**LUSOvar**

Here are some basic instructions for LUSOvar, the stochastic version of LUSO.

Please note that LUSOvar is still very much under development – if you have problems or for the most recent information, please contact Michael Renton or Roger Lawes

Before you start, you need to install python if you haven’t already got it. See the ‘install python.txt’ file.

**Relevant csv parameter files (see inputs directory)**

'\_LUSdetails\_used.csv': all land-use-specific information for an average season

'\_parameters\_used.csv': all non-land-use-specific information for an average season

'\_stochasticParameters\_used.csv': all information on how parameters vary in other-than-average seasons

**Relevant python files**

\* in all these files relevant information is specified in the first few lines of code (eg season sequence to simulate, landuse sequence to simulate etc). All these files are found in the base LUSO directory; other files in the ‘files’ directory are less likely to be of use or interest to most users.

**single run.py** should work as in the orginal LUSO, simulating a specified land use sequence assuming an average season every year, and give the biological and economic results

**single run variable season.py** should simulate a specified land use sequence for a specified sequence of seasons, and give the biological and economic results

**luso.py** should work as in the orginal LUSO, finding the best land use assuming an average season every year, and give the biological and economic results of this best result

**luso variable season.py** should find the best land use for a specified sequence of seasons. If the specified sequence were all average seasons then it should work the same as luso.py)

**multiple runs variable season.py** simulates a given crop rotation for a specified number of times, with each time having a randomly chosen sequence of seasons. The seaons within the sequence can eb chosen with or without replacement (as specified at the top of the file)

**How is disease modelled in LUSOvar?**

There are two variables tracked from year to year: disease incidence DI and disease damage DD.

For flexibility, the functions that control how DI changes from year to year, and the way that DD depends on DI and other factors are specified in their own file: diseasefuncs.py

In the current disease model, both variables are constrained to always lie between zero and one by using a logistic scale.

**Disease incidence DI**

Disease incidence DI is a representation of the amount of the disease-causing organism early in the growing season. It is always between 0 and 1, but could be scaled to any reasonable scale as desired. The 0 to 1 scale can be thought of as a quantile scale, ie DI of 0.5 means a median level of incidence.

Incidence DI can be affected by

* the incidence from the previous year (DI\_prev)
* the previous crop (NOT by the current crop, since it is early season incidence)
* the season (probably the summer weather mostly, or the early growing season weather from this year and maybe the late growing season weather from last year)
* a random factor – this represents anything for which we have no other explanation

The equation used is:

logit(DI) = IE\_previnc \* logit(DI\_prev) + logit(IE\_prevcrop) + logit(IE\_season) + rnorm(0,IE\_random)

IE is abbreviation for ‘incidence effect’

IE\_previnc is a general LUSO parameter that should be zero or greater. If set to zero then previous incidence has no effect at all. If set to one then previous incidence will tend to be maintained. If less than one, then incidence will tend towards average, if greater than one, then incidence will tend away from average.

IE\_prevcrop is a land-use specific parameter that gives the expected incidence, given the previous landuse, all else being equal. It must be greater than zero and less than one.

IE\_season is a season specific parameter that gives the expected incidence, given the previous weather (seasonal effect), all else being equal. It must be greater than zero and less than one. An average season should be ‘0.5’. A bad season for the disease should be closer to one, and a good season for the disease should be closer to zero.

The general parameter IE\_random controls the size of the random component in DI. If IE\_random is set to zero then there is no random effect at all, if IE\_random is set to be small (say 0.05) then there is a small random effect and if IE\_random is set to be large (say 0.5) then there is a large random effect.

As mentioned above, DI is constrained to always lie between zero and one by using a logistic scale. In addition, DI is constrained to be at least DI\_min, where DI\_min is a general LUSO parameter, to represent the fact that there is always some background population of the pathogen.

**Disease damage DD**

Disease damage DD is the proportion of crop yield lost to disease, for example, if DD = 0.02 then yield is reduced by 2% because of disease.

As mentioned above, DD is constrained to always lie between zero and one by using a logistic scale.

Incidence DD can be affected by

* the current incidence
* the current crop
* the season (probably the growing season weather mostly, especially the finish)
* a random factor – this represents anything for which we have no other explanation

The equation used is:

logit(DD) = DE\_inc \* logit(DI) + logit(DE\_crop) + logit(DE\_season) + rnorm(0,DE\_random)

DE is abbreviation for ‘damage effect’

DE\_inc is a general LUSO parameter that should be zero or greater. If set to zero then incidence has no effect at all on damage. If set to one then incidence has an approximately linear effect on damage.

DE\_crop is a land-use specific parameter that represents the ‘average’ damage to this kind of crop, given an average season and an average incidence. It should be between one and zero. If set to zero, no damage will ever occur, if set to one then damage is always 100%.

DE\_season is a season specific parameter that represents the seasonal effect on damage. It should be between one and zero. Setting it to 0.5 means season has no effect, ie an average season. If set to zero, no damage will ever occur, if set to one then damage is always 100%.

The general parameter DE\_random controls the size of the random component in DE. If DE\_random is set to zero then there is no random effect at all, if DE\_random is set to be small (say 0.05) then there is a small random effect and if DE\_random is set to be large (say 0.5) then there is a large random effect.