EECE 200 – Introduction to Electrical and Computer Engineering

Computer Software

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Outline

A. Motivation

B. Software and Languages

C. Become an expert
   - Algorithms and Data Structures
   - Operating systems
   - Database Management Systems
   - Software Engineering
   - Testing and verification
   - Complexity

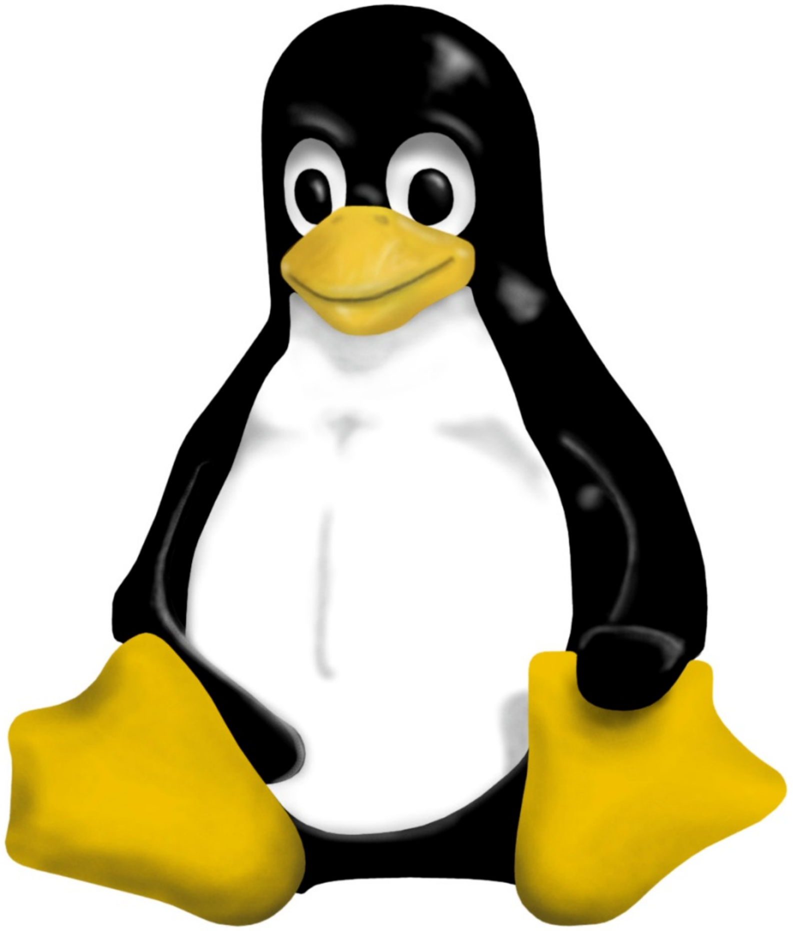
Examples of software systems

Search engines and web portals.

Examples of software systems

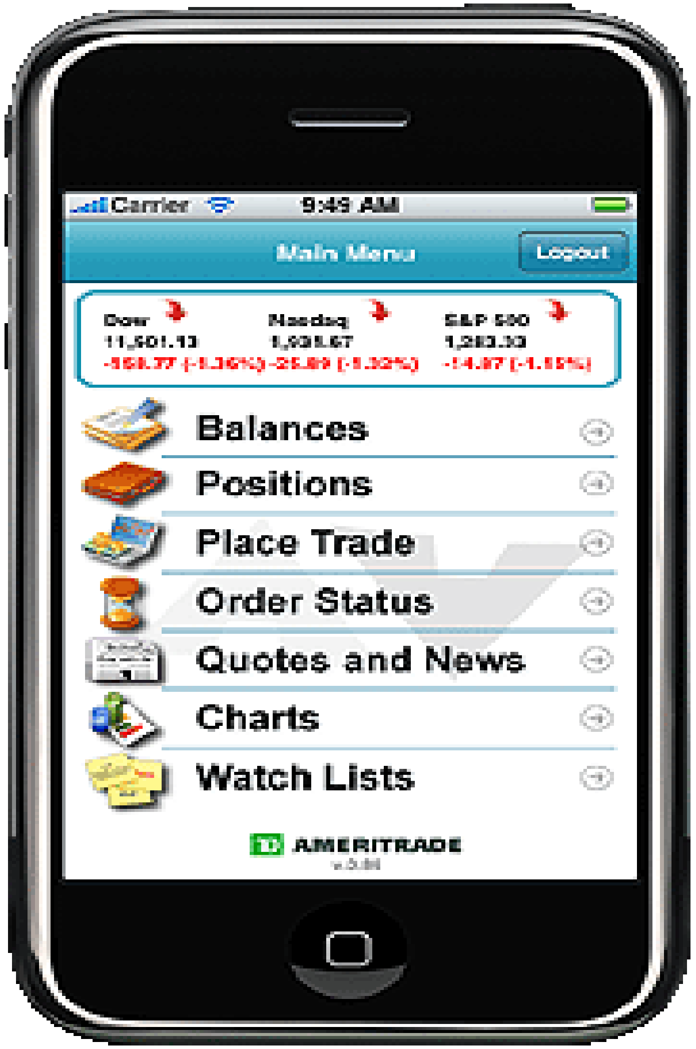
Social network: facebook.

