ECOSYSTEM MODELS

Jack Pine / White Pine / Spruce Frame Model, Part 2

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After you've run through your rule-based model, the next thing we need to do is report what your results are for time-step t+1. Let's go ahead and enter Time t+1. And we're going to be recording the State, the Time Since Fire (TSF), and the Stand Age. These will be outputs so we'll shade cells I18 through K18 as a blue.

Here is our portion of the spreadsheet that is going to be calculating, and recording, and updating the information based on the information we have here. So what would that be?

We're in time-step t. We know the state is S. We then drop down, run our rule-based model. Our rule-based model says we stay in S. We just need to summarize that, by recording that in cell I18. You can use a simple HLOOKUP function where we're going to look up the current state in this table. It will find the S and it'll dropdown and return the value that's in the cell, in this third row of that table. Let's do that now.

It's the HLOOKUP function. We're going to look up the value in cell H8. We're going to look it up in the table; that's cells I12 through K14. We're going to have it return the value in the first, second, third row. And we want to find an exact match so we'll enter the word FALSE. And then press OK.

What is our time since fire? Well, if there was a fire then we need to reset the Time Since Fire to 0. And if there was no fire then we're going to increment this value by a unit of 10. What formula would you use?

There's a couple of ways to go about this. But the easiest way is just to use an IF function. Our Logical test would be that if the fire is equal to 1. There was a fire so the time since fire needs to be reset to 0. Otherwise we're going to just take the previous Time Since Fire value and increment it by 10. Then press OK. If I press F9 there's no fire in my next time-step. I increment the time-step, Time Since Fire by 10 units. If there is a fire my Time Since Fire gets reset to 0.

How about the Stand Age? Well we can make an assumption here that the Stand Age is reset when either we harvest or when there is a fire. So if there is a fire, we can reset the Stand Age to 0. If there is a harvest we can reset it to 0 as well. So either of those will reset the Stand Age.

Here is where I am going to make an assumption about resetting these values. I actually don't know this model as well as Tony does. Here as the modeler, I would want to go back to the stakeholder and determine if this indeed was correct. Let's go ahead and make that assumption. But knowing full well that as the modeler this is where you would need to make sure that this, in fact, a correct assumption.

We said that the stand age would be reset if either of these cases are true. We're going to start off with an IF function. First thing we're going to do is our Logical test is going to be an OR function. First argument is cell K8 equal to 1, or is cell L8 equal to 1. We press OK. And OK again.

Now let's head back up into our IF function dialog box. If either, if there was a fire or a harvest then we're going to reset our Stand Age to 0. If not we're going to simply take our old Stand Age and increment that by 10 units. And press OK.

Let's just summarize where we are at so far. We have unique frames. Each frame is defined by a particular set of inputs that are unique to that frame. It forces us to focus only on those values and parameters that are driving that model, and allows us to get rid of any extra material that are really irrelevant.

We start by inputting our system in these cells here. This is our time-step at Time t. We determine if there was a fire or if there was a harvest during that time-step. We're going to assume that these events happen at the very end of the time-step. You come into a time-step, you're in State S, it's been 10 years since a fire, and the Stand Age is 10. There was no fire at the end of that time-step and there was no harvest at the end of the time-step.

Given that, we are in State S. We drop down here. We find the S for our starting frame. We run the rule-based model. We see that we're still in S. By recording it this way you can drop down and see exactly why you're still in an S, because all of these rules are explicit. Given this, our time-step at t+1 is we remain in State S. We increment our Time Since Fire up to 20. And we increment the Stand Age up to 20 as well.

The next step is for us to write a macro that will run this model through 120 years. To do that macro we're going to go ahead and choose the View tab. And then head over to the right side of the screen and we are going to record a macro. Let's just call this macro Run or whatever you choose to. If you want to run it by entering a shortcut key you can fill that in, and enter a description.

Now we're recording. For this particular model we are going to want to control when the spreadsheet calculates. We're going to go up to the Formulas tab and then choose the Calculation Options. We're going to set it to Manual. That way we're forced to enter F9 to calculate the spreadsheet. And that's going to be useful when we determine whether there is a fire or not.

