## Numbers and Logic

## Common Numbering Systems:

- Decimal
- Binary
- Hexadecimal


## Bits, Bytes, and Nibbles

- Are you hungry yet!
- Bit
- Byte
- Nybble (or Nibble)


## Bit as a Representation of state

$0=$ The switch is off
1 = The switch is on

## Numerical Representation

1 Byte $=8$ Bits
$2^{7} 2^{6} 2^{5} 2^{4} \quad 2^{3} 2^{2} 2^{1} 2^{0}$

## Numerical Representation

| Binary | Decimal |
| :--- | :--- |
| 00000000 | 0 |
| 00000001 | 1 |
| 00001000 | 8 |
| 00000011 | 3 |

00010000

$$
16
$$

$00000011$

## 10000000

## 128

$11111111$


There are 10 type of people in the world

## Those who know binary

- Those who don't


## Hexadecimal (0xHH)

- Binary is Base 2
- Hexadecimal is Base 16
- 0-9
- A-F
- $10=A$
- or 0x0A
- $15=\mathrm{F}$
- 0x0F
- $16=10\left(16^{1 *} 1\right)+0$
- 0x10
- $17=11\left(16^{1 *} 1\right)+1$
- 0x11
- $255=$ FF $\left(16^{1 *} 15\right)+15$
- 0xFF


## ASCII

- American Standard Code for Information Interchange
- Since everything in the computer is represented as numbers, we need a way to represent letters
- An ASCII Table is used to convert the characters to the numerical representation used to store the characters in memory


