CS1800
9/25-Fri ☺

Admin

- say your name ☺
- PS2 due 11:59pm
- 10/2 exam 1 in class
  - ↳ practice exam - at 3:25 review Tues
  - ↳ practice longer than real!

Weekend

- tonight: PS2
- sat: 

- Sun pm: practice test

Agenda

1. Predicates + Quantifiers
2. Binary #s
3. base conversion

joinpd.com

1. Predicates + Quantifiers → slides

universe: colors, animals, characters

jonny(x), karate(x)

where is this valid?

0 grizz: grizz does not study karate, but Johnny fights him anyway → A

0 Tom: Johnny does not fight Tom, but Tom studies karate → B

(A) $\forall x$ karate(x) $\Rightarrow$ jonny(x)
If you study karate, then you fight Jonny

(B) $\forall x$ jonny(x) $\Rightarrow$ karate(x)
If jonny fights you, then you study karate

→ we didn't say what happens if you don't study karate! could fight, or not!

Domain - all integers. Truth value?

(a) $\forall x \exists y (x + y = 0)$ T. For all x, there is a y such that x+y=0
↳ x=6? sure, y=-6
x=-218? yep, y=218
any x? y exists!

(b) $\exists y \forall x (x + y = x)$ T
↳ there exists a y such that, for all x, x+y=x
↳ choose a y. no matter which x, x+y=x?
sure, y=0

(c) $\exists x \forall y (x + y = x)$ F
↳ there exists an x such that, for all y, x+y=x.
↳ choose an x. no matter which y, you get x+y=x? nah. no such x!

(d) $\exists y \forall x (x+y=0)$ F
↳ there exists a y such that, for all x, x+y=0.
• choose a y. no matter which x you get, x+y=0? nah!

2. Binary numbers

0/1 F/T OFF/ON

$P(x)$ ... x is even

domain = integers

Option 1: plug values in ∧ solve... ← output!

$P(1) = F$ 0

$P(2) = T$ 1

$P(3) = F$ 0

$P(4) = T$ 1

...

$P(4338) = T$ 1

↳ now... what are these values?

- represent numeric values in computers
- 0/1 Binary (base 2)

Unsigned - today

~ decimal (base 10) → powers of 10

135_{10}

1	3	5
100s	10s	1s
10^2	10^1	10^0

$= 5 \cdot 1 + 3 \cdot 10 + 1 \cdot 100 = 135_{10}$

↳ compute value

~ same structure, every base ~

Base 2 → powers of 2

only digits: 0, 1

1	0	0	1
2^3	2^2	2^1	2^0
8	4	2	1

$= 1 \cdot 1 + 0 \cdot 2 + 0 \cdot 4 + 1 \cdot 8$

$= 1 + 0 + 0 + 8$

$= 9_{10}$

Binary → decimal conversion!

Counting in binary

↳ all ones = highest value with that # of digits

$11 \rightarrow 100$

$111 \rightarrow 1000$

$1111 \rightarrow 10000$

(like $99 \rightarrow 100$)

base 2	base 10
0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7
...	

sanity check

$10_2 = 1 \cdot 1 + 0 \cdot 2 + 1 \cdot 4$

$= 1 + 0 + 4$

$= 5_{10}$ ✓

decimal → binary

$\sim_{10} = \sim_2$

- repeatedly divide by 2
- keep track of the remainder

Sidenote: long division w/ remainders

$$\begin{array}{r} 4 \\ 7\overline{)30} \\ 28 \\ \hline 2 \end{array} \qquad 4 \text{ R } 2$$

Sidenote: halving binary numbers

1000	8
100	4
10	2
1	1

shift right, divide by 2

ex) $135_{10} = ____2$?

$135/2 = 67 \text{ R } 1$

$67/2 = 33 \text{ R } 1$

$33/2 = 16 \text{ R } 1$

$16/2 = 8 \text{ R } 0$

$8/2 = 4 \text{ R } 0$

$4/2 = 2 \text{ R } 0$

$2/2 = 1 \text{ R } 0$

$1/2 = 0 \text{ R } 1$

flip!

$135_{10} = 10000111_2$

Sanity check!

$$1\,0\,0\,0\,0\,1\,1\,1_2 = ____{10}\ ?$$

$$\frac{1}{2^7}\ \frac{0}{2^6}\ \frac{0}{2^5}\ \frac{0}{2^4}\ \frac{0}{2^3}\ \frac{1}{2^2}\ \frac{1}{2^1}\ \frac{1}{2^0}$$

$= 1\cdot 2^7 + 1\cdot 2^2 + 1\cdot 2^1 + 1\cdot 2^0$

$= 128 + 4 + 2 + 1$

$= 128 + 7$

$= 135$!!!

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$
$2^7 = 128$

Structure works on any base:

important concept!

decimal → base b: repeatedly divide by b, keep the remainder

base b → decimal:

$$\frac{\quad}{b^4}\ \frac{\quad}{b^5}\ \frac{\quad}{b^2}\ \frac{\quad}{b^1}\ \frac{\quad}{b^0}$$

multiply value by position, and add

hexadecimal (base 16)

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

10 11 12 13 14 15