



# Overview 6

## **Numbers and Colors**

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# Numbers



After you have read this, the next section will show how to use a calculator to verify your answers. This and other videos related to numbers and colors are available on the class web site.

**Why are there different numbering systems?** Just as different countries use different words for the same item, there are different numbering systems that represent the same thing in a different way.

**Why are numbers important?** Computer only really use 1s and 0s, so from a theoretical point of view, you should be able to convert our human base <sub>10</sub> numbers to a computer friendly base <sub>2</sub> number. But from a practical point of view: if you are making web pages, and you don't want to be stuck with 16 word colors, you have to be able to express mixtures of red, green, and blue in numbers. The most widely available graphics program is Paint, but it gives the numerical values of red, green, and blue in base <sub>10</sub>... but web pages use base <sub>16</sub>, hexadecimal. So, just to be able to use a lot of colors, you need to be able to convert the numbers. So, you *should* know the process.

But I know what most of you will do: use a calculator to convert; that's fine, IF you understand the theory.

**The three rules of modern numbering systems:**

1. Begin with 0 (zero)
2. The base indicates the number of different characters used to represent the numbers (examples base <sub>10</sub> has 10 characters, base <sub>2</sub> has 2 characters)
3. When you run out of different characters, add a decimal place to the left, and start over.

Decimal (base 10)		Binary (Base 2)	Hexadecimal (Base 16)
0		0	0
1		1	1
2		10	2
3		11	3
4		<b>100</b>	<b>4</b>
5		101	5
6		110	6
7		111	7
8		<b>1000</b>	<b>8</b>
9		1001	9
<b>10</b>		<b>1010</b>	<b>A</b>

Extended to  $16_{10}$

Decimal (base 10)		Binary (Base 2)	Hexadecimal (Base 16)
0		0	0
1		1	1
2		10	2
3		11	3
4		<b>100</b>	<b>4</b>
5		101	5
6		110	6
7		111	7
8		<b>1000</b>	<b>8</b>
9		1001	9
<b>10</b>		<b>1010</b>	<b>A</b>
11		1011	B
12		1100	C
13		1101	D
14		1110	E
15		1111	F
<b>16</b>		<b>10000</b>	<b>10</b>

You should be able to recreate the above chart.

There is a video available to demonstrate counting. The link is below, at the end of the building a 'powers of 2 number line' discussion.

Click class web site for a chart that that goes to  $32_{10}$ , and includes base<sub>4</sub> and base<sub>8</sub>.

Notice how large the binary numbers get; we need a way to represent those numbers that takes up less space, and is more distinctive. If you were to look at the larger example, you can see that base 4, 8, or base 16 are quick ways to represent the same base 2 number with less space. Especially base 16. But decimal, base 10, does not easily fit in this pattern.

Let's find out why.

## HTML and the Art of the Web Page

Look at the numbers in the binary column. Notice the numbers that begin with one, and are followed by nothing or zeros... and compare those to the decimal equivalent.

1	10	100	1000	10000	100000
1	2	4	8	16	32

The decimal values are doubling. This becomes the basis of a quick to build **powers-of-two number line**.

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1

There is a video available on counting, and the Powers of 2 number line [here](#).

This number line is a quick key to converting decimal to binary, and binary to decimal; this is the hardest conversion as the number 10 does not occur on the powers of two number line.

### The Harder Stuff, part 1: Converting decimal to binary.

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

$115_{10}$  converts to  $?_2$

1. Always build a powers-of-two number line. You don't need to calculate it, just start with 1, then double!
2. Notice the subscript is getting smaller... that is our clue to 'subtract'.
3. Computers use 1 to represent success (yes) and 0 to represent failure (no). We will always write our successes and failures (1s and 0s) under the powers-of-two number line.