Examples of software systems



An operating system:
Linux rules!

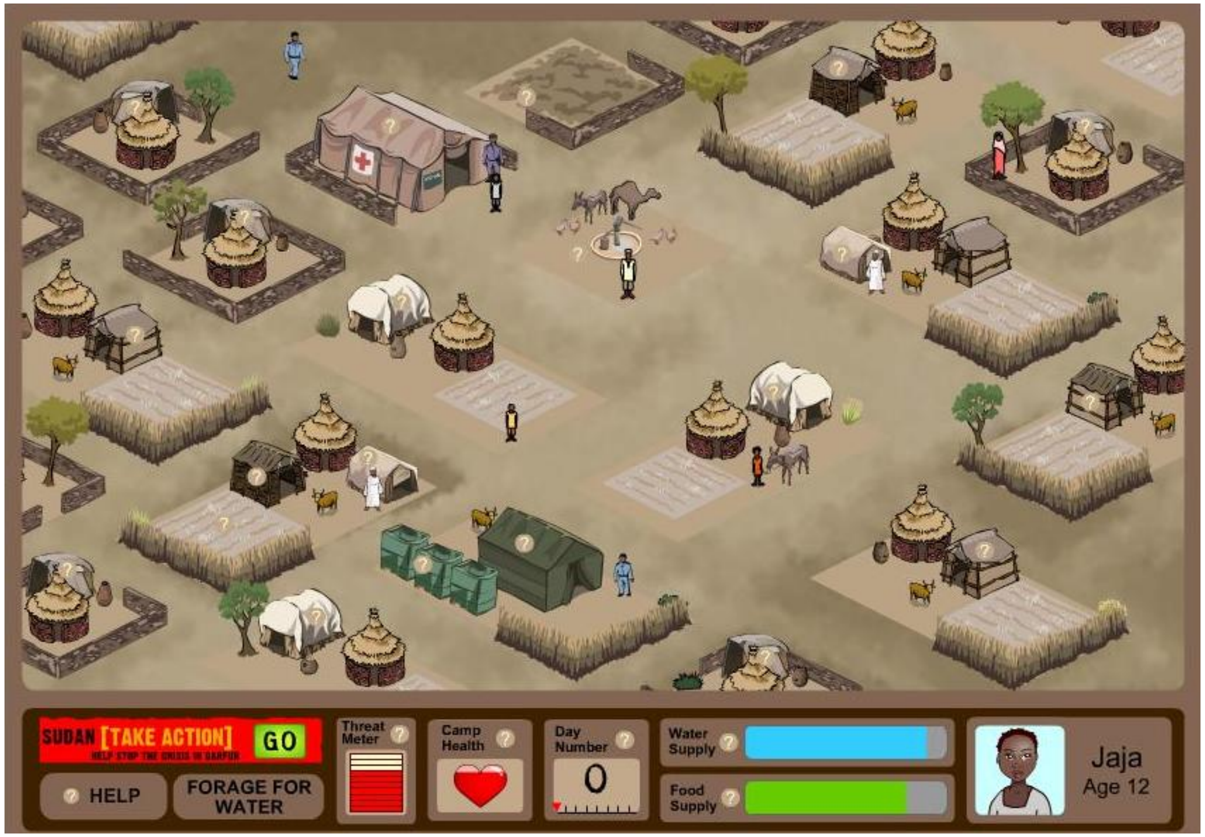
Examples of software systems



Trading application on iPhone:
mobile computation

You can make a fortune!

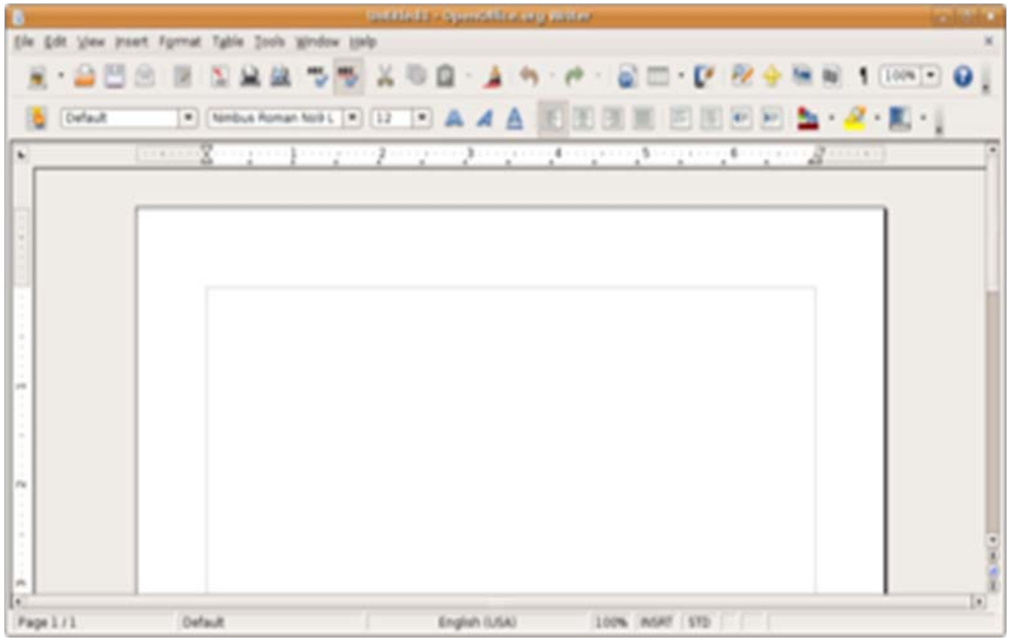
Examples of software systems



Computer games

Interesting!

