Winding up Proj4

- a little NUMERICAL ops & types
  - for getting extra credit now (quick)

filling the red with a tiling of a small picture

The tiling computation uses the modulus function from math (in two code places)

Java uses $\%$ for mod

$N \% D$ is THE REMAINDER when $N$ is divided by $D$

8 % 4 is 0  9 % 4 is 1  10 % 4 is 2  11 % 4 is 3
12 % 4 is 0  13 % 4 is 1  14 % 4 is 2  15 % 4 is 3

- basics

- Going beyond (finish)
We are talking about integer division, which you were taught in school BEFORE DECIMALS

- How to you evenly divide 11 kittens among 4 children (and be nice to the kittens)?
- Well, you CAN'T. The answer is NOT 2.75 kittens per kid,
  which is what a dumb (or poorly taught) kid would get by doing the 11/4 division on a calculator.
  (MATH is solving problems..not calculating junky #s)
- BUT, you can give each kid 2 kittens, leaving 3, the REMAINDER, to be left over, perhaps for the teacher.
Future clicker/exam questions!
like Problem..you make up
Question..what's the best answer?

A) 2.75
B) 2
Division in Java

1. The expression $11/4$ expresses $2$ (NOT $2.75$)

2. The expression $11 \mod 4$ expresses $3$

3. Expressions $11.0/4$ $11/4.0$ $11.0/4.0$
   all express $2.75$, a floating point number
   like $6.022 \times 10^{23}$ molecules/g-mole

   $2.75$ in binary is $1.011000000 \times 2^1$

   in memory: TWO integers*: $101100000000000000000$ and $000000000000000000000$

   (this is a simplification. How the signs of the two integers work is ignored.)
Why is 2.75  
1.01100000000 x 2^1  

- 1.00000 is 1  
- 0.1 is 1/2  
- 0.01 is 1/4  
- 0.001 is 1/8  
- 1.011 is (1 + 1/4 + 1/8) is 1 3/8 when you add 'em up  
- 2^1 is just 2  
- (1 3/8) x 2 is 2 6/8 is 2 3/4 is 2.75  
- 2.75 is (2 75/100) of course
Future clicker/exams questions..like

• How is 5.375 stored as a binary radix fraction in a computer?

• $1.01011 \times 2^3$ is stored as
  
  10101100000 00000011

When Java prints it as a decimal, what do you see?
Applications

int

- Counting or dividing kittens, etc.
- LOCATING Pixels in a DIGITAL PICTURE
- LOCATING all kinds of data in an ARRAY
- Red, green or blue intensities in digital pictures. (0 to 255)
- Addresses (CSI333 C pointers) to LOCATE VARIABLES in MEMORY.

floats or doubles

- Locating or predicting where a satellite, bullet, baseball or other projectile is in space.
- (almost) All kinds of scientific measurements.
- Averages and other statistics.
- Blending color intensities, or maybe judging greenness better.
2 Java rules

• If you want math done with integers only, MAKE ALL THE given values integers. All remainders will be thrown away.

• If you want math done with fractional values (“decimals”, floating, double precision floating) MAKE ONE (or more) of the given values floating or double.
  - Double or single precision floating point values are “contagious” in Java.

• (for later) The Java cast operation can convert between int and floating types when you want that.
Future clicker/exam question.

Program in Java a program that first gets from the user 3 integer inputs.

Second, it computes their average as a double precision floating point value.

Third, it prints that average.