

Online Resources for Teaching Programming to First Year Students



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Outline

1. First year programming courses outline
2. Administrative support tools
3. Learning support tools
 - a. For beginner students
 - b. For intermediate students
 - c. For advanced students
4. The end

First Year Programming Courses' outline

Computer Programming, 1'st Semester

Language: ANSI C

IO operations

Conditional structures

Repetitive structures

Data structures / (vector, matrix)

Operations with Strings

Functions

Recursivity

Programming techniques, 2'nd Semester

Language: ANSI C + Python 3 (optional)

Algorithm design and analysis

Algorithm correctness and testing

Sorting Algorithms

Abstract Data types (Linked lists, Stacks & Queues)

Graphs representation and traversal

Dynamic programming

First Year Programming Courses' evaluation

Computer Programming, 1'st Semester

Oral exam (50 %)

Lab test on computers (25 %)

Lab activity during the semester (25%)

Homeworks

Lab test on computers

Programming techniques, 2'nd Semester

Written exam (40 %)

Lab activity during the semester (30 %)

Homeworks

Lab test on computers

Individual Project or Team Project (30 %)

Technical Documentation written in Latex

Doxygen generated documentation from code comments

Code solving specific problems

First Year Programming Courses' Info

Computer Programming, 1'st Semester

120 students

60 Romanian teaching

60 English teaching

4 assistants

1 teacher

14 labs (2h each)

14 courses (2h each)

Programming techniques, 2'nd Semester

120 students

60 Romanian teaching

60 English teaching

1 assistant

1 teacher

14 labs (2h each)

14 courses (2h each)

14 seminars (1h each)

Administrative support resources

Problem statement

- The University and Faculty does not enforce a common CMS.

Current situation

- Everybody uses whatever CMS is easier for them.
- Students are confused.
- Loss of time for teachers & students.



What do teachers need ?

- Tool to manage and give access to teaching materials.
- Tool to keep track of marks, attendance, etc.
- Tool to manage homeworks/handouts.



What do we think students need ?

- Access to teaching materials
- Access to their current status (marks / attendance)
- Tool to manage homeworks/handouts.



Free solution from Google

- Collaborate on documents
- Share schedules/calendars
- Harness the full power of Gmail
- Work in group easier with Google Groups
- Easily create and manage sites via Google Sites
- Communicate and manage assignments

Google
for Education



goo.gl/pySaku



Classroom

by Google

Exploring Classroom:

Teacher Perspective

- Creating and customizing a new class
- Adding students
- Digital workflow - assignments
- Digital communication - announcements & email
- Integration with Google Drive



Classroom

by Google

Assignment Features

The screenshot shows the Classroom assignment creation interface. At the top, there are tabs for 'STREAM' and 'STUDENTS', and a user profile 'jscheffer@bpsk12.org'. The main content area contains a text prompt: 'What's your Passion?' followed by 'What are 3 things you are passionate about? 2 TED Talks that inspire you? 1 TED-Ed lesson you really enjoyed? Complete the attachment and be prepared to share at our next meeting.' Below the text, there is a 'Due' field with 'Jul 28, 2014' and '2:00 PM' selected, and a red box around it with an arrow pointing to the text 'Assign a due date and time'. To the right of the due date field, there is a red box around the text 'Decide how students can view files' and a dropdown menu with 'Students can view file' selected, and a list of options: 'Students can view file', 'Students can edit file', and 'Make a copy for each student'. Below the text, there is a file attachment area with a red box around it. It shows a file named 'TED-Ed Club Idea Book (1) (1).pdf' with a red arrow pointing to the 'ASSIGN' button. Below the file name, there is a red box around the text 'Select a file to attach and hit ASSIGN'. At the bottom, there are icons for 'Announcement' and 'Assignment', and a 'Send Feedback' button.

STREAM STUDENTS jscheffer@bpsk12.org

What's your Passion?

What are 3 things you are passionate about? 2 TED Talks that inspire you? 1 TED-Ed lesson you really enjoyed?
Complete the attachment and be prepared to share at our next meeting.

