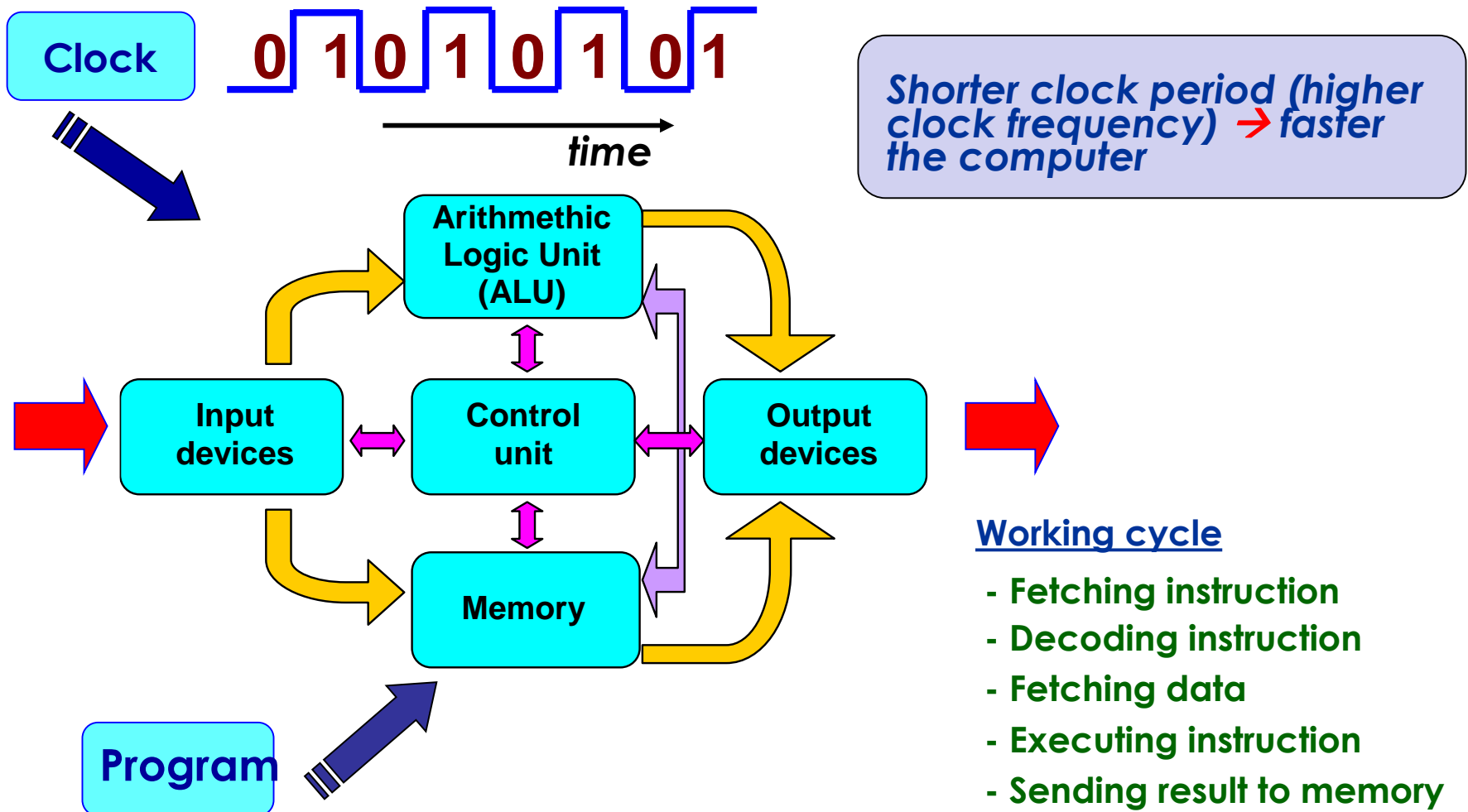
- What is a computer in those applications?
- What functions does it perform?
- Why do we use computers?