## ASCII Table

\begin{tabular}{|c|c|c|c|c|c|c|c|c|c|c|c|c|c|c|c|c|}
\hline \& - 0 \& _1 \& _2 \& _ 3 \& -4 \& _5 \& _6 \& -7 \& _8 \& -9 \& - \& - \({ }^{\text {8 }}\) \& - \& - \& _ \({ }^{\text {E }}\) \& - \({ }^{\text {F }}\) \\
\hline \(0{ }_{-}\) \& \begin{tabular}{l}
nil \\
вее» \\
0
\end{tabular} \& \begin{tabular}{l}
SOH \\
8901 1
\end{tabular} \& \begin{tabular}{l}
STX \\
0002 \\
2
\end{tabular} \& \begin{tabular}{l}
ETX \\
8903 \\
3
\end{tabular} \& \begin{tabular}{l}
EOT \\
8984 \\
4
\end{tabular} \& \begin{tabular}{l}
eno \\
6005 \\
5
\end{tabular} \& \begin{tabular}{l}
ACK \\
8906 \\
6
\end{tabular} \& \[
\begin{gathered}
\text { BEL } \\
\text { 8987 } \\
7
\end{gathered}
\] \& \begin{tabular}{l}
BS \\
6908 \\
8
\end{tabular} \& \[
\begin{gathered}
\mathrm{HT} \\
0089 \\
9
\end{gathered}
\] \& \begin{tabular}{l}
Lf \\
өвед 10
\end{tabular} \& \begin{tabular}{l}
VI \\
өеев 11
\end{tabular} \& \begin{tabular}{l}
ff \\
-80C \\
12
\end{tabular} \& \begin{tabular}{l}
CR \\
веео \\
13
\end{tabular} \& \begin{tabular}{l}
so \\
900E \\
14
\end{tabular} \& \begin{tabular}{l}
SI \\
080F 15
\end{tabular} \\
\hline 1 \& \begin{tabular}{l}
dLE \\
8910 16
\end{tabular} \& \begin{tabular}{l}
DC1 \\
8011 \\
17
\end{tabular} \& \[
\begin{gathered}
\mathrm{DC} 2 \\
e 912 \\
18
\end{gathered}
\] \& \begin{tabular}{l}
DC3 \\
0013 \\
19
\end{tabular} \& \begin{tabular}{l}
DC4 \\
\({ }^{0} 014\) \\
20
\end{tabular} \& \begin{tabular}{l}
NaK \\
6015 \\
21
\end{tabular} \& \begin{tabular}{l}
STM \\
0016 \\
22
\end{tabular} \& \begin{tabular}{l}
ETB \\
8917 \\
23
\end{tabular} \& \begin{tabular}{l}
CAN \\
8018 \\
24
\end{tabular} \& \[
\begin{gathered}
\text { EM } \\
8019 \\
25
\end{gathered}
\] \& \begin{tabular}{l}
Sus \\
001A \\
26
\end{tabular} \& \begin{tabular}{l}
ESC \\
9018 \\
27
\end{tabular} \& \begin{tabular}{l}
FS \\
0016 \\
28
\end{tabular} \& \[
\begin{gathered}
\text { GS } \\
8010 \\
29
\end{gathered}
\] \& \begin{tabular}{l}
RS \\
\({ }^{001 E}\) 30
\end{tabular} \& \begin{tabular}{l}
us \\
801F \\
31
\end{tabular} \\
\hline \(2{ }^{2}\) \& \[
\begin{gathered}
\text { sp } \\
\text { eare } \\
32
\end{gathered}
\] \& \[
\begin{gathered}
! \\
8021 \\
33
\end{gathered}
\] \& \begin{tabular}{l}
II \\
8022 \\
34
\end{tabular} \& \begin{tabular}{l}
\# \\
e923 \\
35
\end{tabular} \& \begin{tabular}{l}
\[
\$
\] \\
e924 \\
36
\end{tabular} \& \begin{tabular}{l}
\% \\
e925
\[
37
\]
\end{tabular} \& \[
\begin{gathered}
\& \\
8026 \\
38
\end{gathered}
\] \& \[
\begin{gathered}
8927 \\
39
\end{gathered}
\] \& \[
\begin{gathered}
\text { ( } \\
4028 \\
40
\end{gathered}
\] \& \[
\begin{gathered}
\text { ) } \\
8029 \\
41
\end{gathered}
\] \& \begin{tabular}{l}
* \\
802A 42
\end{tabular} \&  \& \[
\begin{aligned}
\& \prime \\
\& \theta 02 \mathrm{C} \\
\& 44
\end{aligned}
\] \& \[
\begin{gathered}
- \\
8020 \\
45
\end{gathered}
\] \& \[
\begin{gathered}
\cdot \\
\theta 02 E \\
46
\end{gathered}
\] \& \begin{tabular}{l}
1 \\
日02F
\[
47
\]
\end{tabular} \\
\hline 3. \& \begin{tabular}{l}
0 \\
8930
\[
48
\]
\end{tabular} \& \[
\begin{gathered}
1 \\
\text { e931 } \\
49
\end{gathered}
\] \& \[
\begin{gathered}
2 \\
8032 \\
50
\end{gathered}
\] \& \[
\begin{gathered}
3 \\
\\
5933
\end{gathered}
\] \& \begin{tabular}{l}
4 \\
8934 \\
52
\end{tabular} \& \[
\begin{gathered}
5 \\
6935 \\
53
\end{gathered}
\] \& \[
\begin{gathered}
6 \\
\text { e936 } \\
54
\end{gathered}
\] \& \[
\begin{gathered}
7 \\
\text { e937 } \\
55
\end{gathered}
\] \& \begin{tabular}{l}
8 \\
8938 \\
56
\end{tabular} \& \begin{tabular}{l}
\[
9
\] \\
-839
\[
57
\]
\end{tabular} \&  \&  \& \begin{tabular}{l}
803C \\
60
\end{tabular} \&  \& \begin{tabular}{l}
\[
>
\] \\
803E \\
62
\end{tabular} \& \begin{tabular}{l}
? \\
өe3F
\[
63
\]
\end{tabular} \\
\hline 4- \& \[
\begin{gathered}
@ \\
6040 \\
64
\end{gathered}
\] \& \begin{tabular}{l}
A \\
\({ }^{8} 841\) \\
65
\end{tabular} \& \begin{tabular}{l}
B \\
\({ }^{6} 942\) \\
66
\end{tabular} \& \begin{tabular}{l}
C \\
e943
\[
67
\]
\end{tabular} \& \[
\begin{gathered}
D \\
8844 \\
68
\end{gathered}
\] \& \begin{tabular}{l}
E \\
8945 \\
69
\end{tabular} \& \begin{tabular}{l}
F \\
e946 \\
70
\end{tabular} \& \[
\begin{gathered}
G \\
8947 \\
71
\end{gathered}
\] \& \begin{tabular}{l}
H \\
8948 \\
72
\end{tabular} \& \[
\begin{gathered}
\text { I } \\
8849 \\
73
\end{gathered}
\] \& \[
\begin{gathered}
\mathrm{J} \\
084 \mathrm{~A} \\
74
\end{gathered}
\] \& \[
\begin{gathered}
\mathrm{K} \\
\text { ө84B } \\
75
\end{gathered}
\] \& \begin{tabular}{l}
\[
\mathrm{L}
\] \\
веас \\
76
\end{tabular} \& \begin{tabular}{l}
M \\
8940 \\
77
\end{tabular} \& \begin{tabular}{l}
N \\
804E \\
78
\end{tabular} \& \[
\begin{gathered}
0 \\
884 \mathrm{~F} \\
79
\end{gathered}
\] \\
\hline 5 \& \begin{tabular}{l}
P \\
عase \\
80
\end{tabular} \& \[
\begin{gathered}
Q \\
8951 \\
81
\end{gathered}
\] \& \begin{tabular}{l}
R \\
8952 \\
82
\end{tabular} \& \[
\begin{gathered}
S \\
\text { eas3 } \\
83
\end{gathered}
\] \& \begin{tabular}{l}
T \\
eas4 \\
84
\end{tabular} \& \begin{tabular}{l}
U \\
eas5 85
\end{tabular} \& \begin{tabular}{l}
V \\
8956 \\
86
\end{tabular} \& \begin{tabular}{l}
W \\
8957 \\
87
\end{tabular} \& \begin{tabular}{l}
X \\
0958 \\
88
\end{tabular} \& \begin{tabular}{l}
Y \\
0059 \\
89
\end{tabular} \& \[
\begin{gathered}
Z \\
905 \mathrm{~A} \\
90
\end{gathered}
\] \& \[
\begin{gathered}
{[ } \\
\text { easb } \\
91
\end{gathered}
\] \& \begin{tabular}{l}
1 \\
B05C \\
92
\end{tabular} \& \begin{tabular}{l}
] \\
\({ }^{8050}\) \\
93
\end{tabular} \& \(\wedge\) 805E 94 \& \[
\begin{gathered}
- \\
\text {-85F } \\
95
\end{gathered}
\] \\
\hline \({ }^{6}\) \& 6960 96 \& \begin{tabular}{l}
a \\
2061 \\
97
\end{tabular} \& \begin{tabular}{l}
b \\
8962 \\
98
\end{tabular} \&  \& \begin{tabular}{l}
d \\
8064 100
\end{tabular} \&  \& \begin{tabular}{l}
f \\
\({ }^{2} 966\) \\
102
\end{tabular} \& \[
\begin{gathered}
\mathrm{g} \\
\text { e967 } \\
103
\end{gathered}
\] \& \begin{tabular}{l}
h \\
8968 \\
104
\end{tabular} \& \[
\begin{gathered}
\mathrm{i} \\
8869 \\
105
\end{gathered}
\] \& \begin{tabular}{l}
\[
j
\] \\
өебA \\
106
\end{tabular} \& \begin{tabular}{l}
k \\
986B \\
107
\end{tabular} \& \begin{tabular}{l}
1 \\
0860 \\
108
\end{tabular} \& \begin{tabular}{l}
m \\
8860 \\
109
\end{tabular} \& \begin{tabular}{l}
n \\
886E \\
110
\end{tabular} \&  \\
\hline 7. \& \begin{tabular}{l}
p \\
8978 \\
112
\end{tabular} \& \[
\begin{gathered}
9 \\
8971 \\
113
\end{gathered}
\] \&  \& \[
\begin{gathered}
5 \\
0973 \\
115
\end{gathered}
\] \& \begin{tabular}{l}
t \\
8974 \\
116
\end{tabular} \& \[
\begin{gathered}
\text { U } \\
6975 \\
117
\end{gathered}
\] \& \[
\begin{gathered}
\mathrm{V} \\
6976 \\
118
\end{gathered}
\] \& \begin{tabular}{l}
W \\
8977 \\
119
\end{tabular} \& \begin{tabular}{l}
X \\
8978 \\
120
\end{tabular} \& \begin{tabular}{l}
y \\
8079 \\
121
\end{tabular} \& \[
\begin{gathered}
Z \\
\text { B67A } \\
122
\end{gathered}
\] \& \[
\begin{gathered}
\{ \\
\text { \&978 } \\
123
\end{gathered}
\] \& |
8976
124 \& \begin{tabular}{l}
\[
\}
\] \\
8970 \\
125
\end{tabular} \& \(\sim\)

