**Chapter 9: Number Systems**

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## 9.1 The Decimal System

In everyday life, we use a system based on decimal digits. The decimal system is said to have a based, or radix, of , meaning each digit is the number multiplies by raised to a power corresponding to the digits position.

The same method applies for decimal fractions, but negative powers of are used.

In any number system, the leftmost digit is called the most significant digit since it has the highest value and the rightmost digit is called the least significant digit since it has the least value.

## 9.2 Positional Number Systems

In a positional number system, each number is represented by a string of digits in which each digit position has an associated weight , where is the base of the number system. For decimal values, the dot between and is called the radix point. The decimal system is just a special case of the positional number system.

## 9.3 The Binary System

The numbers in the binary system only have the digits and , and thus are represented to base . The digits and in binary notation have the same meaning as in decimal notation. For larger numbers, the values differ.

## 9.4 Converting Between Binary and Decimal

Converting from binary to decimal is fairly simple. An example is given in the last section.

When converting from decimal to binary, we need to handle the integer and fractional parts separately.

For the integer part, we divide the number by to get a quotient and a remainder. If the remainder is , the value for this position in the binary system is . If the remainder is , the value for this position in the binary system is . Then, we divide the quotient by and keep repeating the process until we have a quotient of .

If we get remainders, the complete binary number is .

For the fractional part, we must multiply the fractional part by . If the result we get is greater than or equal to , the value for this position in the fractional part of the binary number is . Else, it is . Then, we take the fractional part of the result of the previous multiplication and repeat the process. This continues until we reach a point where the fractional part is .

Binary form of decimal part:

Binary form of fractional part:

## 9.5 Hexadecimal Notation

Converting between base and base is cumbersome, so hexadecimal notation is used more often. Binary digits are grouped into sets of four bits, called a nibble.

Consider the binary string .

|  |  |  |
| --- | --- | --- |
| Decimal (Base ) | Binary (Base ) | Hexadecimal (Base ) |
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