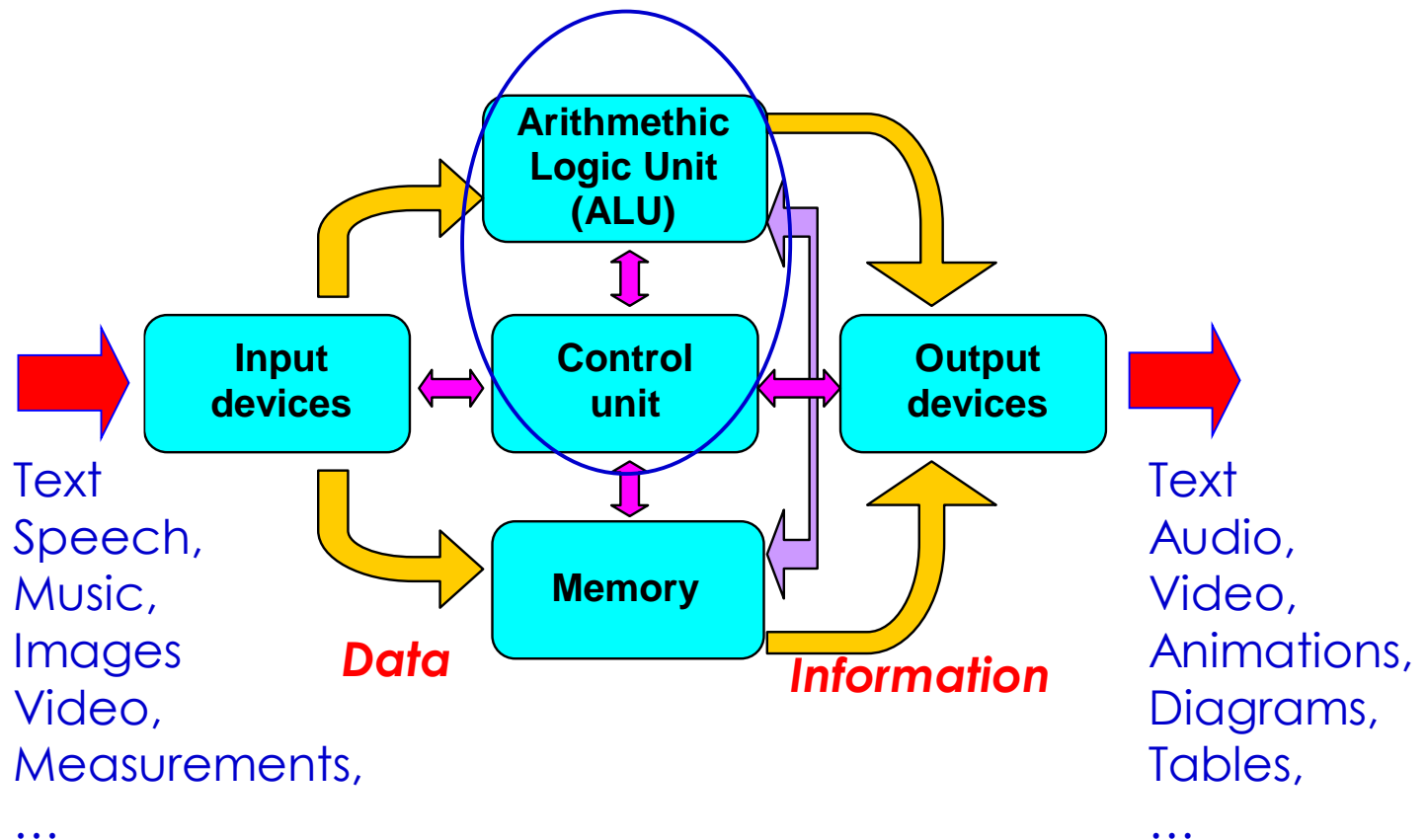
Basics of Computer Architecture

John von Neumann (1903-1957)