Examples of software systems


Untitled1 - OpenOffice.org Writer
File Edit View Insert Format Table Tools Window Help
Default
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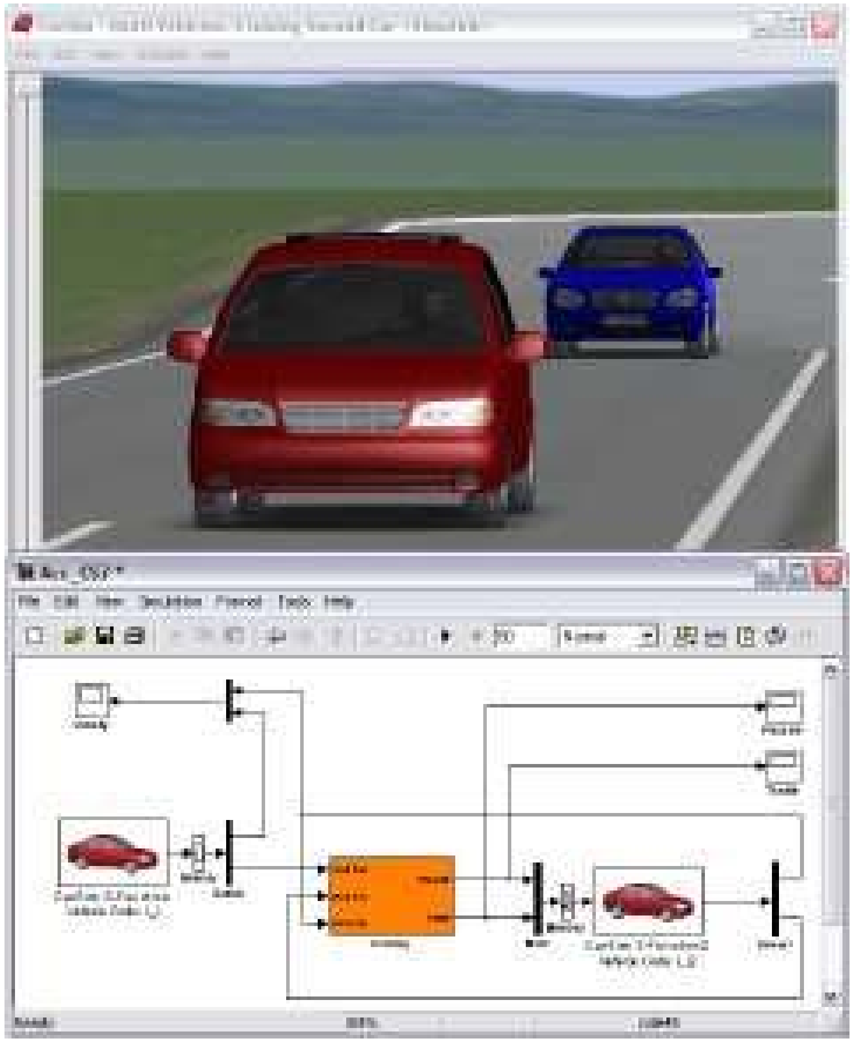
Default
English (USA)
100%
INSRT
STD

Office and productivity tools.

Examples of software systems

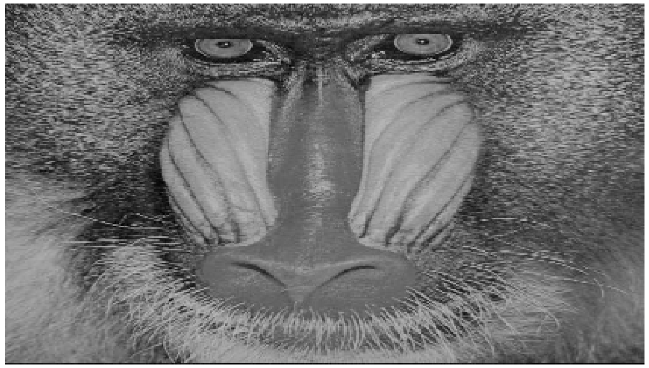


Simulators and computer aided design

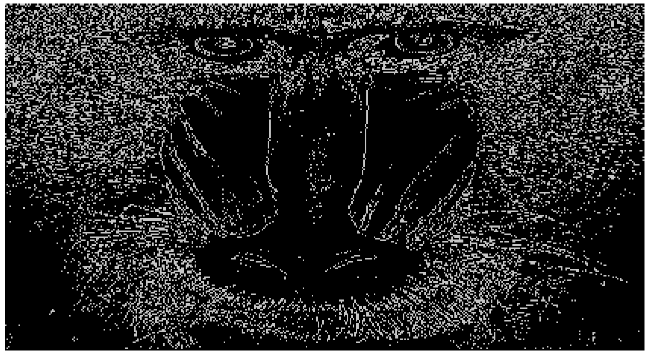
labview, autocad, simulink, spice

Software for Image Processing

BABOON IMAGE



Input Image



Detected edges

What is Software and what is not

- Each processor provides an instruction set
- A software program is a sequence of instructions that control the processor
  - The program handles data stored in memory or on disk

