IDX G9 Computer Science S
**Study Guide S1 Monthly 2**
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Contents:

Computer Colors:

- A computer's primary colors are **red, green and blue**
  - all colors we generate form the three spectral hues of red, green and blue
  - CMYK: proper reference for printed color
- HSV/HSL/HSI
  - H: Hue -> the pure dominant color (original colorness)
  - S: Saturation -> intensity/purity of a color
  - V: Value -> lightness or darkness
  - L: Lightness -> color's brightness (amount of black/white)
  - I: Intensity -> brightness or dullness of a color
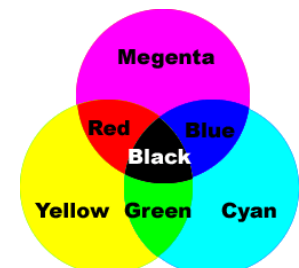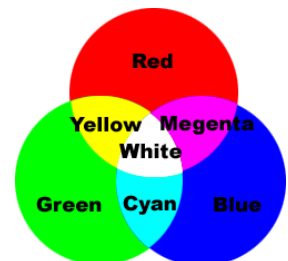
- Binary notation of colors: using 24 numbers to represent a color

  - EG: 111111 111111 111111 is white

  - The first 6 "1"s represent the red part of the color, the next group of "1"s represent the green part and the last group of "1"s represent the blue part
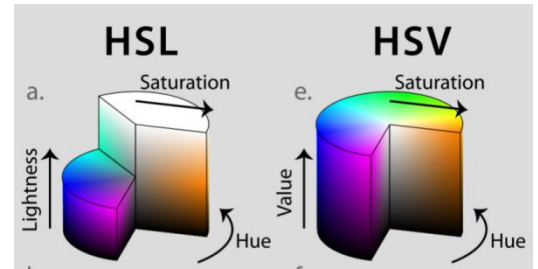
- Hexadecimal: using 6 letters/numbers to represent a color

  - EG: #FF FF FF represents white

  - The first group of "F"s represent the red part, the second group represents green, and the third group represents blue

- Ways to store characters:

  - **Morse code**: the use of dots and dashes. This can be uneffective as letters can be mixed up

  - ASC II: developed from telegraph codes, encodes 128 specified characters into **7-bit integers**

  - For letters, it it is a capital leter, start with "10" and lowercase letters start with "11"

Dec	Hx	Oct	Char		Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL	(null)	32	20	040	 	Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH	(start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX	(start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX	(end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT	(end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ	(enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK	(acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL	(bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS	(backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB	(horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF	(NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT	(vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF	(NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR	(carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO	(shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI	(shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE	(data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1	(device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2	(device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3	(device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4	(device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK	(negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN	(synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB	(end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN	(cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM	(end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB	(substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC	(escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS	(file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174	|	|
29	1D	035	GS	(group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS	(record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US	(unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

Source: www.LookupTables.com

- Graphic formats: format in

  - GIF, shows 256 kinds of colors at most in one picture

  - JPEG: millions of kidns of colors ($2^8*2^8*2^8=16777216$), saves memory space in computer

  - PNG: combines advantages of GIF and JPEG, good quality, can be transparent, not very popular as many web pages cannot show pictures in this format

  - BMP/RLE: one of the most popular formats used to save images on windows operating system

- o PSD: used in photoshop, save all detailed elements made in photoshop such as layers, color modes, path and channel etc, occupy large memory in computer but can be compressed
- o HEIF: supports multiple bit depths, depending on the encoder and use case, memory is about 50% smaller than the JPEG format, shows billions of colors (2^{30}), records images with richer information, compatibility is limited
- bit depth: color depth per chennel, not the total file size or container overhead

Digital Graphics:

- An image created/edited on a computer is either a bitmapped or vector graphic
  - o **Bitmapped**: AKA raster graphics, consists of pixels, if you enlarge a bitmap you enlarge a pixel
    - ▪ pixels become more obvious and image loses cripsness and clarity
  - o **Vector**: uses mathematical formulas to define lines, curves and other attributes of digital images
    - ▪ you use vector graphics editing program
    - ▪ Vector files are generally much smaller than bitmapped
- The number of **pixel per inch** (ppi) determines the resolution of bitmap grapics
  - o photo display on a computer screen usually looks realistic at 72 ppi
  - o vector graphics do not rely on resolution for clarity, but its' display on a computer screen does
- **color depth**: in graphic files and applications, color depth refers to the number of distinct colors an image can contain/how many bits per pixel
  - o EG 24-bit image has color depth of 16.7 million colors, called **full color imag**
- **Field of View/Field of vision (FOV):** extent of observable world that is seen at any given moment
  - o Humans have ≈210 degree of forward facing horizontal arc of their visual field'
  - o vertical range of the visual field in humans is around 150 degrees
  - o some birds have complete/nearly complete 360 degree FOV
- **Aspect ratio**: relationship between its width and height