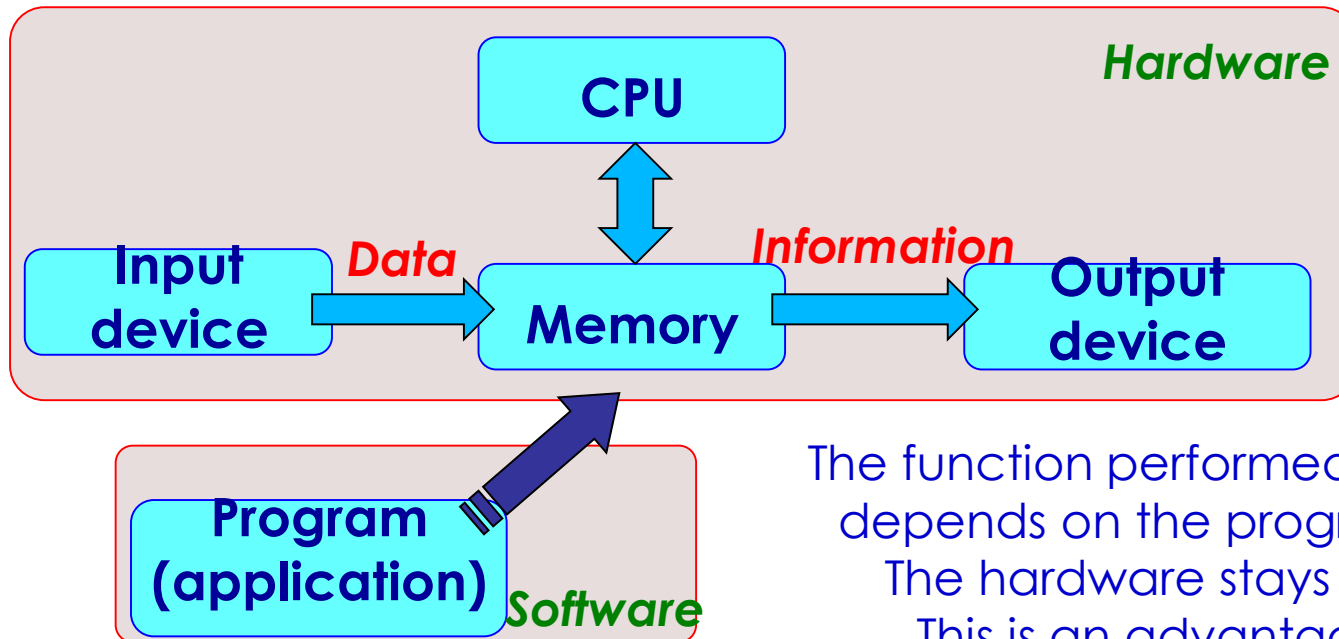
Basics of Computing

(Arithmetic Logic Unit + Control Unit) = Central Processing Unit (CPU)





The need for programming

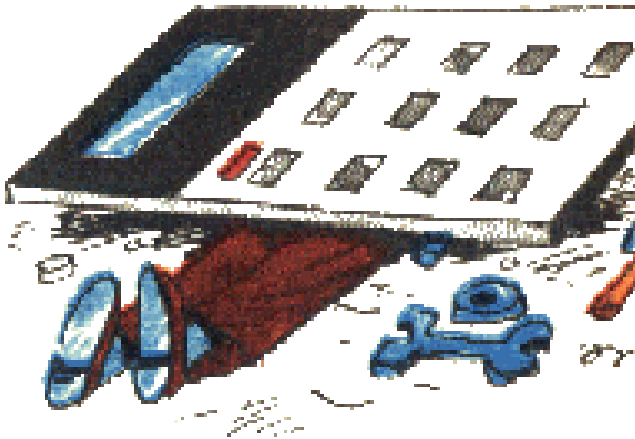


The function performed by a computer depends on the program (software).
The hardware stays all the same.
This is an advantage of digital computers (functional flexibility).



Basic assumptions

- The data are represented by binary numbers
- Time of execution of elementary instructions is very short
- The processing elements are of very small size



Representation	
decimal	binary
10 1	8 4 2 1
0	0
1	1
2	1 0
3	1 1
4	1 0 0
...	...
1 5	1 1 1 1

- decomposition into simple operations
- robustness to noise



Basic operations

Examples of binary operations

Rules of addition

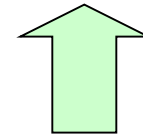
0	0	1	1
+0	+1	+0	+1
<hr/>	<hr/>	<hr/>	<hr/>
0	1	1	10

6×5:

$$\begin{array}{r} 1 1 0 \\ \times 1 0 1 \\ \hline 1 1 0 \\ 0 0 0 \\ + 1 1 0 \\ \hline 1 1 1 1 0 \end{array}$$

Text encoding

! - 00100001
\$ - 00100100
A - 01000001
B - 01000010
Z - 01011010
a - 01100001
m - 01101110