The largest number on the powers-of-two number line we can **subtract** from 115 is 64. Put a one under the 64 to represent "yes, I can subtract this," then do the math... subtract  $115 - 64 = 51$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1						

Can we subtract the next number to the right from 51? Yes! Record the success with a 1, and do the math.  $51-32=19$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1					

Can we subtract the next number to the right from 19? Yes! Record the success with a 1, and do the math.  $19-16=3$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1	1				

Can we subtract the next number to the right from 3? No! Record the failure with a 0, and continue.

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1	1	0			

Can we subtract the next number to the right from 3? No! Record the failure with a 0, and continue.

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1	1	0	0		

Can we subtract the next number to the right from 3? Yes! Record the success with a 1, and do the math.  $3-2=1$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1	1	0	0	1	

## HTML and the Art of the Web Page

Can we subtract the next number to the right from 1? Yes! Record the success with a 1, and do the math.  $1-1=0$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
				1	1	1	0	0	1	1

There are no more subtractions possible, but we have our number!  $115_{10}$  converts to  $1110011_2$

Note: since 115 is odd, it must end in 1.

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

### The Harder Stuff, part 2: Converting binary to decimal.

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

$11101_2$  converts to  $?_{10}$

1. Always build a powers-of-two number line. You don't need to calculate it, just start with 1, then double!
2. Notice the subscript is getting larger... that is our clue to 'add'.
3. Computers use 1 to represent success (yes) and 0 to represent failure (no). We will always write our successes and failures (1s and 0s) under the powers-of-two number line.

Write the 1s and 0s under the powers-of-two number line.

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1
						1	1	1	0	1

Add the value **above** the successes (1s) and ignore the failures (0s).

$$16+8+4+1 = 29$$

We have our number!  $11101_2$  converts to  $29_{10}$

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

## The Really Easy Stuff, part 1: Binary to Octal, see class website

### The Really Easy Stuff, part 2: Binary to Hexadecimal

After you have read this, there is a section on how to use a calculator to verify your answers.

$110001011101_2$  converts to  $?_{16}$

Divide the number into blocks of four, starting from the right. If you don't have enough numbers, add 0s to the left.

1100 0101 1101

Put a short powers-of-two number line above each of the blocks of four; remember, the 1s and 0s always go under the powers-of-two number line.

8 4 2 1	8 4 2 1	8 4 2 1
1 1 0 0	0 1 0 1	1 1 0 1
12	5	13
12 in hex from the chart , C	5 in hex from the chart , 5	13 in hex from the chart , D

There's our number!  $110001011101_2$  converts to  $C5D_{16}$

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

### Hexadecimal, a BAD numbering system, to Binary

$BAD_{16}$

B	A	D
11 in hex from the chart or	10 in hex from the chart or	13 in hex from the chart or
1011	1010	1011

1011 1010 1101 <sub>2</sub>

After you have read this, you may wish to click [here](#) see how to use a calculator to verify your answers.

## HTML and the Art of the Web Page

Just for jollies, Hexadecimal, a BAD numbering system, to Decimal (just use all the skills he have learned)

$BAD_{16}$

B	A	D
11 in hex from the chart or	10 in hex from the chart or	13 in hex from the chart or
1011 in binary from chart of conversion	1010 in binary from chart of conversion	1101 in binary from chart of conversion

Put 101110101101 under a powers-of-two number line, add the successes to get 298910!

### PRACTICE QUESTIONS

Converting decimal to binary.

$13_{10}$  converts to  $?_2$

$255_{10}$  converts to  $?_2$

$5_{10}$  converts to  $?_2$

Converting binary to decimal.

$1011_2$  converts to  $?_{10}$

$111_2$  converts to  $?_{10}$

$111010_2$  converts to  $?_{10}$

Converting hexadecimal to binary.

$25_{16}$  converts to  $?_2$

$1F_{16}$  converts to  $?_2$

$F1_{16}$  converts to  $?_2$

Converting hexadecimal to decimal.