Due Jul 28, 2014 2:00 PM × Assign a due date and time

Decide how students can view files

Students can view file ×

Students can view file

Students can edit file

Make a copy for each student

TED-Ed Club Idea Book (1) (1).pdf PDF Select a file to attach and hit ASSIGN

ASSIGN

Announcement Assignment

Send Feedback



Assignment: Basic Italian Vocabulary

DUE: AUG 12

RETURN



EMAIL



FOLDER



DOWNLOAD

<input type="checkbox"/>	Student	Status	Grade	Points	100	▼
<input checked="" type="checkbox"/>	 Zach Yeskel We'd done... Zach: I can tell you have	DONE Aug 7	100/100	<i>Not Returned</i>		
<input type="checkbox"/>	 Ben Schrom Send a note	DONE	No Grade			
<input type="checkbox"/>	 Jen Miller Thanks, Jen. Great job. Moon is	RETURNED Aug 7	98/100			
<input type="checkbox"/>	 Sheryl Jackson Send a note	NOT DONE	No Grade			
<input type="checkbox"/>	 Mike McCollum Send a note	NOT DONE	No Grade			
<input type="checkbox"/>	 Matt Thomas We'd done... Matt?	RETURNED Aug 7	92/100			
<input checked="" type="checkbox"/>	 Elizabeth Frank Send a note	DONE	86/100	<i>Not Returned</i>		
<input type="checkbox"/>	 Brittany McGinnis Send a note	DONE	No Grade			
<input type="checkbox"/>	 Chat Atapattu Send a note	NOT DONE	No Grade			

Send Feedback



Classroom

by Google

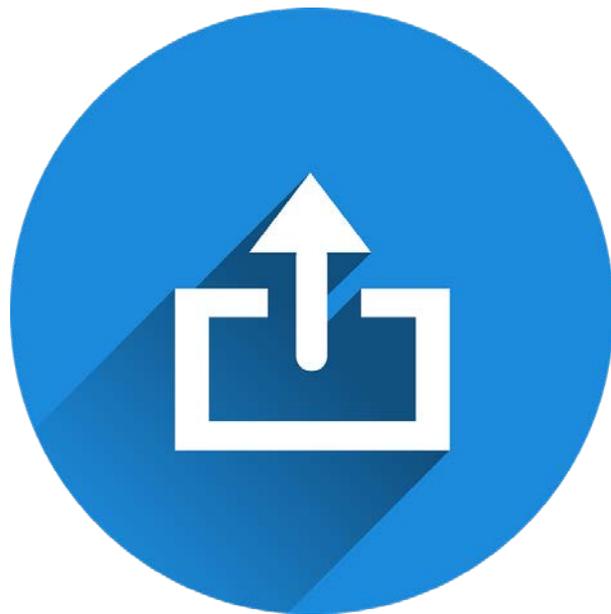
Exploring Classroom:

Student Perspective

- Joining a new class
- Digital communication - discussion & email
- Digital workflow - creating & submitting assignments
- Integration with Drive
- Opportunity to integrate digital citizenship

Manage Homeworks/ Handouts

- Html web form to upload files to Google Drive
- Easy to personalize script
- The uploader can download/view the file uploaded
- Only the teacher has access to all files



<http://goo.gl/6GRI5p>

Sharing Code

- Codepad is an online compiler/interpreter
- A simple collaboration tool
- Codepad will give you a short URL you can use to share your code

