COMPSCI 1JC3

Introduction to Computational Thinking

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07 The Internet

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Admin

- Assignment 1 will be posted this week.
- Midterm 1 marks and solutions will be posted this week.
- Assignment 3 has been posted on Avenue.
- Office hours: To see me please send me a note with times.
- Are there any questions?

Two-Stage Midterm Format (iClicker)

What did you think of the two-stage midterm format?

A. It was great; I hope all my midterms are two stage.
B. It was OK; I see benefit in having this format.
C. I am undecided about whether this format is useful.
D. I would prefer not to have any more two-stage tests.

Advice

Learn from your fellow students!

- Get advice and studying tips from those who are doing well in the course.
- Get other students to review your code.
- Form study groups (meet in ETB 126 10:30–14:30 weekdays.)

Review

1. Graphic user interfaces and event handling.
2. Command line interfaces, shells, and shell scripts.
3. Files and file trees.

Physical Networks

- A physical network is a set of computers that exchange digital information with each other via a physical medium.
  - The computers are connected to a physical network via a network interface.
- There are a wide variety of physical networks based on different technologies and communication protocols.
  - Wired vs. wireless.
  - Connection-oriented vs. connectionless.
  - Local area networks vs. wide area networks.
  - Bus, ring, star, and point-to-point topologies.
- Examples of physical network technologies: Ethernet, WiFi (wireless LAN), Asynchronous transfer Mode (ATM), Fiber Distributed Data Interface (FDDI).

Internets

- Problem: How can communication be performed across different computer networks, possibly based on different network technologies.
- Solution: Universal virtual network built on top of the physical networks.
- An internet is a virtual network based on:
  1. The internet architecture.
  2. The TCP/IP Internet Protocol Suite.
- The global Internet is an internet that serves as a universal virtual network.

Internet Architecture

- The internet architecture consists of:
  - A set of physical networks.
  - Routers that connect the networks to each other.
- An internet has the structure of a bipartite graph:
  - Two kinds of nodes:
    1. Hosts (including routers).
    2. Physical networks.
  - Edges: network interfaces.

Structure of the Internet

- The Internet is a two-layered system:
  - Heterogeneous collection of underlying physical networks.
  - Homogeneous virtual network implemented using TCP/IP protocol software on top of the physical networks.
- Corresponding to the two layers of the Internet are two layers of addresses:
  - Physical addresses are assigned according to schemes which vary from one network technology to another.
  - IP addresses are assigned according to a scheme that is uniform across the Internet.

TCP/IP

- The TCP/IP Internet Protocol Suite consists of a set of communication protocols for communicating across interconnected physical networks.
- TCP/IP enables communication across any set of interconnected networks.
  - Hardware independent.
  - Universal connection.
  - Communication is end-to-end oriented, rather than router-to-router oriented.

Internet Services

- The purpose of an internet is to provide useful services to users on the component networks.
- Each service is specified by a communication protocol.
- Network-level internet services:
  - Connectionless packet delivery (via IP).
  - Reliable stream transport (via TCP).
- Application-level internet services:
  - Electronic mail (e.g., via SMTP).
  - File transfer (e.g., via SSH).
  - Remote login (e.g., via SSH).
  - Web (e.g., via HTTP).

History: ARPA

- The U.S. Department of Defense's Advanced Research Projects Agency (ARPA) started funding research in internet technology in the 1970s.
  - Lead to the creation of the ARPANET.
  - ARPA was later called DARPA (Defense Advanced Research Projects Agency).
- The global, TCP/IP-based Internet started about 1980 with the ARPANET as the backbone.
  - Used mainly to support U.S. military communication and university research.

The TCP/IP Internet Layering Model

- Hardware Layer.
  - Transmits communication signals over a physical network.
- Network Interface Layer.
  - Transmits packets called frames using physical addresses.
- Internet Layer.
  - Transmits packets called IP datagrams using IP addresses.
  - Main protocol: IP.
- Transport Layer.
  - Transmits packets called TCP segments using protocol ports.
  - Main protocol: TCP.
- Application Layer.

IP Addresses

- There are two Internet naming systems:
  1. The primary system is the internet address system which uses binary IP addresses.
  2. The secondary system is the domain name system (DNS) which uses natural language DNS names.
- IP addresses are 32-bit integers.
  - Composed of four 8-bit octets.
  - Represented as four integers, usually in base 2 or base 10, separated by dots.

    base 2: 11000111.00010001.00101000.11010010.
    base 10: 199.17.40.210.
- Each network interface on the Internet is normally assigned a unique IP address.

Internet Protocol (IP)

- Provides a connectionless packet delivery service between internet hosts.
  - Connectionless: packets bounce across a sea of computers.
  - Best-effort delivery: service is designed to deliver every packet.
  - Unreliable: packet delivery is not guaranteed.
- IP defines a mechanism consisting of:
  - A basic unit of data transfer called an IP datagram.
  - Software for routing datagrams using IP addresses.
  - Rules for how hosts (and routers) should process datagrams.

Transmission Control Protocol (TCP)

- Provides a reliable stream delivery service.
- Divides a stream of bits into a stream of packets called TCP segments.
- Establishes a virtual circuit connection called a TCP connection between host-port endpoints.
  - Enables a client process to initiate communication with a server process.
- Reliability is obtained by an acknowledgment and retransmission system.
  - Can handle lost, out-of-order, and duplicated data.