

Exercises

1. An Internet Protocol (IP) address is a unique 32 bit integer that identifies a host on a computer network. IPv4 is one version of IP addresses that is typically written out as a group of 4 integers separated by dots.

e.g: 192.168.0.1

Each integer above is called an 'octet' (meaning 8 bits wide) and ranges from 0-255. The unique 32 bit integer representation for this IPv4 address can be computed by converting all octets to binary, concatenating the binary bits from left to right and interpreting the resulting 32 bit string as a binary integer.

Examples:

- (a) Convert each octet in 192.168.0.1 to binary

```
192 = 11000000
168 = 10101000
0   = 00000000
1   = 00000001
```

- (b) Concatenate bits from left to right

```
11000000101010000000000000000001
```

- (c) Print out 32 bit unsigned integer representation

```
3232235521
```

Question: Write a program called 'ip2int' that takes in an IPv4 address and returns it's equivalent unique 32 bit integer.

2. Endianess refers to the order in which your computer stores the bytes for an integer. In little endian, the bytes are arranged from least significant byte (LSB) to most significant byte (MSB). Whereas, in big endian the bytes are arranged from MSB to LSB.

In little endian, the 16 bit integer '1' is represented as:

Address:	0	1
Byte:	00000001	00000000

However in big endian, it is

Address:	0	1
Byte:	00000000	00000001

Question: More precisely, in little endian the lowest memory address contains the _____, whereas in big endian the lowest memory address contains the _____.

- (a) MSB, LSB
- (b) LSB, MSB
- (c) MSB, MSB
- (d) LSB, LSB

Most computers today are little endian. You can verify this with the following program

```
bool is_little_endian() {

    int x = 1;

    return *((char*)&x) == 1;
}
```

Question: Explain, in plain English, how this program works.

Question: Write a function called ‘littleorbig’ that takes in a 32 bit integer and reverses it’s byte order. Effectively converting little-endian to big-endian and vica versa.

Big endian is also known as ‘network byte order’. It is a standard that when integers need to be sent over a network, they are transmitted with the MSB first.

Please do not confuse endianness with the order of bits in a byte. The order of bits in a byte will always be the same. The 0th bit (rightmost) is always the least significant bit.

3. An XOR cipher is an encryption algorithm that uses the XOR operation \oplus . The XOR operation is short for ”exclusive-or”, meaning ”either but not both”.

The truth table for XOR,

A	B	$A \oplus B$
1	0	1
0	1	1
0	0	0
1	1	0

Notice that \oplus has the following properties,

- (a) Nilpotency: $A \oplus A = 0$
- (b) Commutativity: $A \oplus B = B \oplus A$

Question: Given a key K and message M , the ciphertext is $K \oplus M$. Write a program called ‘strxor’ that computes $K \oplus M$. If the length of K is less than the length of M , concatenate K with itself until it either matches or exceeds the length of M .

4.