

# Computer Networks

## Assignment 1

Group 55 - Hien Le - 2594428 - hien.le@student.auc.nl

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### Assignment

In computer networking, routers are responsible for forwarding data packets between computer networks. A router is connected, usually via cables, to at least two different networks. When it receives a new packet from one of the networks, it reads the packet's destination address (usually an IP address) and attempts to forward it to the appropriate network, so that it will (eventually, hopefully) reach its destination.

To successfully forward a data packet towards its destination, the router needs to know which destinations can be reached through the different networks to which it is connected. This information is stored in a routing table.

A router uses its routing table to decide where to forward incoming packets. A typical routing table may contain the following columns:

- Network destination: The range of destination IPs that can be reached on this network.
- Subnet mask: This separates the destination IP into its network address and host address components.
- Gateway: The IP address of the next router to which to send the packet.

When the router receives a packet, it checks which network destination(s) correspond(s) to the packet's destination address. (If there are multiple network destinations possible, the one with the highest-bit-number subnet mask is preferred.) It then forwards the packet to the appropriate gateway.

## 1. Exploration

1. Across Linux, macOS, and Windows, these commands will print not one but two different routing tables. What is the difference between these two tables?

After typing the command `netstat -nr` in my Linux terminal, I get the following results:

| Destination | Gateway  | Genmask       | Flags | MSS Window | irtt | Iface  |
|-------------|----------|---------------|-------|------------|------|--------|
| 0.0.0.0     | 10.0.0.1 | 0.0.0.0       | UG    | 0 0        | 0    | wlp2s0 |
| 10.0.0.0    | 0.0.0.0  | 255.255.255.0 | U     | 0 0        | 0    | wlp2s0 |

Looking at this table, I see two rows, corresponding to two routes. As my computer is connected to the Internet, one of these two routes is the default route, and the other one represents the Internet interface. Specifically, the default destination 0.0.0.0 with gateway 10.0.0.1 defines the packet forwarding rule when no route can be determined for a given IP destination address, this gateway is the default IP address for my network router. Meanwhile, the destination 10.0.0.0 with gateway 0.0.0.0, this gateway generally means "unspecified", or there is no gateway. So any packets sent to this destination don't need to be routed and can be sent directly on the local network.

2. What column headers correspond to the ones mentioned in the introduction (network destination, subnet mask, and gateway)? Hint: on macOS, two of these may be combined.

**Destination** corresponds to **Network destination**, **Gateway** corresponds to **Gateway**, and **Genmask** corresponds to **Subnet mask**.

3. A typical destination might be expressed in two ways: as a network destination of 145.94.162.184 with subnet mask 255.255.255.255, or as those two combined as 145.94.162.184/32. How do you convert between these two formats?

The `\32` part signifies that 32 bits are used by network (i.e. network portion) and is also the length of the prefix. 145.94.162.184 is the network prefix, this could be obtained by ANDing the subnet mask with the IP address.

```
1001001.01011110.10100001.10111000 AND
11111111.11111111.11111111.11111111
= 1001001.01011110.10100001.10111000
```

## 2. Implementation

See .py files.