$25_{16}$  converts to  $?_{10}$

$1F_{16}$  converts to  $?_{10}$

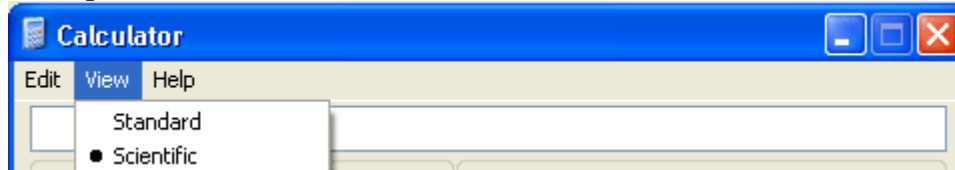
$F1_{16}$  converts to  $?_{10}$

You might want to check your answers with the Windows calculator.

Class website has videos on Starting the Windows Calculator/Using the Windows Calculator

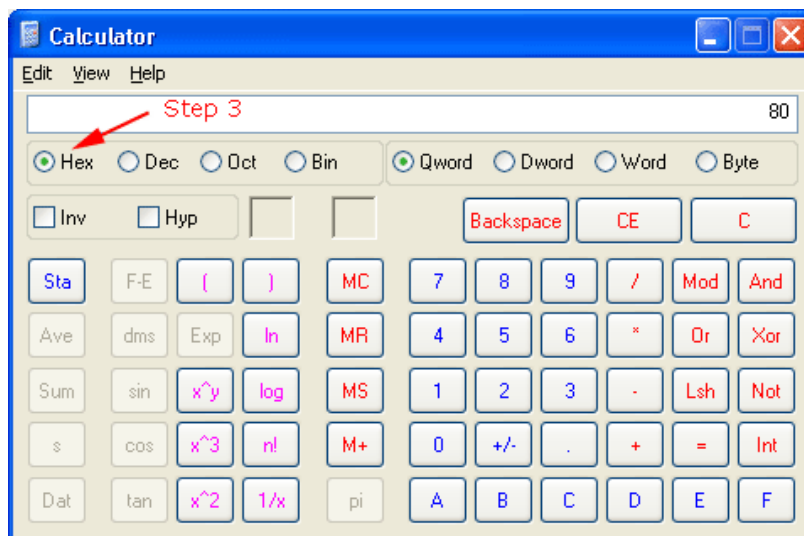
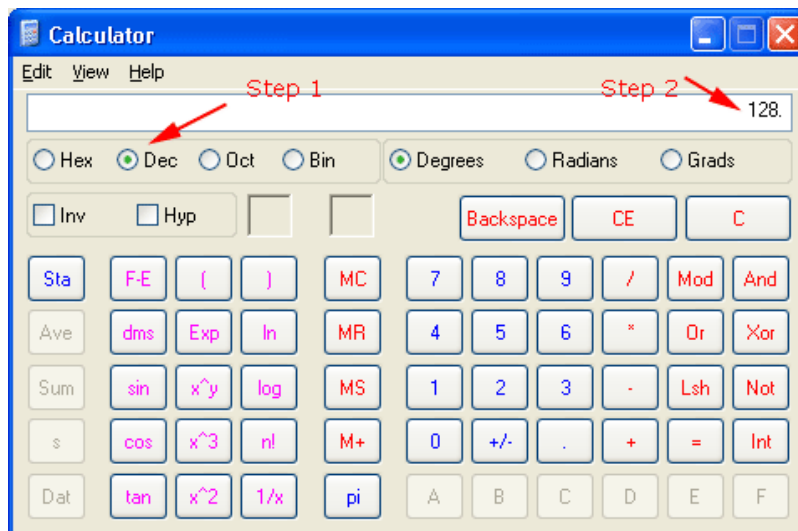


First, go to View menu, and choose Scientific View.



If the starting number is in base 10, set the button to dec, enter the number to convert, then click to bin, oct, or hex.

Example  $128_{10}=?_{16}$



## HTML and the Art of the Web Page

If the starting number is in base 2, set the button to bin, enter the number to convert, then click to dec, oct, or hex.

If the starting number is in base 16, set the button to hex, enter the number to convert, then click to dec, oct, or bin.