Possibility of
operations on symbols



Computer memory

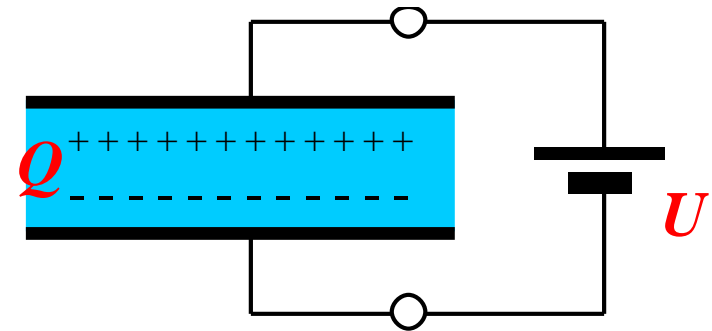
Capacitor

Plates

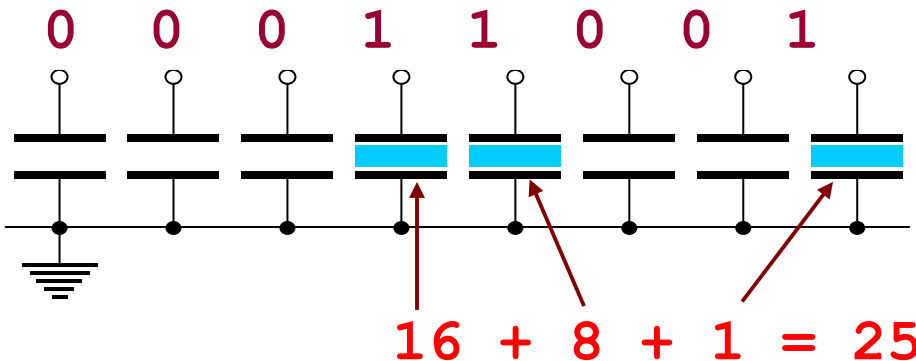
Insulator

$$C = \frac{\epsilon A}{d}$$

Capacity of a capacitor



1 byte of memory (8 bits)



$$Q = CU$$

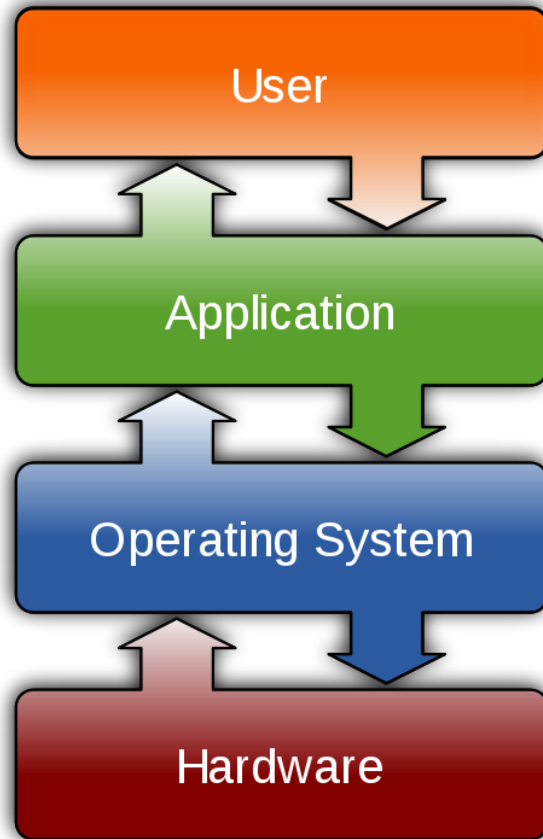
Charge

Capacity

Voltage



Operating system (OS)



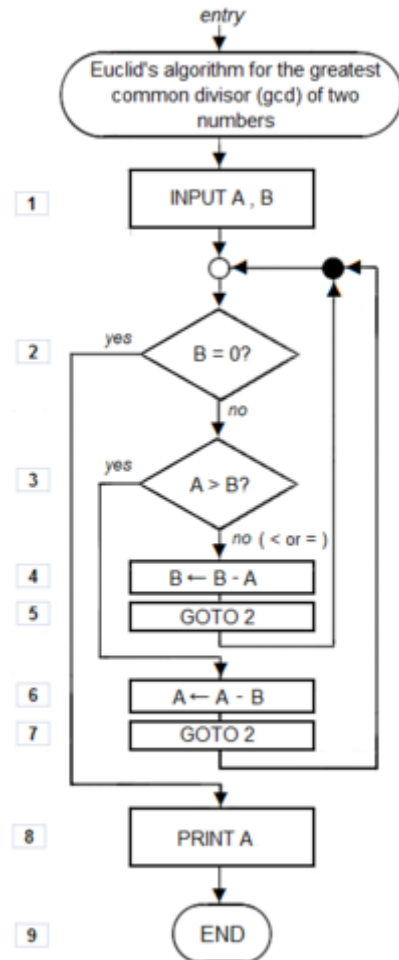
A collection of software to manage the hardware and to provide services to application programs.