CODEPAD.ORG

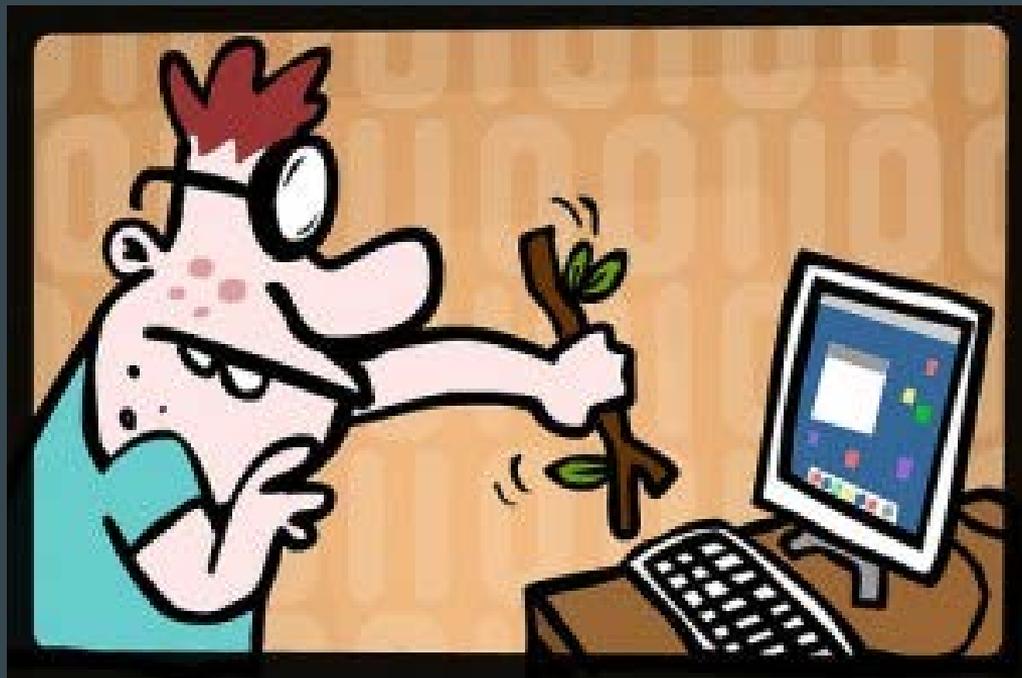
<http://codepad.org/>

Learning support resources

Problem statement

- Students learn differently due to their background and personality.
- First year student's prior knowledge of programming varies.
- Students have to be kept in the loop, they should not be presented with too advanced/basic knowledge.





NOOB



Bits and Bytes TV Series

- How programs work
- File and data management
- Communication between computers
- Computer languages
- Computer assisted instructions
- Simulations and Games
- Computer Graphics
- Computer Music



<https://goo.gl/AcGRUZ>

a[0] a[1] a[2] a[3] a[4] a[5] a[6] a[7] a[8] a[9]



Youtube Course about C

- Binary tutorial
- Hexadecimal tutorial
- Numeric overflow
- **Why do we need to learn pointers?**
- Changing data using bitmasks

Free Online Programming Course in C for Beginners

Carl Herold

<https://goo.gl/Brxfw4>

Learn C by doing

- 4.c: printf output
- 12.c: nested for loops
- 35.c: multiple files compiled together
- 46.c: Arrays of Structures
- 59.c: pointers to structures
- 78.c: register const storage qualifiers

88 C Programs

JT Kalnay

<https://goo.gl/yUT0Ss>



Algorithms for beginners

- Lecture Videos & Notes
- Handouts
- Problem statements
- Topics:
 - Greedy algorithms
 - Dynamic programming
 - ...

Intensive post-baccalaureate program in Computer Science based on the undergraduate course of study at MIT.

<http://aduni.org/courses/algorithm/index.php?view=cw>

Algorithms Visualisation

- Basics: stacks, queues, linked lists, ...
- Recursion: factorial, n-queens, ...
- Indexing: B+ Trees, Red-Black Trees, ...
- Sorting: Shell Sort, Radix Sort, Heap Sort
- Heap-like Structures: Skew, Leftlist, ...
- Graph Algorithms: DFS, Kruskal, Prim, ...
- Dynamic Programming
- Geometric Algorithms
 - [2D Rotation and Scale Matrices](#)
 - [2D Rotation and Translation Matrices](#)
 - [2D Changing Coordinate Systems](#)
 - [3D Rotation and Scale Matrices](#)
 - [3D Changing Coordinate Systems](#)
- Others: Disjoint Sets, Huffman Coding, etc.

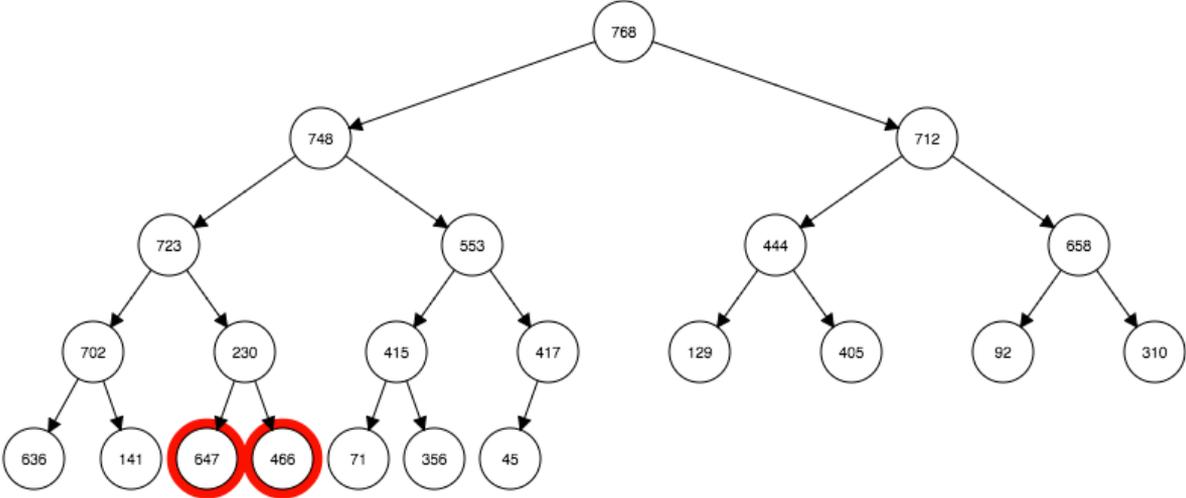


<https://www.cs.usfca.edu/~galles/visualization/Algorithms.html>

Heap Sort

Randomize Array Heap Sort

768	748	712	723	553	444	658	702	230	415	417	129	405	92	310	636	141	647	466	71	356	45	777	819	851	901	915	953	960	971	980
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30



