Worksheet Data Representation

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Week 3

Do not use a calculator on any of the one below. You must be able to do this using mental arithmetic, or a piece of paper if you require it. On the last sheet you will find a table with ASCII encodings.

1. Assume that we have the datatype char and int.

   (a) Which set belongs 0 to? Give two other example values of that datatype.
   Answer:
   int. Other values include 42, -789412123

   (b) Which set belongs '0' to? Give two other example values of that datatype.
   Answer:
   char. Other values include '+', 'Z' (note that the 's are important 'Z' is the character constant representing the 26th letter of the alphabet in capital. Z without primes is something else, probably an identifier.

   (c) Which set belongs '\0' to? Give two other example values of that datatype.
   Answer:
   char. Other values include 'A' and '0'!

2. Assume an 8-bit machine. Write down the binary representations for

   (a) The `int` 0
   Answer:
   00000000

   (b) The `int` 1
   Answer:
   00000001

   (c) The `int` 10
   Answer:
   00001010

   (d) The `int` 100
   Answer:
   01100100

(e) The `int` -1
Answer:
11111111

(f) The `int` -10
Answer:
11110110

(g) The `int` -100
Answer:
10011100

(h) The `unsigned` 10
Answer:
00001010

(i) The `unsigned` 100
Answer:
01100100

(j) The `unsigned` 156
Answer:
10011100

(k) The `unsigned` 246
Answer:
11110110

(l) The `unsigned` 255
Answer:
11111111

(m) The character ‘d’
Answer:
01100100

(n) The character ‘+’
Answer:
00101011

3. Assume an 8-bit machine. What is the interpretation of each of the following as an int, unsigned, and char?

(a) ‘01100110’
Answer:
Int 102, unsigned 102, char `'f'`

(b) ‘01000110’
Answer:
Int 70, unsigned 70, char `'F'`

4. Assume an 8-bit machine programmed in C. How much is

   (a) `int` 100 + 100 + 100 + 100
   Answer:
   -112

   (b) `unsigned` 100 + 100 + 100 + 100
   Answer:
   144

   (c) `int` 100 + 100 + 100 - 400
   Answer:
   -100

   (d) `unsigned` 100 + 100 + 100 - 400
   Answer:
   156

   (e) `char` '1' + 2
   Answer:
   the character `'3'` or the number 51 (they are the same)

   (f) `char` '2' + 1
   Answer:
   the character `'3'` or the number 51

   (g) `char` '1' + '2'
   Answer:
   the character `'c'` or the number 99

   (h) `char` 'p' + ('A' - 'a')
   Answer:
   the character `'P'` or the number 80

5. Assume a 32-bit floating point number, containing a sign bit s, an 8-bit unsigned biased exponent e, and a 23 bit manitssa m, such that the value of a number $s|e|m$ is $(-1)^s 2^{e-127}(1+\frac{m}{2^{23}})$. Write down the representations for

   (a) 1
   Answer:
   0 01111111 00000000000000000000000

   (b) 0.5
   Answer:
   0 01111110 00000000000000000000000

   (c) 0.125
   Answer:
   0 01111100 00000000000000000000000

(d) -257

Answer:

0 10000111 00000001000000000000000

(e) 0.1

Answer:

0 01111011 10011001100110011001100

And interpretations for

(f) `0 10000000 10000000000000000000000`

Answer:

3

(g) `0 01111111 01010101000000000000000`

Answer:

1.33203125

How much is (nb, 2^{-23} is 0.0000001192...)

(f) `1 + 0.1`

Answer:

1.1 (rounded)

(g) `1 + 0.0000001`

Answer:

1.0000001192 (rounded)

(h) `1 + 0.00000005`

Answer:

1

(i) `(((1 + 0.00000005) + 0.00000005) + 0.00000005)`

Answer:

1

(j) `(1 + (0.00000005 + (0.00000005 + 0.00000005)))`

Answer:

1.0000001192 (rounded)

6. (a) In a computer language we make identifiers out of characters. In C, an identifier consists of a letter or underscore, followed by any number of letters, digits or underscores. How many different identifiers are there with up to 7 characters? (do NOT use a caclulator, but write it down in terms of multiplications and additions, then make a guess as to how many zeroes the answer has). Note: case is important.

Answer:

Roughly $63^7 \simeq 64^7 = 2^{42} \simeq 4 \times 10^{12}$

(b) Write down the formula for identifiers of exactly N characters long.

Answer:

$(2 \times 26 + 1 + 10)^{N-1} \times (2 \times 26 + 1) = 63^{N-1}53$

0	**null**	32		64	@	96	‘
1	**CTRL-A**	33	!	65	A	97	a
2	**CTRL-B**	34	”	66	B	98	b
3	**CTRL-C**	35	#	67	C	99	c
4	**CTRL-D**	36	$	68	D	100	d
5	**CTRL-E**	37	%	69	E	101	e
6	**CTRL-F**	38	&	70	F	102	f
7	**bell**	39	’	71	G	103	g
8	**backspace**	40	(	72	H	104	h
9	**tab**	41	)	73	I	105	i
10	**newline**	42	*	74	J	106	j
11	**CTRL-K**	43	+	75	K	107	k
12	**newpage**	44	,	76	L	108	l
13	**carr return**	45	-	77	M	109	m
14	**CTRL-N**	46	.	78	N	110	n
15	**CTRL-O**	47	/	79	O	111	o
16	**CTRL-P**	48	0	80	P	112	p
17	**start**	49	1	81	Q	113	q
18	**CTRL-R**	50	2	82	R	114	r
19	**stop**	51	3	83	S	115	s
20	**CTRL-T**	52	4	84	T	116	t
21	**CTRL-U**	53	5	85	U	117	u
22	**CTRL-V**	54	6	86	V	118	v
23	**CTRL-W**	55	7	87	W	119	w
24	**CTRL-X**	56	8	88	X	120	x
25	**CTRL-Y**	57	9	89	Y	121	y
26	**CTRL-Z**	58	:	90	Z	122	z
27	**CTRL-[**	59	;	91	[	123	{
28	**CTRL-**	60	<	92	\	124	—
29	**CTRL-]**	61	=	93	]	125	}
30	**CTRL-^**	62	>	94	^	126	~
31	**CTRL-_**	63	?	95	_	127	**del**