- Data stored in digital form is also considered software
  - Movies, spreadsheets, documents, autocad sketches
- Even a file containing hardware configuration is considered software

Where does the program come from?

- Software developers write software programs with high-level programming languages
  - A programming language is a language with a clear and non-ambiguous meaning
  - C/C++, Java, Basic, FORTRAN, COBOL, Pascal, C#, and SQL
- It follows that the low level language is the machine language (that is the instruction set)

Where does the program come from?

- A compiler transforms the high level code into a sequence of instructions
- The compiler is a software program by itself

An integrated development environment (IDE)

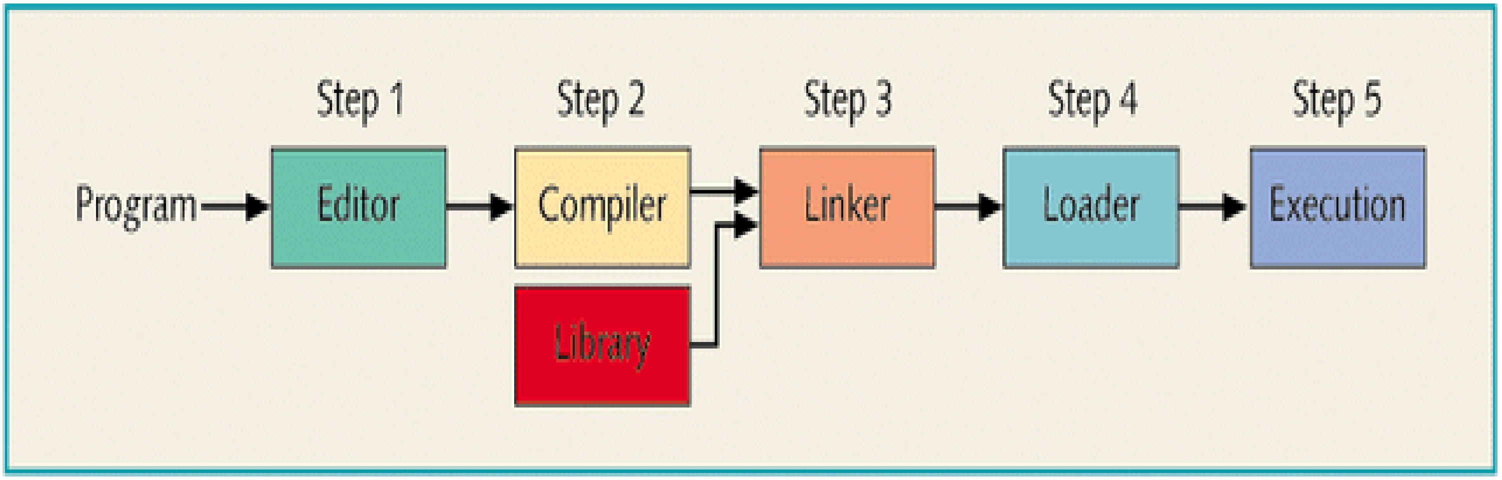


Figure 1-3 Processing a high-level language program

- A development environment comes with at least a library of services and a compiler
  - An full blown GUI integrated environment is often referred to as an IDE
- Each contemporary computational system comes with an IDE and an SDK