Animation Running

Skip Back Step Back Pause Step Forward Skip Forward w: 1000 h: 500 Change Canvas Size Move Controls

Animation Speed

Algorithms Complexity

- Common data structure alg: array, B-Tree, AVL, KD-Tree, ...
- Array sorting: Timsort, Quicksort, Radix, ...
- Graph data structure: incidence list, adjacency list, ...
- Heap Data Structure: Binary, Fibonacci, ...
- Graph alg: A*, Topological sort, ...

Array Sorting Algorithms

Algorithm	Time Complexity			Space Complexity
	Best	Average	Worst	Worst
Quicksort	$\Omega(n \log(n))$	$\Theta(n \log(n))$	$O(n^2)$	$O(\log(n))$
Mergesort	$\Omega(n \log(n))$	$\Theta(n \log(n))$	$O(n \log(n))$	$O(n)$
Timsort	$\Omega(n)$	$\Theta(n \log(n))$	$O(n \log(n))$	$O(n)$
Heapsort	$\Omega(n \log(n))$	$\Theta(n \log(n))$	$O(n \log(n))$	$O(1)$
Bubble Sort	$\Omega(n)$	$\Theta(n^2)$	$O(n^2)$	$O(1)$
Insertion Sort	$\Omega(n)$	$\Theta(n^2)$	$O(n^2)$	$O(1)$
Selection Sort	$\Omega(n^2)$	$\Theta(n^2)$	$O(n^2)$	$O(1)$
Tree Sort	$\Omega(n \log(n))$	$\Theta(n \log(n))$	$O(n^2)$	$O(n)$
Shell Sort	$\Omega(n \log(n))$	$\Theta(n(\log(n))^2)$	$O(n(\log(n))^2)$	$O(1)$
Bucket Sort	$\Omega(n+k)$	$\Theta(n+k)$	$O(n^2)$	$O(n)$
Radix Sort	$\Omega(nk)$	$\Theta(nk)$	$O(nk)$	$O(n+k)$
Counting Sort	$\Omega(n+k)$	$\Theta(n+k)$	$O(n+k)$	$O(k)$
Cubesort	$\Omega(n)$	$\Theta(n \log(n))$	$O(n \log(n))$	$O(n)$

<http://bigocheatsheet.com/>

Git and Github Course

- Keep track of multiple versions of a file
- Track bugs by reverting to previous working versions of a file
- Seamlessly collaborate with other developers on a project



UDACITY



[https://www.udacity.com/
course/how-to-use-git-
and-github--ud775](https://www.udacity.com/course/how-to-use-git-and-github--ud775)

Coding Style

- Tabs are 8 characters, and thus indentations are also 8 characters.
- “If you need more than 3 levels of indentation, you're screwed”
- The limit on the length of lines is 80
- “If you have some random integer loop counter, it should probably be called "i".“
- “You know you're brilliant, but maybe you'd like to understand what you did 2 weeks from now.”

Linux Kernel indentation

Linus Torvalds

<https://goo.gl/nZbVKd>



LaTeX online introduction

- Introduction to LaTeX
- Producing simple documents using LaTeX
- Producing Mathematical Formulae using LaTeX
 - Greek Letters
 - Matrices and other arrays in LaTeX
 - ...
- Further Features of LaTeX
 - Lists
 - Tables
 - ...

University of Dublin
School of Mathematics

David R. Wilkins

[http://www.maths.tcd.ie/
~dwilkins/LaTeXPrimer/](http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/)

LaTeX online IDE

- Collaboration
- Ease of Use
- Document history
- Dropbox sync
- Templates
- Easy to use LaTeX
documentation



