

Lab02matlabConversion

Aaron Swoboda and Oliver Hall

2025-04-15

This file aims to convert a series of Matlab scripts and data files into a R Markdown file that replicates the Tol (2023) Lab 2 for the economics of climate change. <https://github.com/rtol/ClimateEconomics>

The Matlab files this replicates are:

- MLIAM01.m
- MLIAM.mat
- init01.m
- MRHparam.m
- MRH.m
- RFparam.m
- RadForc.m
- STparam.m
- ST.m
- init02.m
- Popparam
- Outputparam
- CO2param

Overview - the MLIAM02.m script

```
# clear all
# load MLIAM
# init01
# init02
#
# for t=StartYear+1:EndYear,
#     i = t - StartYear + 1;
#     MRHbox(i,:) = MRH(MRHbox(i-1,:),CO2global(i-1),MRHlife,MRHshare,CO2convert);
#     CO2conc(i) = sum(MRHbox(i,:));
#     RF(i) = RadForc(CO2conc(i),RF0,CO20);
#     [atmtemp(i) oceantemp(i)] = ST(atmtemp(i-1),oceantemp(i-1),RF(i),STpar);
#     if t > 2010,
#         population(i,:) = population(i-1,:).*(1+popgrowth);
#         popgrowth= popdecline*popgrowth;
#         TFPgrowth= TFPdecline*TFPgrowth;
#     end
#     if t > 1960,
#         capital(i,:) = invest(capital(i-1,:),output(i-1,:),savings,depreciation);
#         TFP(i,:) = TFP(i-1,:).*(1+TFPgrowth);
#     end
#     if t >= 1960,
#         output(i,:) = CobbDouglas(TFP(i,:),capital(i,:),population(i,:),lambda);
```

```

#     end
#     if t > 2010,
#         energyint(i,:) = AEEI.*energyint(i-1,:);
#         emissint(i,:) = ACEI.*emissint(i-1,:);
#         energy(i,:) = energyint(i,:).*output(i,:);
#         CO2emit(i,:) = emissint(i,:).*energy(i,:);
#         CO2global(i) = CO2global(i-1)*sum(CO2emit(i,:))/sum(CO2emit(i-1,:));
#     end
# end

```

Step 1 - load the MLIAM.mat file

```
library(R.matlab)
```

```
## R.matlab v3.7.0 (2022-08-25 21:52:34 UTC) successfully loaded. See ?R.matlab for help.
```

```
##
```

```
## Attaching package: 'R.matlab'
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      getOption, isOpen
```

```
#MLIAM <- readMat("../TolMatlabFiles/MLIAM.mat")
```

```
MLIAM <- readMat("./MLIAM.mat")
```

```
ls.str()
```

```
## MLIAM : List of 11
```

```
## $ CO2global : num [1:551, 1] 0 3 3 3 3 3 3 3 3 3 ...
```

```
## $ CO2emit : num [1:551, 1:3] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ CO2concobs : num [1:689, 1:2] 2006 2005 2004 2003 2002 ...
```

```
## $ population : num [1:551, 1:3] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ output : num [1:551, 1:3] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ atmtempobs : num [1:551, 1] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ oceantempobs: num [1:551, 1] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ CO2emitobs : num [1:551, 1] 0 3 3 3 3 3 3 3 3 3 ...
```

```
## $ outputobs : num [1:551, 1:3] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ energy : num [1:551, 1:3] 0 0 0 0 0 0 0 0 0 0 ...
```

```
## $ NReg : num [1, 1] 3
```

```
CO2global <- MLIAM$CO2global # should we use this?
```

```
CO2emit <- MLIAM$CO2emit
```

```
# CO2concobs <- MLIAM$CO2concobs
```

```
population <- MLIAM$population
```

```
# output <- MLIAM$output
```

```
# atmtempobs <- MLIAM$atmtempobs
```

```
# oceantempobs <- MLIAM$oceantempobs
```

```
# CO2emitobs <- MLIAM$CO2emitobs # should we use this?
```

```
outputobs <- MLIAM$outputobs
```

```
energy <- MLIAM$energy
```

```
NReg <- MLIAM$NReg
```

Step 2 - run the init01.m script

```
climsens = 4.260547;
EndYear = 2300;
StartYear = 1750;
year = StartYear:EndYear
NYear = length(year)
```