Categories of software

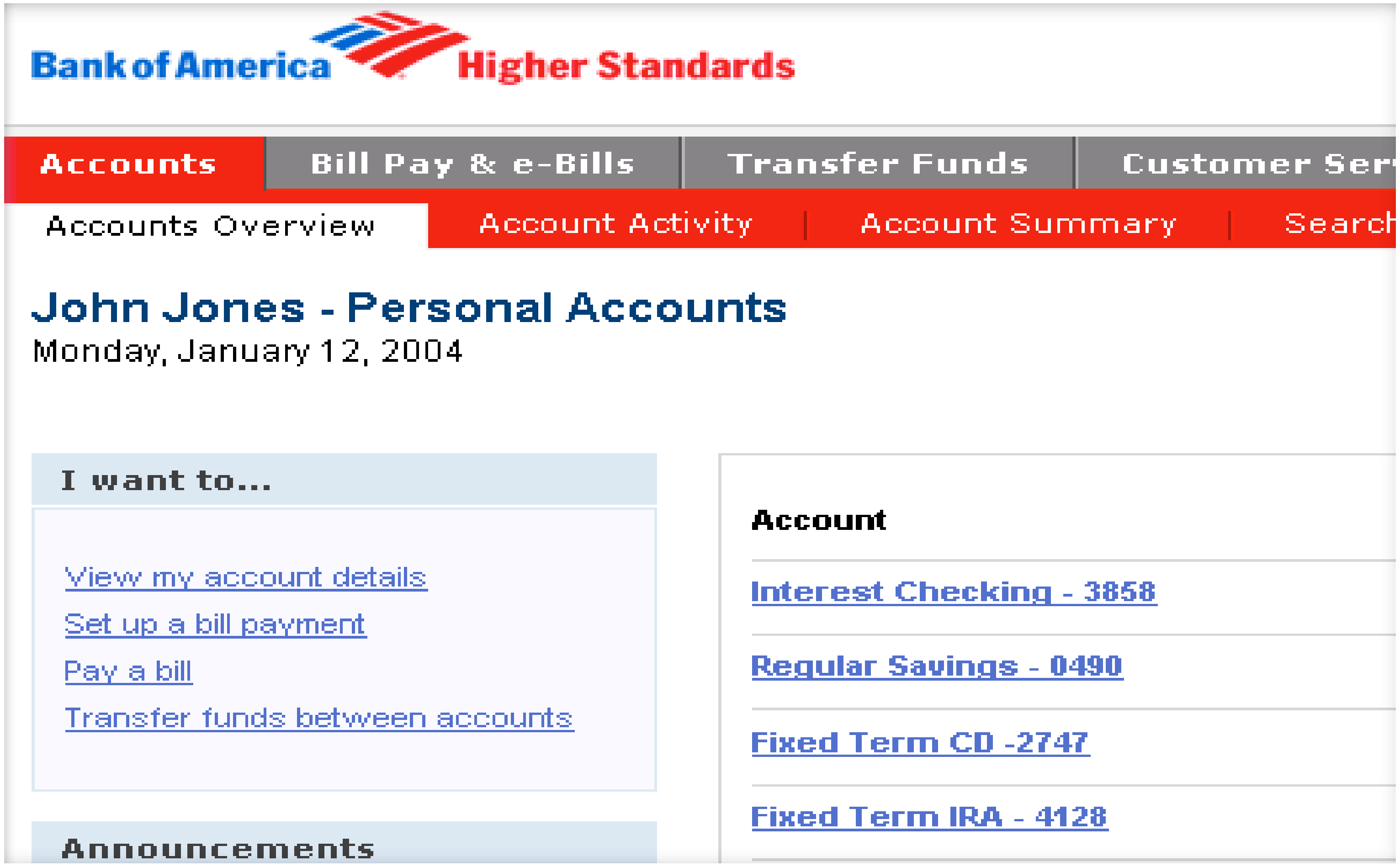
- Applications
  - User level software such as a web browser
- Middleware
  - Libraries and services that link software components together
- Firmware
  - Fixed and small code that controls electronic devices
- Kernel or operating system software
  - System code that makes up the operating system
- Data
  - Movie files, hardware configuration, code, databases, text files, pictures, etc…

Sample C++ program

```
#include <iostream>
using namespace std;

int
main(int argc, char* argv[]) {
  cout << "Hello ECE 200 Students! ; )" << endl;
  return 0;
}
```

Example Software application



John Jones - Personal Accounts
Monday, January 12, 2004

I want to...

View my account details
Set up a bill payment
Pay a bill
Transfer funds between accounts

Announcements

Account

Interest Checking - 3858
Regular Savings - 0490
Fixed Term CD -2747
Fixed Term IRA - 4128

How you become an expert software engineer

- Study and learn
  - Programming Languages (e.g. C++, Java) -- EECE 230
  - Data Structures – EECE 330
  - Operating Systems – EECE 432
  - Algorithms – EECE 431
  - Software Engineering – EECE 430
  - Databases – EECE 433
  - Programming practices – EECE 636
  - Testing – EECE 635
  - Verification – EECE 637
  - Compilers – EECE 434
  - Data Mining – EECE 635
  - Complexity theory – EECE 631

Algorithms

- Al-Khawarizmi documented the first algorithm in the 9th century
  - Using the decimal notation to express numbers
  - Fibonacci was instrumental in spreading the word
- Al algorithm is a procedure that solves a problem
  - Within a set of constraints on resources
    - such as time and memory,
- More complex problems
  - More efficient algorithms

Efficient Algorithms

- An efficient algorithm is based on:
  - Efficient data representation associated with a set of operations
    - Add numbers in Roman notation versus in decimal notation
- Measured in terms of memory and time needed to solve the problem

Data Structures

- Textual data does not have structure
  - “My name is Samir. I am from Lebanon. I was born in 1963.”
- Structured data is an abstraction that makes data access easier
  - Declaration {string: **name**, string: **origin**, integer: **dob**}
  - Instantiation: {“Samir”, **“**Lebanon”, 1963}