<https://www.sharelatex.com/>

- figures
- sections
 - instantons
 - introduction.tex
 - low-energ...
 - moduli-space.tex
- m2-branes
- polytopes
 - abstract.tex
 - conclusion.tex
 - introduction.tex
- bibliography.bib
- dmathesis.cls
- logo.pdf
- main.tex
- preamble.tex
- utphys.bst

```

301 - \section{Geodesic completeness of the moduli
space} \label{sec:geodesic completeness of
the moduli space}
302
303 It is straightforward to see that the
instanton moduli space is not geodesically
complete, but the equivalent question for
motion in the presence of a potential is not
so straightforward. For pure instantons, a
small negative perturbation in the size
parameter will cause the instanton to shrink
steadily until it hits the zero size
singularity. For dyonic instantons however,
there is a non-zero conserved angular
momentum on the moduli space from the
rotation in the unbroken  $U(1)$  gauge
group. This prevents the dyonic instanton
from shrinking to zero size under small
perturbations.
304
305 For a single dyonic instanton, the angular
momentum is given by
306 - \begin{equation}
307 l = \rho^2 \dot{\theta}
308 \end{equation}
309 but for two dyonic instantons the angular
momentum is more complicated and the picture
is not as clear.
310 On the two instanton moduli space the
conserved gauge angular momentum arises from
the Killing direction  $\theta$  in the metric
and is given by
311 - \begin{equation}
312 l = g_{\theta\theta} \dot{\theta}
313 \end{equation}
314 where  $\theta$  is the embedding angle in the
unbroken  $U(1)$  as in equation
\eqref{eq:polar coordinate metric}.

```

Recompile

6.4 Geodesic completeness of the moduli space

It is straightforward to see that the instanton moduli space is not geodesically complete, but the equivalent question for motion in the presence of a potential is not so straightforward. For pure instantons, a small negative perturbation in the size parameter will cause the instanton to shrink steadily until it hits the zero size singularity. For dyonic instantons however, there is a non-zero conserved angular momentum on the moduli space from the rotation in the unbroken $U(1)$ gauge group. This prevents the dyonic instanton from shrinking to zero size under small perturbations.

For a single dyonic instanton, the angular momentum is given by

$$l = \rho^2 \dot{\theta}, \quad (6.41)$$

but for two dyonic instantons the angular momentum is more complicated and the picture is not as clear. On the two instanton moduli space the conserved gauge angular momentum arises from the Killing direction θ in the metric and is given by

$$l = g_{\theta\theta} \dot{\theta}, \quad (6.42)$$

where θ is the embedding angle in the unbroken $U(1)$ as in equation (A.5.11). Consider now just the complex plane submanifold, the angular momentum for two dyonic

instantons is

$$l = \rho_1^2 \dot{\theta}_1 + \rho_2^2 \dot{\theta}_2 - \frac{2}{\sqrt{2}} \rho_1 \rho_2 \sin 2\theta \dot{\theta} = \frac{2}{\sqrt{2}} \rho_1^2 \rho_2^2 \sin^2 \theta \dot{\theta} - 2l_1. \quad (6.43)$$

The last two terms describe the angular momentum of each dyonic instanton when they are well separated. However, there is only one overall conserved quantity and the individual instantons are free to transfer angular momentum when close together. It is no longer clear a priori whether one of the dyonic instantons can shrink to zero size by exchanging angular momentum with the other.

By numerically exploring motion on the moduli space we have been unable to find trajectories where the instantons do indeed exchange angular momentum in such a way that one dyonic instanton shrinks to zero size. This is most easily observed when the dyonic instantons are far enough apart to be clearly distinct yet still within range of attraction. An illustrative example is shown in Figure 6.17 where both dyonic instantons start with a non-zero angular momentum but one dyonic instanton remains free, the other with it passes through zero size. Both dyonic instantons continue to oscillate as a steady state well so long as the dyonic instanton reaches the lowest point of its oscillation at the same time as passing through zero angular momentum it will hit the zero size singularity. This explains the fixing of one of the parameters which we

C for beginners

- Lecture Slides
- Project assignments
- Assignments
- Topics:
 - Multithreading and concurrency
 - Garbage collection
 - ...

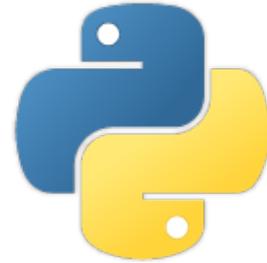
MIT OPENCOURSEWARE
Practical C programming

<http://goo.gl/ZRkDN6>

Python Course for beginners

- 13 Hours
Estimated Course Time
- 9 Projects
- 9 Quizzes
- Online Console

codecademy



<https://www.codecademy.com/learn/python>

Coding Style

- All loops must have a fixed upper-bound
- No function should be longer than what can be printed on a single sheet of paper
- The return value of non-void functions must be checked by each calling function

NASA's 10 rules for
Developing Safety
Critical Code

**Gerard J. Holzmann
(JPL)**

<http://goo.gl/hURmHp>