Here we are at time-step t. What we want to do is press F9 to determine; here's the starting conditions of that state at time-step t. And then we determine was there a fire or was that stand harvested at the end of that 10-year time-step. We're going to take this and copy this. So go up to your Home tab and copy it. Then choose cell B7. Then head over to the Find and Select button. We're going to find the next blank cell. Make sure we're searching By Columns. And if this dialog box is closed you can open it up by pressing the Options button. When you click Find Next the active cell drops down one. Now you can press Close. Then we're going to select Paste Values. That establishes our first time-step.

Given this time-step, we've already pressed F9, so it's already determined that there is no fire or no harvest. Our next time-step needs to take the value, we run this J through the rule-based model and we see that we end up still in J. The next time-step is going to begin with Time Since Fire of 10 and the Stand Age will increment by 10. We need to paste those values. So we're going to copy those and then paste those values in here. So we'll go up to Paste Special, Paste Values. We're done with our spreadsheet.

The first thing that the macro does is it presses F9 to determine the starting conditions of the time-step. Press F9 to determine the harvest at the end of the time-step. Then it records those here. Then it takes the next time-step and makes those become the starting conditions for the next time-step, and so on.

We can now go back up to the View tab and press Macros, Stop Recording. To run that model, you can insert a shape. We've used the smiley face in the past. I have a button up on my

Quick toolbar, and so I'm going to load a button in there, and I'm going to have it run the macro called Run. I'm just going to label this Run Model.

If we press this button we should be able to see what is happening; what State we're in. And we should also be able to reason through why the changes happen when they have. We're in Jack Pine. Jack Pine switches to W if there is a fire. It switches to W if there is no fire for 80 years. There's no worry about that here. It switches to S if there is no fire for 80 years and the deer density is high. We're still in Jack Pine. We're going to be in Jack Pine until there is a fire. Now there's a fire. Jack Pine switches to W, if there is a fire and there has been no fire for 40 years. In our next model run we see it switching over to 0. We also see that our Time Since Fire has been reset to 0, as has the Stand Age.

Now we're in White Pine. White Pine switches to S when it's harvested. White Pine will be harvested at 120 years. Let's actually drop our model down a bit longer. The Stand Age is only 50. Let's drop this down quite a bit actually. And then we'll run the model. Here it's 120 years old. What we expect to happen now if our model is working correctly, is that because it's 120 years old - we are going to harvest it at the end of that time-step. What does it change to? White Pine switches to Spruce when harvested. And we see that's playing out as we expect.

That's basically what the frame model involves. I know this has been a long spreadsheet, but hopefully you've hung in there with us. The key points is that each model has its own input and once you're in a model you pay attention only to the key factors that drive that model. And those tell you when you switch out of that frame and move into a new frame.

What you would want to do then, is to do some graphics and some summary statistics for these projections. As you well know by now, you can also set this up as a Monte Carlo Simulation. Where you'll run this kind of a model repeatedly, so that you can start to tell your stakeholders what the behavior of the model is when you've repeated the runs time and time again.

Now that you have your spreadsheet working let's go ahead and save it by pressing the Office button. Then press Save As. You can name it whatever you'd like. I've called mine JWS Frame model. The thing you want to keep in mind is you want to save it as an Excel Macro Enabled Workbook, which has the extension .xlsm. When you're finished press Save. Now we can move on.

The other thing we'd like to do is take a peek at the Visual Basic code from our macro. If you choose the View tab and head over to the Macro button you can choose the View Macros. Then find your macro name. And we're going to edit this particular macro. The macro subroutine is labeled on the first line. I called mine Run.

The areas, the lines, that are coded that begin with an asterisk are comments. Those are not read by the computer as instructions, but are rather for you as the programmer to keep notes for yourself. Now if you do a lot of programming, you'll want to become very good at commenting your programs. The subroutine consists of lines of code. Then you end the subroutine with this End Sub statement.

Let's step through our macro. In our macro we started off by setting the calculation key to manual. Then we actually pressed F9, the calculate key, to generate new random numbers. We selected cells H8 through L8, which is the state of the system at time-step t. We copied those. Then we headed over to cell B7 and we found the next blank cell. And then we pasted in the values that represent the state of our system.

Then we headed down to cells I18 to K18 and selected those. Those tell us the state of the system at time-step T+1. We copied those values and then went to cell H8 and then pasted those values in. That establishes the next starting conditions for the next time we run the macro. Your code ought to look something like this. When you are finished you can press the red X button and it will return you to your spreadsheet.

Tony is going to show us how the same kind of model would look when it's coded into a standard computer science language.

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