If the starting number is in base 8, set the button to oct, enter the number to convert, then click to dec, hex, or bin.

### Exponents

If you are trying to solve something like  $2^8 \cdot 2^8 \cdot 2^8 = 2^{24}$ , and you want to know what  $2^{24}$  is, Type in 2

then click the  $x^y$  button

then type the exponent, 24

then press =, or hit the enter key to calculate



Notes:

## Instructor notes

Even though I have separate 'lecture' material on most of these topics, and try to avoid duplicating information; there is still a bit to comment on, until I write better chapters for this book.

### Overview 6

I hate working in black and white for 5 weeks, so as a class, we began using color much earlier than many other books. You were lightly introduced to number theory, and hex a previously, so you had access to more color choices than the 16 word colors. (Practice web page)

You may then use the color numbers, as we have been learning, to define millions of different color schemes, using

```
<body bgcolor="#rrggbb" text="#rrggbb" link="#rrggbb" vlink="#rrggbb">  
...  
</body>
```

Yet another extension to the <body ... family is background=, which will allow you to place an image behind your text, basically covering up the bgcolor. (Choose a similar bgcolor and use it, even with background=, in case the image doesn't download... your contrast is protected.) Background images should be small, to download quickly. If the image does not cover the web page, it will repeat until it does cover the page. The image should also not be so busy as to interfere with reading the contrasting colored text.

The book also mentions some other addons for `<body...>`, such as `bgcolor="fixed"` so an background image does not scroll, or specifying in pixels a `bottommargin`, `topmargin`, `leftmargin`, or `rightmargin`.

## Overview 7 Preview

### Fonts

Aside from deprecated `<font>`, coming up in Overview 7, something that can always change the face successfully is to use `<tt>` `</tt>`, which displays the text as a typewriter would, using a monospace font, such as Courier New, which is made to look like Courier New by using the `<tt>` `</tt>` in my code.

Another similar trick is to use `<pre>` `</pre>` (preformatted). This will display as typewriter text, but will also display the text **as typed** in Notepad, **including line breaks, spaces, and tabs**. But avoid overdoing typewriter text, it is harder to read, as it is any monospace font.

Another useful tag is the non-breaking space... this can be entered into your html to accomplish what hitting the space bar cannot, as spaces and other white space are usually ignored.

Example:     the space to the left could be created with several `&nbsp;` tags.

Please note, the font tag is deprecated, meaning there are newer ways to do this in HTML 4.x. That's fine, we'll learn some of those news ways later... but this is a quick and simple way to do things now, and is still widely used.

We have been using the `` for awhile, but we can also use `` to control how big the image displays and where; but if the display is huge, requiring us to lower the height and width just to see the entire picture without scrolling, it probably means to file size is big. A file of over 20 or 30 KB will take longer to download, and a file of 1MB will drive dial up users away from your site. We need to be able to actually **adjust** the image. (Coming up in Overview 7.)

### About Graphic: Preview

#### Imaging background info

See class website for links to Photoshop (Trail Version of Photoshop), GIMP (Free download of GIMP) or a similar graphic editor, to adjust images for web pages requires you to use just a few menu items...typically:

File	Edit	Image	Select
Save	Copy	Adjustments	Deselect
Save As	Paste	>Auto...	
		>Brightness...	
Save for Web		Crop	

Other linked readings on the class website will introduce you to making backgrounds, gif animation, editing digital images, optimizing pages.

### Planting seeds for later, Image Maps and Hot spots

Image maps will be discussed more fully later.

At least know that an image map places invisible hotspots on an image... and these hotspots are links to web pages.

Hot spot Example from any of my lab pages:

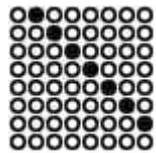
If on the class web site and you click on the image shown below, Discussions, or Dropbox, or Quizzes, you link to relevant pages. Click anywhere else, such as locker and nothing happens.



The three kinds of hotspots are rectangle, circle, and polygon.

Again, image maps will be discussed more fully during the run up to lab 7, where at that time you may refer to Image Maps on the class web site.