- o expressed as (x,y)
- o common aspect ratios: 5:4, 4:3, 16:10, 16:9
- Brief history
  - o **2003:** most computer monitors had 4:3 aspect ratio, some had 5:4
  - o **2003-2006**: 16:10 became common in laptops and standalone monitors
  - o **2008**: industry moved from 4:3 and 16:10 to 19:9 as the standard ratio
  - o **2010**: All monitors and laptops moved to 16:9 aspect ratio
  - o **2011**: 16:9 reso of 1920*1080 became popular among steam users
  - o **2012**: resolution became 1366*768

Alpha Channel:
- **alpha compositing**: process of combining an image with a background to create the appearance of partial or full transparency
  - o keep an associate matte for each element
  - o In a 2D image element, which stores a color for each pixel, additional data is stored in the alpha channel with a value between 0 and 1
    - ▪ 0 means pixel does not have any coverage info and is transparent
    - ▪ 1 means the pixel is opaque because the geometry overlapped the pixel
  - o one more number is required to store **alpha**
    - ▪ from (148,255,255) to (148,255,255,0)
      - • first 3 numbers imply the color
      - • last three imply the alpha
- if three primary colors share the same number, this color contains only brightness, it can only be black, white or gray
  - o (0,0,0) is black
  - o (255,255,255) is white
  - o (100,100,100) is gray
- **premultiplied alpha**: if the alpha channel is used in an image, its common to alsp multiply the color by the alpha value
  - o saves space

- o **linear interpolation**: riven two red points, the blue line is the linear interpolate between the points, and then value y at x may be found using this method

Computer monitors:

- **computer monitors**: the size of a display is usually given by monitor manufacturers based on the diagonal
  - o measure in unit inch
  - o display devices: cathode ray tube (CRT), liquid crytal display(LCD), organic light-emitting diode (OLED)
    - **CRT**: old fashioned, vacuum tube containing an electron gun and phosphorescent screen used to view images
    - **LCD:** most common, has diffraction grating, crystal and backlight
    - **OLED:** monitor of the future, simple structure, self emissive

Image Compression:

- **uncompressed image - raw file**: captured by a digital camera or scanner's scensors, this captures a high level of image detail, with large file sizes and losslessquality
  - o direct image data means you start with a high-quality image that can be edited, converted and compressed in a non-destructive manner
- **lossy vs lossless**
  - o lossless: oreferred for archival purposes, for medical imaging, technical drawings, clip art, comics
  - o lossy: suitable for natural images EG photographs in applications
- **lossless compression**
  - o Run-length encoding (RLE) is a simple form of data compression where runs of data are stored as a single data value and count, rather than as the original run
    - example of RLE: W representing white and B representing black: WWWWWBWW
    - instead this can be compressed into 5W1B2W
  - o Differential pulse-code modulation (DPCM) encodes the changes between consecutive samples of a signal rather than the signal's value directly

- reduces the bit rate
- input can be an analog signal or digital signal
- methods of encoding:
  - quantize the samples, output is the difference between the current and previous sample
  - quantize the difference between the current sample and output of a local decoder
- color spaced is reduced to the most common colots, these selected colors are defined in a color palette stored within the mage harder
  - each pixel references the index of its corresponding color in the palette
  - this approach can be combined with dithering to minimize posterization artifacts

- **entropy encoding**:
  - **Huffman coding**: separating the input into component symbols and replacing each with a code, uses variable length codes to represent different characters
    - shorter codes -> assigned to more frequently occuring characters and longer to less frequent ones, results in compressed data representation
    - optimal for minimizing the total number of bits used
  - **Arithmetic coding**: encoding the entire message into a single number, a fraction n where $(0 \leq n \leq 1)$

- **chroma subsampling**: human eye perceives spatial changes of brightness more sharply than color, so this method averages/drops some of the chominance info in the image
- **transform coding:** most commonly used method, Fourier related transform such as the **discrete cosine transform (DCT)** is widely used
  - wavelet transform is also used extensively, followed by quantization and entropy coding