Math 140 Forest fire model with wind

To demonstrate how to add further features to the basic model, today we'll look at adding effects of wind to the basic forest fire model, as well as setting some units.

1. Let's start with wind. We need to include both the strength of the wind and its direction, so create sliders for wind-speed and wind-angle. Remember that in NetLogo, 0° is north, 90° is east, and so on, which is different from the usual math convention. We use the cosine of the difference between the wind angle and the angle of the patch we're considering setting on fire (as described in class). Look up the *atan* function: it's a souped-up version of arctan that converts x and y values to an angle in the correct quadrant.

```
ask fires [
   let currx xcor
   let curry ycor
  ask patches in-radius 3 with [ pcolor = green ] ;; or use neighbors
 [
 let wind-effect  wind-speed / 100 * cos ( wind-angle - atan ( pxcor - currx ) ( pycor - curry ) )
 let urgency .5 * ( 1 + wind-effect ) / ( distancexy currx curry )
 if (random-float 1) < urgency
  [ ignite ]
] ]
```

2. Verify that your code is working as expected by running some tests. Do the wind-angle and wind-speed parameters appropriately change the way the fire spreads? Set the range of wind-speed values to be realistic with units of kilometers per hour.

3. Suppose you expect the fire front to expand at 1 meter per minute. Decide how large your patches will be (side length in units of meters) and how long each tick is (such as a second, a few seconds, a minute). Make these choices in conjunction with your choice of how the fire spreads (only to neighbors or to patches within some radius).

4. Have your model report a rate of fire spread over time, to compare with the 1 meter per minute estimate.

5. For a more realistic effect of wind (rather than the simple made-up formula given above), see the Fire Behavior section 8.2 at http://www.firefightermath.org/.

6. To add the effect of slope of the terrain, we can do something very similar to the wind. In this case, use the uphill direction in place of wind-angle. For an overview of how strongly slope affects rate of spread of the fire, see the Slope Effect section 8.7 of http://www.firefightermath.org/. (Or find your own sources relevant to the type of forest fire or wildfire that you want to model.)

For further examples of how to extend the basic model (to generate ideas and see how to code different aspects), see the following:

http://ccl.northwestern.edu/netlogo/models/community/Fire%20Ecology
http://files.bookboon.com/ai/Firebreak.html
http://computationalmodelingblogs.stanford.edu/winter2012/2012/01/17/extended-fire-model/
http://www.spatial-modelling.info/SimFeFeu-a-new-version-of-the-fire

(Note that some of these are more realistic than others, so be sure to do your own background research to decide how you want to develop your model.)