Fundamental Data Structures

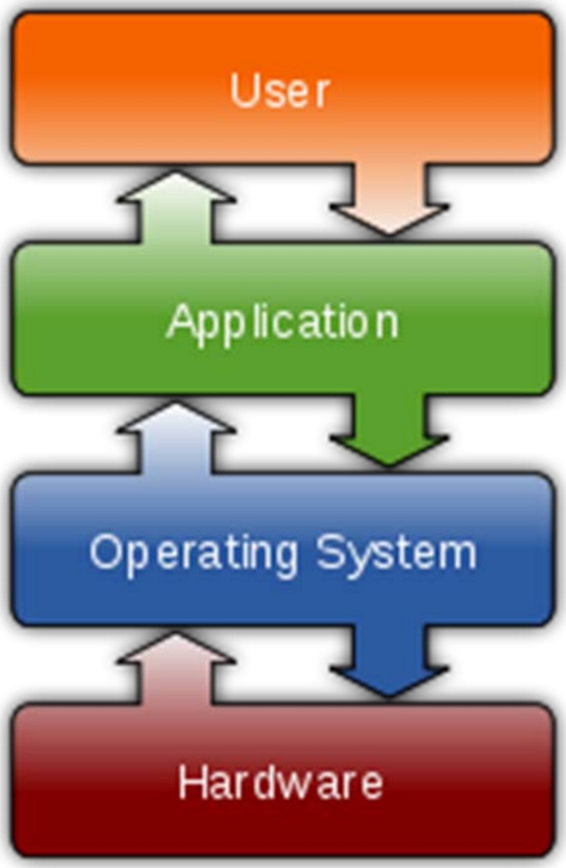
- These for software are what beams and columns are for civil engineering
- Examples:
  - Lists
  - Stacks
  - Queues
  - Binary Trees
  - Hash Tables…

Operating Systems

- Provide logical abstractions over the physical machine
  - A file is an abstraction of a block on disk
  - A process is an abstraction of an active sequence of instructions
  - Memory is an abstraction of infinite storage
- Manage computer Resources
  - Processors, Memory, External Storage, Input/Output Devices…

Operating Systems

- By the power of abstraction, an illusion of
  - infinite memory
  - infinite storage
  - infinite computation power
- Efficient use of resources
  - good understanding of underlying OS techniques



