

Wrapping up, and future directions

ESC101: Fundamentals of Computing

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No More Prutor after a few days

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Prutor logins for all of us will be disabled a few days after the grades are declared – will warn you beforehand!

New logins will be created for your friends in A batch

Need to start using other compilers like gcc

Can keep using Clang as well (need to install it though) – gcc is always available on Linux computers

Windows computers need to install a compiler (VS etc)



Linux and Windows

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On Linux systems, gcc compiler will always be available

Can install clang too if you own that machine

On Windows, can install gcc via the Cygwin or the MinGW routes

<https://sourceforge.net/projects/tdm-gcc/>

Can install Clang on Windows too

<http://releases.lvm.org/download.html>

However, easier to install Visual Studio on Windows

<https://visualstudio.microsoft.com/vs/community/>



Compilation and Execution

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Suppose your C program is in the file `test.c`

To compile the C program type **`gcc test.c`**

It will create an executable file called `a.out`

Can execute that file by typing **`./a.out`**

If you want to give the executable a nice name, use the following command **`gcc -o myname test.c`**

An executable called `myname` will get created

Can execute that file by typing **`./myname`**



Explore More..

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Interpreted languages such as **Python** (very popular nowadays)

Object-oriented programming (e.g., C++, Java)



Pursue your Interest

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If interested in problem solving – take up competitive programming

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

<https://leetcode.com/>

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

<https://www.geeksforgeeks.org/>

<http://codeforces.com/>

Many application areas require heavy programming

Fluid dynamics (AE, CHE), Particle accelerators (PHY), Data Analysis (MTH, CSE), Wireless communications (EE), Optimization (IME, ECO, MTH, CSE)

Several applications within CSE

Architecture, Operating Systems, Compilers, Theory, Algorithm Design, Databases, Web Programming, Machine Learning and AI, and many more



Possibilities at CSE@IITK

- All department UGs are welcome to contact CSE faculty



Overview of CSE@IITK's programming

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Systems

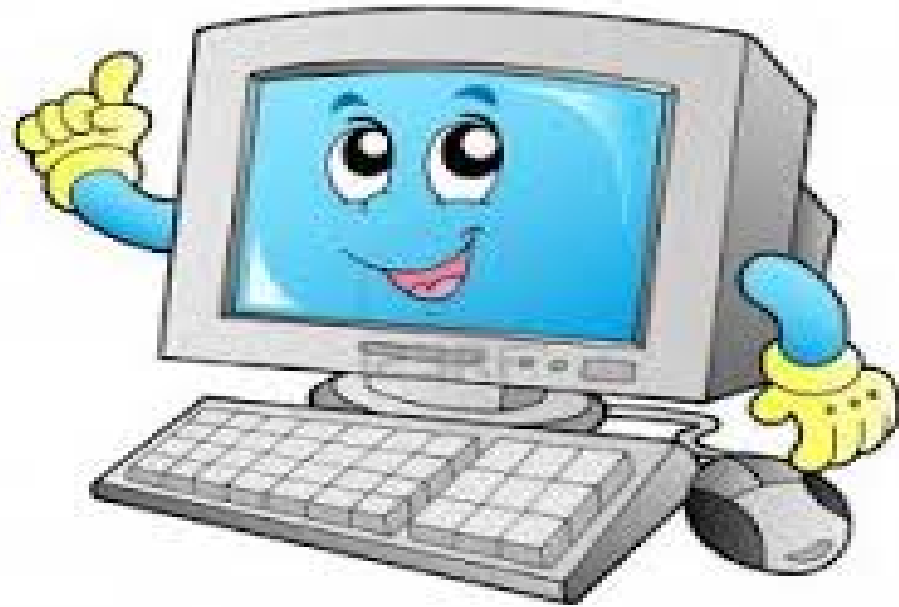
- Operating system
- Networks
- Software design
- Security

Theory

- Algorithms
- Complexity

Applications

- Data mining
- Machine learning
- Computational science
- Game design



Writing OS code

What does an OS do?

Talk to devices

Controls programs

Manages data access

Manages resource access

Manages network communication

Linux kernel written in C

You can create your own OS by adding kernel modules to pre-existing base OS

Try it on a PC you don't mind wrecking!



