csci54 – discrete math & functional programming
tuples and lists

Recap

- Write a function cap' that not only caps the upper limit at 100, but additionally evaluates to 0 if n is less then or equal to 0.
- Write a function pow that takes two parameters n and k and returns n to the kth power. (assume that k is guaranteed to be a non-negative integer. do not use the ** operator)

```
cap' n =
   if n > 100
   then 100
   else
      if n < 0
      then 0
      else n
```

```
cap n =
   if n > 100
   then 100
   else n

cap' n =
      if n < 0
      then 0
      else (cap n)
```

```
pow n k =
  if k == 0
  then 1
  else n * (pow n (k-1))
```

maxInt

- write a function `maxInt` that takes a list of integers and returns the value of the largest element. you may assume the list is not empty.

```
maxInt [x] = x
maxInt (x:xs) = max x (maxInt xs)
```

Lists in Haskell

- Homogeneous (all same type)
- square brackets with element separated by commas
- building lists
  - square brackets with values separated by commas

```
ghci> aList = [1, 10, -3, 5]
```

  - cons

```
ghci> aList2 = 2 : [1, 10, -3, 5]
```

  - concatenation

```
ghci> aList3 = aList ++ aList2
```

Lists in Haskell continued

- functions on lists
  - head, tail
  - init, last
  - take, drop
  - length, null
  - reverse
  - ...

```
aList = [2, 1, 10, -3, 5]
```

- \`elem\` vs elem
  - infix vs. prefix
  - same with arithmetic functions: div, mod
    - div: round down
    - mod: integer mod (goes with div)

```
elem 1 [2, 1, 10, -3, 5]
1 `elem` [2, 1, 10, -3, 5]
```

```
-->true
-->true
```

(Haskell also has quot, rem, which behave differently than div/mod with negative numbers)

Practice problems

- what does this function do?

```
numList n =
   if n <= 0
   then []
   else
      n : (numList (n-1))
```

Practice problems

- (on week01-ps) numList n evaluates to a list of integers from n down to 1

```
numList n =
   if n <= 0
   then []
   else
      n : (numList (n-1))
```

- numList 3 →
    - 3 : numList 2 →
    - 3 : (2 : numList 1) →
    - 3 : (2 : (1 : numList 0) →
    - 3 : (2 : (1 : []))) == [3, 2, 1]

Practice problems

- (on week01-ps) numList n evaluates to a list of integers from n down to 1

```
numList n =
   if n <= 0
   then []
   else
      n : (numList (n-1))
```

- Write a function oddList where oddList n evaluates to a list of odd integers from n down to 1. If n < 1 the function should return an empty list.
- Write a function oddList' where oddList' evaluates to a list of odd integers from 1 up to, but possibly not including, n. If n < 1 the function should return an empty list. Do not use the reverse function.

- In this example, will aList and bList be the same at the end?

```
aList = [2, 1, 10, -3, 5]
bList = 2:aList
aList = 2:aList
```

List comprehensions (and ranges)

- A way to build up lists:

```
[ x*2 | x <- [1..3] ]
```

  - Note use of ranges in Haskell

```
[ 1,3..10 ]
[ 10,9..1 ]
```

```
[ 1,4..]
[ 47.. ]
```

- Can add more to list comprehensions:

```
[ x*y | x <- [1..3], y <- [6,4,2] ]
```

```
[ x*y | y <- [6,4,2], x <- [1..3] ]
```

More on list comprehensions

- Can add predicates:

```
[ x*y | x <- [1..3], y <- [1..3], x > y]
```

- Can use any expression:

```
[ if x*y > 3 then "BIG" else "SMALL" | x <- [1..3], y <- [1..3]]
```

```
[ (x,y) | x <- ['a'..'c'], y <- ["rat","ox","tiger"]]
```

  - a tuple does not need to be homogeneous; cannot append or concatenate, so must know number of elements from start

Practice problems

- Write a function oddList where oddList n evaluates to a list of odd integers from n down to 1. If n < 1 the function should return an empty list.
- Write a function oddList' where oddList' evaluates to a list of odd integers from 1 up to, but possibly not including, n. If n < 1 the function should return an empty list
- Rewrite oddList and oddList' using list comprehensions
- What do these evaluate to?

```
[ if x*y > 3 then [1] else [2] | x <- [1..3], y <- [1..3]]
[ (x,y,z) | x <- [1..3], y <- [1..3], z <- [1..3], x < y, y < z ]

[ (x,y,z) | z <- [1..3], y <- [1..3], x <- [1..3], x < y, y < z ]
```