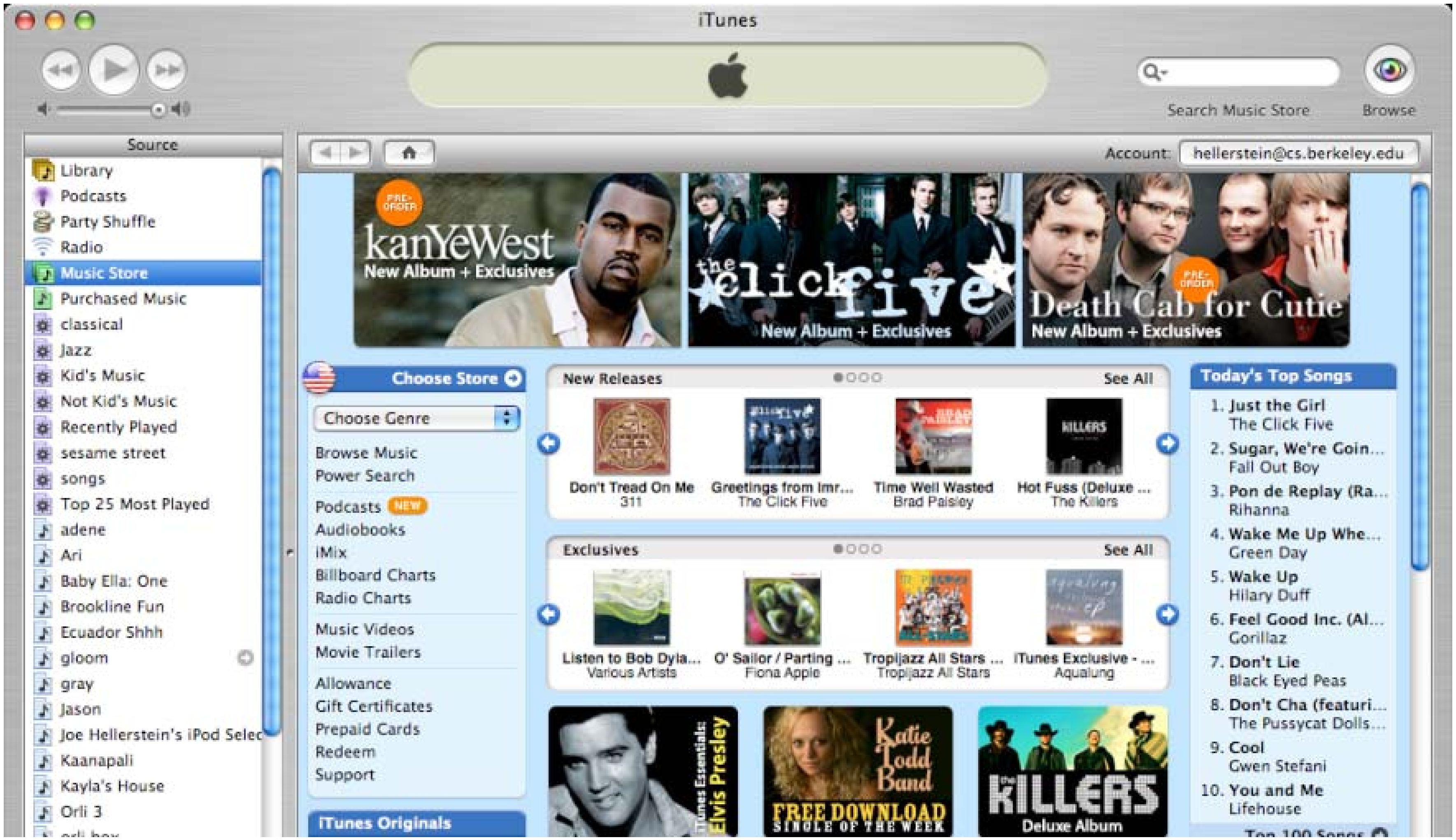
Examples of Operating Systems

- Linux
  - – Free, open source, robust and efficient
- Apple
  - – GUI oriented, elegant
- Windows
  - – Dominant personal computer OS
- Application specific
  - – Digital camera OS
  - – Cell phone OS

What is a DataBase

- Large, integrated collection of data.
  - Entities (e.g., students, courses)
  - Relationships (e.g., Raghib Alami is taking ECE200)
- *Database Management System (DBMS)*
  - software designed to store and manage databases
- Applications:
  - Student Information Systems, Banking, Manufacturing, production, inventory, orders, Human resources, Salaries , employees

Today's Databases


iTunes
Search Music Store
Browse
Source
Library
Podcasts
Party Shuffle
Radio
Music Store
Purchased Music
classical
Jazz
Kid's Music
Not Kid's Music
Recently Played
sesame street
songs
Top 25 Most Played
adene
Ari
Baby Ella: One
Brookline Fun
Ecuador Shhh
gloom
gray
Jason
Joe Hellerstein's iPod Selec
Kaanapali
Kayla's House
Orli 3
Account: hellerstein@cs.berkeley.edu
kanYeWest New Album + Exclusives
the click five New Album + Exclusives
Death Cab for Cutie New Album + Exclusives
Choose Store
Choose Genre
Browse Music
Power Search
Podcasts NEW
Audiobooks
iMix
Billboard Charts
Radio Charts
Music Videos
Movie Trailers
Allowance
Gift Certificates
Prepaid Cards
Redeem
Support
iTunes Originals
New Releases
See All
Don't Tread On Me 311
Greetings from Imr... The Click Five
Time Well Wasted Brad Paisley
Hot Fuss (Deluxe ... The Killers
Exclusives
See All
Listen to Bob Dyla... Various Artists
O' Sailor / Parting ... Fiona Apple
Tropijazz All Stars ... Tropijazz All Stars
iTunes Exclusive - ... Aqualung
Today's Top Songs
1. Just the Girl The Click Five
2. Sugar, We're Goin... Fall Out Boy
3. Pon de Replay (Ra... Rihanna
4. Wake Me Up Whe... Green Day
5. Wake Up Hilary Duff
6. Feel Good Inc. (Al... Gorillaz
7. Don't Lie Black Eyed Peas
8. Don't Cha (featuri... The Pussycat Dolls...
9. Cool Gwen Stefani
10. You and Me Lifehouse
iTunes Essentials: Elvis Presley
Katie Todd Band FREE DOWNLOAD SINGLE OF THE WEEK
the KILLERS Deluxe Album

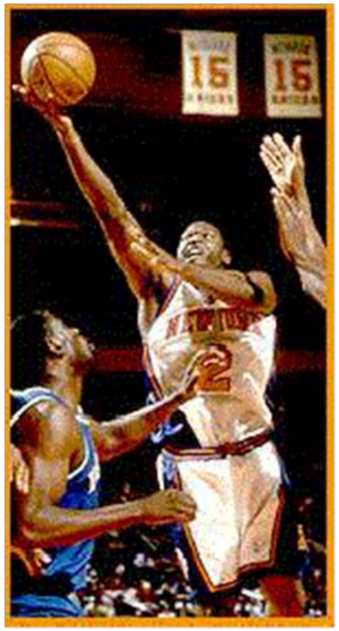
Example: Friendship Database

- Entities
  - Persons, Locations, Professions
- Relations
  - Friends
  - Colleagues
  - Neighbors
- Result
  - Social networks: Facebook, LinkedIn

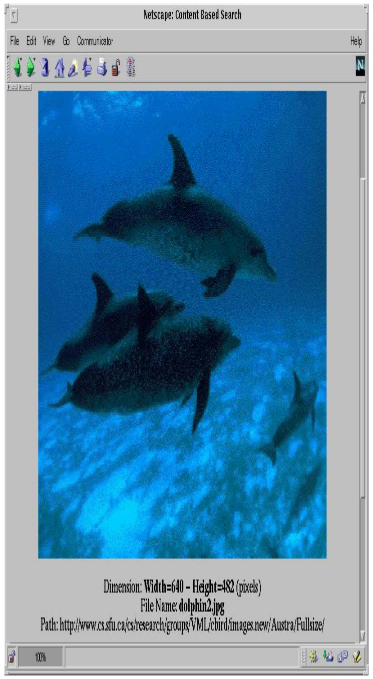
Advantages of Database Systems

- Atomicity of updates
  - Failures may leave database in an inconsistent state with partial updates carried out
  - Example: Transfer of funds from one account to another should either complete or not happen at all
- Concurrent access by multiple users
  - Uncontrolled concurrent accesses can lead to inconsistencies
    - Example: Two people reading a balance and updating it at the same time
- Security problems
  - Hard to provide user access to some, but not all, data

