Negative Binary Numbers, and Characters

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Negative Numbers

- Unsigned vs. signed numbers
- Sign bit
- Positive number representation

Unsigned Binary

- With n bits, can represent $0..2^n - 1$

Signed-Magnitude Binary

- With n bits, can represent $-2^{n-1} - 1$ to $+2^{n-1} - 1$
- Two representations for 0!
- Not convenient for doing addition and subtraction
  - "if signs are equal, add and retain sign, but if signs are not equal, subtract smaller from larger and use sign of larger magnitude"

Twos-Complement Binary

- To convert a number to number with same magnitude, but opposite sign
  - Complement (logical) and add 1
  - or, subtract from 2^{n+1}
- Works for both positive or negative numbers
- One representation for 0
  - However, one more negative number than positive non-zero number

Example

Extending Precision (Unsigned Numbers)

- Convert byte-sized unsigned integer into doubleword-sized unsigned integer
- SASM instruction: movezx
- "Pad" the extra 3 bytes with zeros

Extending Precision (Two's Complement Numbers)

- Convert byte-sized signed integer into doubleword-sized signed integer
- SASM instruction: movesx
- "Pad" the extra 3 bytes with all zeros if positive, with all ones if negative

ASCII Characters

- ASCII Code - American Standard Code for Information Interchange
- 7 bits, encode in one byte 128 different values
- Printable characters – letters, digits, punctuation
- Control characters -- formatting, communication, delimiters
- ASCII Digits don't = decimal numbers!
  - Conversion: subtract ASCII '0' (decimal 48) from digit, weight each digit by power of 10 before summing

ASCII Table

HEX	DEC	CHR	HEX	DEC	CHR	HEX	DEC	CHR	HEX	DEC	CHR
00	0	*NUL*	20	32	SPC	40	64	@	60	96	`
01	1	*SOH*	21	33	!	41	65	**A**	61	97	**a**
02	2	*STX*	22	34	"	42	66	**B**	62	98	**b**
03	3	*ETX*	23	35	#	43	67	**C**	63	99	**c**
04	4	*EOT*	24	36	$	44	68	**D**	64	100	**d**
05	5	*ENQ*	25	37	%	45	69	**E**	65	101	**e**
06	6	*ACK*	26	38	&	46	70	**F**	66	102	**f**
07	7	*BEL*	27	39	'	47	71	**G**	67	103	**g**
08	8	*BS*	28	40	(	48	72	**H**	68	104	**h**
09	9	*HT*	29	41	)	49	73	**I**	69	105	**i**
0A	10	*LF*	2A	42	*	4A	74	**J**	6A	106	**j**
0B	11	*VT*	2B	43	+	4B	75	**K**	6B	107	**k**
0C	12	*FF*	2C	44	,	4C	76	**L**	6C	108	**l**
0D	13	*CR*	2D	45	-	4D	77	**M**	6D	109	**m**
0E	14	*SO*	2E	46	.	4E	78	**N**	6E	110	**n**
0F	15	*SI*	2F	47	/	4F	79	**O**	6F	111	**o**
10	16	*DLE*	30	48	**0**	50	80	**P**	70	112	**p**
11	17	*DC1*	31	49	**1**	51	81	**Q**	71	113	**q**
12	18	*DC2*	32	50	**2**	52	82	**R**	72	114	**r**
13	19	*DC3*	33	51	**3**	53	83	**S**	73	115	**s**
14	20	*DC4*	34	52	**4**	54	84	**T**	74	116	**t**
15	21	*NAK*	35	53	**5**	55	85	**U**	75	117	**u**
16	22	*SYN*	36	54	**6**	56	86	**V**	76	118	**v**
17	23	*ETB*	37	55	**7**	57	87	**W**	77	119	**w**
18	24	*CAN*	38	56	**8**	58	88	**X**	78	120	**x**
19	25	*EM*	39	57	**9**	59	89	**Y**	79	121	**y**
1A	26	*SUB*	3A	58	:	5A	90	**Z**	7A	122	**z**
1B	27	*ESC*	3B	59	;	5B	91	[	7B	123	{
1C	28	*FS*	3C	60	<	5C	92	\	7C	124	|
1D	29	*GS*	3D	61	=	5D	93	]	7D	125	}
1E	20	*RS*	3E	62	>	5E	94	^	7E	126	~
1F	31	*US*	3F	63	?	5F	95	_	7F	127	*DEL*