907 E

126 \& | DEL |
| :--- |
| e97F |
| 127 | <br>

\hline
\end{tabular}

Basic Computer Logic

- AND $=\square-$
- OR



## 1 = True

- NOT ->

0 = False


## Truth Tables

- The computer is constantly evaluating values.
- We can use truth table to help visualize the outcome


## And \&\& <br> 

| AND (\&\&) | TRUE | FALSE |
| :--- | :--- | :--- |
| TRUE | TRUE | FALSE |
| FALSE | FALSE | FALSE |

And - \& \&


| And \&\& | 1 | 0 |
| :--- | :--- | :--- |
| 1 |  |  |
| 0 |  |  |

## OR - || <br> 

| OR \\|I | True | False |
| :--- | :--- | :--- |
| True | True | True |
| False | True | False |

OR-\| $\quad=\square$

| OR II | 1 | 0 |
| :--- | :--- | :--- |
| 1 |  |  |
| 0 |  |  |

## Not -- -

- Not X
- Not $1=0$
- $\operatorname{Not} 0=1$
- $->-01110011$ (Bitwise Not)
- 10001100

Bitwise And $=\square$


## Bitwise OR <br> 


$01011001-1100 \longrightarrow 111$
01101

And


Or


0

## NAND



- NAND is Not And


NAND


## NOR - Not OR



## XOR - Exclusive Or