## Colors



If you zoom in on a digital image, you would see something like the image to the left... a series of dots. The most simple image might be black and white dots... to tell the computer how to save this, you might just say white=1 and black=0.

Now think of a box of crayons, maybe then white=7, red=6, magenta=5, yellow=4, green=3, turquoise=2, blue=1, and black=0.

So numbers can represent colors. The more shades you want, the larger the number would be for each dot. But better than 8 colors would be about 200 colors, or 65,000 colors.

But in modern digital images, color is about mixing wavelengths of light to form **millions** of colors. When discussing color and computers, you normally are discussing combining various values, or intensities, of: **red, green, and blue.**

A computer monitor typically creates the colors you see with thousands and thousands of pixels, or picture elements. These tiny glowing points of light that cover your screen consist of three tiny points, one that controls the intensity or red, one for green, and one for blue.

For each dot or pixel you see on a screen, a series of 1s and 0s is being feed to the computer, indicating the values to be fed to the red, green, and blue pixel components. When you mix these pixel parts, your eyes see different colors. Normally, to get about 16 million colors, this would be sent to the computer as twenty four 1s and 0s

eight 1s and 0s for red,  
eight 1s and 0s for green, and  
eight 1s and 0s for blue.

Something like

**110010110011110011001010**  
└ Red part ┘ └ Green part ┘ └ Blue part ┘

While not a problem for computers, all of these numbers get quite out of hand for people, so the three color octets are normally represented with their hexadecimal equivalents, which range from 00-FF, or 256 possibilities per primary color. (See numbers for an explanation on hex earlier in this chapter.)

And again, these primary colors are combined to generate the 16 million odd shades, and on the Internet are represented with the three hex values for red, green, and blue in sequence, such as bgcolor="#ff0000" to color the background a bright red. (Think full red, no green, and no blue)

### How computers mix colors

Above, there is a binary color chart with three components involved: Red Green Blue.

In hex, it would be

**X X X X X X**  
Red part Green part Blue part

that is, the amount of each color ranging from 00 (none) to FF (all) that are mixed together.

The mixture behaves like light:

add full values of red, green, and blue light,  
in equal parts, and you have white light (FF FF FF).

Add no red, green or blue light, and you would be in the dark, or black (00 00 00).

See the Colors web page on the class website in Overview 6 for colorful charts on mixing 8 simple colors, up to 216 colors.

## Completing Overview 6

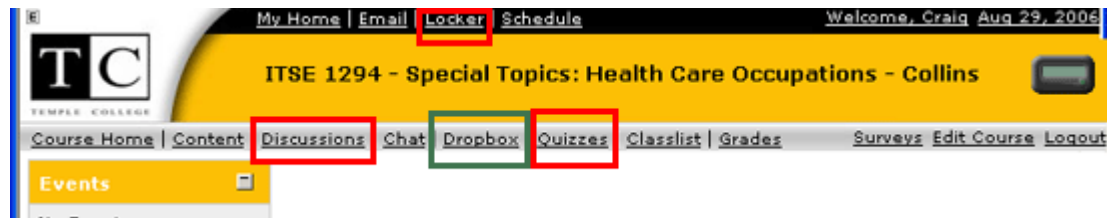
- Submit by Test 1, check class website for due date
- Submit by 11:59 pm, Friday, of the current week (see due dates on course web site)
  - Lab 4 is not due until the next overview, but you should be working

### MUD 6 (My Understanding, Details)

Respond in the class D2L Discussion forum to the following:

What topics, if any, during this time frame do you feel very comfortable with? Why?  
What topics, if any, during this time frame do you not feel comfortable with?

- Participation Discussion 6 Respond in the class D2L Discussion forum to the following:  
There is no set discussion topic for overview 6, but drop a line on any topic



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For the next time frame:

- Read Overview 7
- Each test has a review; you may wish to write out pertinent information from the readings and activities
- After completing this overview, you may wish to preview Lab 4