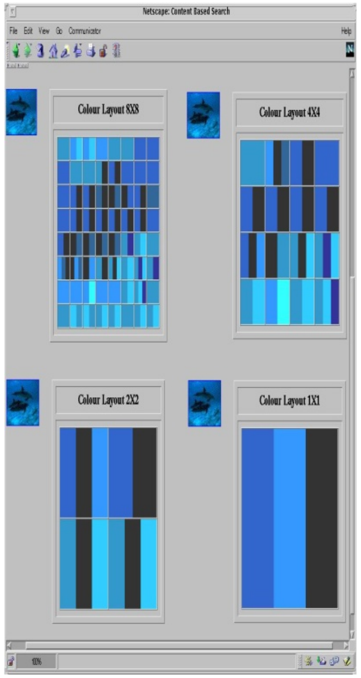
Data Mining



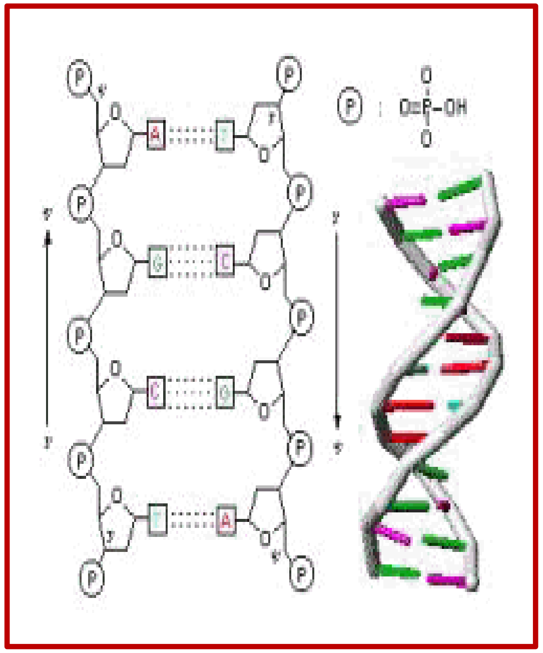
Best combination of players?


Netscape: Content Based Search
File Edit View Go Communicator
Help

Dimension: Width=640 - Height=482 (pixels)
File Name: dolphin2.jpg
Path: http://www.cs.sfu.ca/cs/research/groups/VML/cbird/images.new/Austra/Fullsize/



Multimedia mining



genetic contributions to disease and drug response

Software costs

- Software costs often dominate computer system costs
  - greater than the hardware cost.
- Roughly 60% of costs are development costs, 40% are testing costs.
  - For custom software, evolution costs often exceed development costs.

Software Engineering

- Software maintenance costs more than software development
  - For systems with a long life, maintenance costs may be several times development costs.
- Software engineering is concerned with cost-effective software development
  - theories, methods and tools for professional software development.

Software Engineering

- Systematic and organised approach
- Appropriate tools and techniques
  - depending on the problem to be solved
  - the development constraints
  - the resources available.

Software Verification and Testing

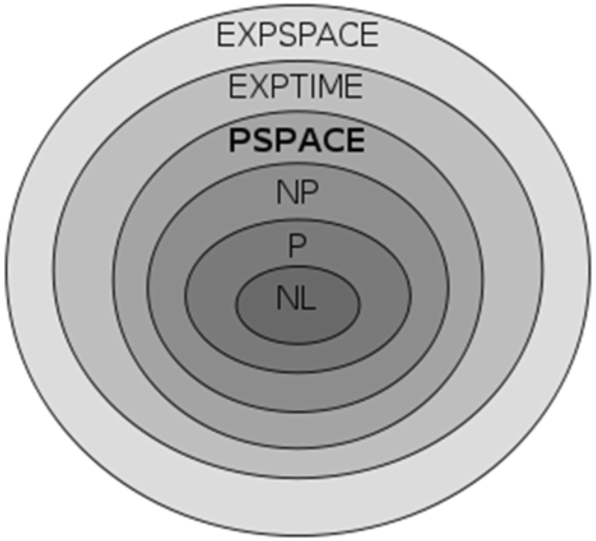
- Software deals with infinite resources
  - Impossible to be fully tested
- Software deals with flexible and abstract concepts
  - High complexity
- Almost always software systems have logical flaws
  - AKA bugs

Software Verification and Testing

- Techniques to detect bugs
  - Dynamic verification: testing
  - Static verification: proof and model checking
- Techniques to solve bugs
  - Debugging
- NIST report 2006
  - More than 64 billion dollars

Computational Complexity

- Can a problem be solved with automated reasoning?
  - At what cost in time
  - At what cost in space (memory)



- Very important to know
  - Do not waste your life trying to solve a problem that is known to be unsolvable

Questions?