OS examples: Microsoft Windows, Apple Mac OSX, Android.



Algorithm

Step-by-step procedure for calculation



Muḥammad ibn Mūsā al-Khwārizmī (Persian)



Programming languages

Generations

1. Machine code (100011 00011 01000...)

2. Assembly code →

3. Closer to human languages,
compiled or assembled prior to execution
(e.g. Java, C, Python, Pascal)

4. Domain-specific languages
(e.g. COBOL)

5. Problem solving by using program constraints,
instead of algorithms written by programmer
(artificial intelligence, learning from examples).

<u>Address</u>	<u>Instruction mnemonic</u>	<u>Arguments</u>
00000000	push	ebp
00000001	mov	ebp, esp
00000003	movzx	ecx, [ebp+arg_0]
00000007	pop	ebp
00000008	movzx	dx, cl
0000000C	lea	eax, [edx+edx]
0000000F	add	eax, edx
00000011	shl	eax, 2
00000014	add	eax, edx
00000016	shr	eax, 8
00000019	sub	cl, al
0000001B	shr	cl, 1
0000001D	add	al, cl
0000001F	shr	al, 5
00000022	movzx	eax, al
00000025	ret	



Python versus assembler example

Program for printing a „Hello World” message

X86 assembly language – x86-64 Linux, AT&T syntax

```
.section          .rodata
string:
    .ascii "Hello, World!\n\0"

length:
    .quad . -string          #Dot = 'here'

.section          .text
.globl _start           #Make entry point visible to linker
_start:
    movq $4, %rax        #4=write
    movq $1, %rbx        #1=stdout
    movq $string, %rcx
    movq length, %rdx
    int $0x80            #Call Operating System
    movq %rax, %rbx      #Make program return syscall exit status
    movq $1, %rax        #1=exit
    int $0x80            #Call System Again
```



Python versus assembler example

Program for printing a „Hello World” message

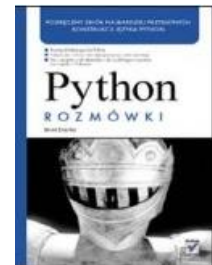
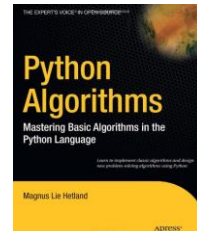
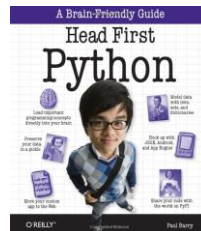
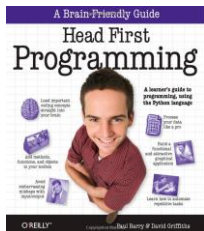
Python language

```
print "Hello World"
```



Literature

- **Head First Programming: A Learner's Guide to Programming Using the Python Language** by David Griffiths
- **Head First Python** by Paul Barry
- **Python Algorithms: Mastering Basic Algorithms in the Python Language** by Magnus Lie hetland
- **Python. Rozmówki**, Brad Dyley
- **Python od Podstaw** – zespół autorów
- **Zanurkuj w pythonie** (http://pl.wikibooks.org/wiki/Zanurkuj_w_Pythonie)
- **Programowanie z Pythonem** podręcznik stworzony dla studentów I roku neuroinformatyki I fizyki medycznej na Wydziale Fizyki Uniwersytetu Warszawskiego (http://brain.fuw.edu.pl/edu/TI:Programowanie_z_Pythonem/Wersja_do_druku)
- Many many more books and tutorials available on the Internet





Final mark

- 5 computer tests during the semester (75 %)
- Activity during classes (attendance, presentations, programming project) (25 %)



General Advice

- Slides shown during lectures do not cover all knowledge needed for passing the exam.
- Knowledge is acquired through studying and exercise.
- It is wise to take notes.
- It is worth browsing tutorials of Python modules used during classes.