Flavor of OS programming

Sample Linux device driver code

- Could compile with kernel code

- Safer to work with kernel modules

Basic operations

- Device declaration

- Device usage



Device declaration

In Linux, devices ID'ed with a *major* device number and, optionally, a *minor* device number

Basic hardware I/O operation: content in device buffer (file) is copied to kernel module-directed system buffer (file)

I/O device files can be block or character

Use the function `register_chrdev` to register a new device

Requires device number, name and a `file_operations` data structure as parameters



File operations

```
struct file_operations {
    struct module *owner;
    loff_t (*llseek) (struct file *, loff_t, int);
    ssize_t (*read) (struct file *, char *, size_t, loff_t *);
    ssize_t (*write) (struct file *, const char *, size_t, loff_t *);
    int (*readdir) (struct file *, void *, filldir_t);
    unsigned int (*poll) (struct file *, struct poll_table_struct *);
    int (*ioctl) (struct inode *, struct file *, unsigned int, unsigned long);
    int (*mmap) (struct file *, struct vm_area_struct *);
    int (*open) (struct inode *, struct file *);
    int (*flush) (struct file *);
    int (*release) (struct inode *, struct file *);
    int (*fsync) (struct file *, struct dentry *, int datasync);
    int (*fasync) (int, struct file *, int);
    int (*lock) (struct file *, int, struct file_lock *);
    ssize_t (*readv) (struct file *, const struct iovec *, unsigned long,
        loff_t *);
    ssize_t (*writev) (struct file *, const struct iovec *, unsigned long,
        loff_t *);
};
```



Device usage

Use a function that copies entries into the device buffer to the kernel

```
long copy_to_user( void __user *to, const void * from,  
unsigned long n );
```

You get a working driver!



Network communication

We just saw device to system communication

Network to system communication?

- Network identity is dynamic

- Channel capacity is dynamic

But essential idea remains the same

- Declare identity of network source

- Copy contents from source to local buffer



Security

Reading from and writing to unknown parties is risky

Particularly when information is financial

Have to secure access

This is a job for cryptography

Basic idea is to encrypt message such that only entities that should be receiving the information can decrypt



System design

Designing systems that can communicate internally and externally

Securely

Efficiently

Scalably

In general: you want to know C (Unix), C++ (Windows)



Web service design

Can get started with AWS free

Have to choose basic tech stack

- Python

- Java

- JavaScript

Have to design for two types of database access

- Structured (RDBMS)

- Real-time (MongoDB)

Front-end

- C++, C# etc.

- JS

- PhoneGap (HTML)

In general: you want to know JavaScript (personal opinion)



Theory

Algorithm design tries to address issues of efficiency and scale

We've seen some examples, such as in merge-sort and quick-sort

Vast area, with massive multiplier influence

If you like discrete math, you may like computational theory

CS201,202,203 offer math background for this



Data analysis

abhinav_garg | esc101 S... x Home x Cricinfo_ETL x trains_analysis x This Year's / 12003 - Trai... x

https://www.runningstatus.in/history/12003/thisyear

12003 13th of November 2017 (To) Get Running Status

Home / (12003) History

45/311 Right Time

262/311 Late

4/311 Before

77 Avg. Late Mins.

10 records per page Search:

Started On	Status	Delay	Reach Time
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01st, Aug, 2017 at 03:35 PM	Late	15 Mins	10:30 PM on 01st, Aug
01st, Feb, 2017 at 06:45 PM	Late	03 Hrs 55 Mins	02:10 AM on 02nd, Feb
01st, Jan, 2017 at 12:55 AM	Late	16 Hrs 21 Mins	02:36 PM on 02nd, Jan
01st, Jul, 2017 at 03:35 PM	Late	15 Mins	10:30 PM on 02nd, Jul
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01st, Sep, 2017 at 04:10 PM	Late	01 Hr 19 Mins	11:34 PM on 01st, Sep

Showing 1 to 10 of 311 entries

(12003) Status History Pie chart for 311 Runs

On Time: 14% Before Time: 1%

Windows Taskbar: 11:13 AM 11/13/2017



Working with data

When we know what we're looking for

- Data analysis

- Targeted, high quality data

- Domain knowledge matters

When we don't know what we're looking for

- Data mining

- Exploratory, data quality unknown

- Algorithmic prowess and skill matters



Machine learning

Subset of data mining

Basic idea is to

Get algorithms to find things that look like other things we show them

Get algorithms to categorize things automatically

Lots of very well-developed code libraries pre-exist

Weka

Matlab ML toolbox

Scikit-learn library in python

You want to know python



Computational science

- Mathematical analysis breaks down as soon as the number of elements you're studying grows
- Physicists, chemists, biologists, and neuroscientists are all are trying to build realistic simulations of scientific phenomena to study them counterfactually
- Designers, social scientists, artists are doing the same for their creations
- “What I can't create, I don't understand” - Feynman



Possibilities are wide open

Have fun writing code the rest of your time here

Don't hesitate to talk to any of the CSE faculty

It would help if you know what you want to talk about

Be bold in coming up with ideas

Worst case scenario: it won't work

Your next idea will be a better one, guaranteed

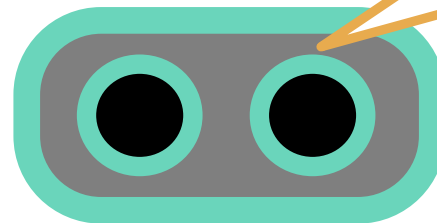


ESC101 is just a beginning...

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Have fun computing and thinking programmatically..



Mr. C signing off..
Thanks!