Used Materials

1. Python for Scientist and Engineers – slides from course by Enthought, Inc. www.enthought.com
2. www.pl.python.org
 1. <http://pl.python.org/docs/>
 2. <http://pl.python.org/kursy,jezyka.html>
 3. <http://pl.python.org/wyklady.html>



Download and Installation of EPD

The screenshot shows the Enthought website with the following content:

- Browser Address Bar:** www.enthought.com (circled in red).
- Navigation Links:** [www.scipy.org](#), [downloads](#), [blog](#) (circled in red).
- EPD repository | code.enthought.com**
- PRODUCTS | CONSULTING | TRAINING | SECTORS | COMPANY | CONTACT US**
- Enthought Python Distribution 7.3**
100+ packages for analysis & visualization
[SUBSCRIBE](#)
- EPDFree 7.3**
One click installs NumPy, SciPy, IPython, matplotlib, Traits & Chaco
[DOWNLOAD](#)
- EuroSciPy 2012**
8.23-27, BRUSSELS, BELGIUM
- Software Developer**
MULTIPLE OPENINGS
- UPCOMING LIVE TRAINING**
Python for Scientists and Engineers
Sep 10-14, Dayton, OH
Open Course- Finance
Sep 10-14, London, UK
Python for Scientists and Engineers
- EPD 7.3**
Single-click installation of Python 2.7 and 100+ libraries for scientists, engineers and analysts
Now with enaml and Shapely
Windows, Mac OS X, Linux, Solaris
[SUBSCRIBE](#)
- PRODUCTS**
The Enthought Python Distribution provides a comprehensive, cross-platform environment for scientific computing with the Python programming language. A single-click installer allows immediate access to over 100 libraries and tools. Our open source initiatives include SciPy, NumPy, and the Enthought Tool Suite.
- CONSULTING**
We work with you to develop software for interactive data manipulation and visualization. In addition to full application development, we also offer short-term consultation to address critical technical computing needs. Our areas of expertise include geoscience, financial analysis, 3D modeling, fluid dynamics and microrheology.
- TRAINING**
Taught by full-time Enthought developers, our Intensive Python Training Courses, custom courses, and webinars are geared toward scientists,



Download and Installation of EPD

The screenshot shows the Enthought website's 'Get EPD' page. The URL is www.enthought.com/products/getepd.php. The page features a navigation bar with links to PRODUCTS, CONSULTING, TRAINING, SECTORS, COMPANY, and CONTACT US. Below the navigation bar, there is a 'PRODUCTS' section with a sidebar on the left containing links like Overview, Enthought Python Distribution, Support Levels, Purchase/Download, Package Index, FAQ, Getting Started, License, Repository, Changelog, EPDFree, Upgrade, and Open Source Products. The main content area is titled 'DOWNLOADS:' and includes three buttons: 'SUBSCRIBE', 'ACADEMIC' (circled in red), and 'EPD FREE'. Below these buttons, there is a section titled 'Buy a Subscription to EPD' with the text 'Multi-platform 32-bit & 64-bit, with updates, virtual training, and support.' and a prompt to 'Please choose a subscription level below select the number of subscriptions you would like to purchase.' The subscription levels are listed in a table:

	BASIC	SILVER	GOLD	PLATINUM
Price	\$199	\$180 per user	\$990 per user	Specialized pricing
License	individual license	10 license minimum	10 license minimum	structure based on enterprise budget & needs
Platforms	All platforms & architectures	Add users in increments of 10	Add users in increments of 3	
Installation	Email installation	Phone & email	Phone & email	Custom phone/email



Download and Installation of EPD

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SCIENTIFIC COMPUTING SOLUTIONS

EPD repository | code.enthought.com | www.scipy.org | [downloads](#) | [blog](#)

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- Support Levels
- Purchase/Download**
- Package Index
- FAQ
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- Upgrade
- Open Source Products

**Focus on the forest...
Leave the trees to us.**

Enthought Python Distribution Academic Download

The academic version of EPD is a fully functional installation of the software that can be used indefinitely by students and employees at degree-granting institutions. See [academic license terms](#) for details.

To download epd-7.3-1, please enter your academic email address below. A download link will be sent to the address you provide. For details on this release, see [EPD release notes](#).

ACADEMIC E-MAIL

EPD FOR PPC

For a OSX I0.4 Intel/PPC-compatible version of EPD, please submit your academic email address below. A download link will be sent to the address you provide.

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