Step 2a,b,c - run MRHparam, RFparam, STparam

```
# %MRHparam
MRHlife <- c(0, 1-exp(-1/363), 1-exp(-1/74), 1-exp(-1/17), 1-exp(-1/2))
#
MRH1750 <- c(275, 0, 0, 0, 0);
#
MRHshare <- c(0.13, 0.20, 0.32, 0.25, 0.10);
#
CO2convert = 1/2.13/1000;
#
MRHbox = matrix(0, NYear, 5); # "five boxes" for each year
MRHbox[1, ] = MRH1750;
CO2conc = matrix(0, NYear, 1);
CO20 = sum(MRH1750);
CO2conc[1] = CO20;

# %RFparam
### RadForc
RadForc <-function(CO2,RF0,CO20) RF0*log(CO2/CO20);
#
RF0 = 5.35;
RF = matrix(0, NYear, 1);
RF[1] = RadForc(CO20, RF0, CO20) #Needs the RadForc function

# %STparam

atmtemp0 = 0;
oceantemp0 = 0;

atmtemp = matrix(0, NYear, 1);
oceantemp = matrix(0, NYear, 1);

atmtemp[(1)] = atmtemp0;
oceantemp[(1)] = oceantemp0;

STpar <- c(climsens/RF0/log(2), 0.0256, 0.00738, 0.00568)
```

Step 3 - run init02.m script

```
consumption <- matrix(0, nrow = NYear, ncol = NReg)
# This script also calls scripts Popparam, Outputparam, and CO2param
```

Step 3a - Popparam

```
popgrowth <- population[2010 - StartYear + 1, ] / population[2009 - StartYear + 1, ] - 1
popdecline <- 0.95
popgrowth <- popdecline * popgrowth
```

Step 3b - Outputparam

```
capital <- matrix(0, nrow = NYear, ncol = NReg)
TFP <- matrix(0, nrow = NYear, ncol = NReg)
output <- matrix(0, nrow = NYear, ncol = NReg)
outputpc <- matrix(0, nrow = NYear, ncol = NReg)

TFPgrowth <- c(0.0206, 0.0260, 0.0236)
TFPdecline <- 0.99
outputpc2010 <- c(33498, 3170, 954)

lambda <- 0.2
savings <- 0.2
depreciation <- 0.1

A0 <- (outputobs[1960 - StartYear + 1, ] / population[1960 - StartYear + 1, ])^{(1 - lambda)}
A0 <- A0 * (depreciation / savings)^lambda
K0 <- (A0 ^ (1 / (1 - lambda))) * population[1960 - StartYear + 1, ]
K0 <- (savings / depreciation)^(1 / (1 - lambda)) * K0

capital[1960 - StartYear + 1, ] <- K0
TFP[1960 - StartYear + 1, ] <- A0
```

Step 3b - CO2param

```
CO2emitbau <- CO2emit
energyint <- energy / outputobs
emissint <- CO2emit / energy

AEEI <- energyint[(2010 - StartYear + 1), ] / energyint[(1960 - StartYear + 1), ]
AEEI <- AEEI ^ (1 / 50)
ACEI <- emissint[(2010 - StartYear + 1), ] / emissint[(1960 - StartYear + 1), ]
ACEI <- ACEI ^ (1 / 50)

AEEI <- c(0.98926539, 0.98782002, 0.99025746)
ACEI <- c(0.99594960, 1.00029674, 1.00979371)
```

Step 4 - define MRH, ST, and Cobb-Douglas functions

```
### MRH - Maier-Reimer Hasselmann model
MRH <- function(CO2concold, CO2emit, CO2life, CO2share, CO2convert) {
  CO2connew = (1-CO2life)*CO2concold + CO2convert*CO2share*CO2emit
  CO2connew
}

### Schneider-Thompson model of Ocean and Atm Temps
```

```

# updates the temperature of the atmosphere and the ocean using the Schneider-Thompson model
ST <- function(atmtempold,oceantempold,radforc,STpar) {
  atmtempnew = atmtempold +
    STpar[2]*(STpar[1]*radforc-atmtempold) +
    STpar[3]*(oceantempold-atmtempold)
  oceantempnew = oceantempold +
    STpar[4]*(atmtempold-oceantempold)
  temps <- c(atmtempnew, oceantempnew)
  names(temps) <- c("atm", "ocean")
  temps
}

```

Step 4a- define new Cobb-Douglas and invest functions

```

### Cobb-Douglas function
CobbDouglas <- function(A, K, L, lambda) {
  Y <- A * (K^lambda) * (L^(1 - lambda))
  return(Y)
}

### invest function
invest <- function(oldK, Y, s, d) {
  newK <- (1 - d) * oldK + s * Y
  return(newK)
}

```

Step 5 - the main loop, MLIAM02

```

for (t in (StartYear + 1):EndYear) {
  i <- t - StartYear + 1
  MRHbox[i, ] <- MRH(MRHbox[i - 1, ], CO2global[i - 1], MRHlife, MRHshare, CO2convert)
  CO2conc[i] <- sum(MRHbox[i, ])
  RF[i] <- RadForc(CO2conc[i], RF0, CO20)
  atmtemp[i] <- ST(atmtemp[i - 1], oceantemp[i - 1], RF[i], STpar)[1]
  oceantemp[i] <- ST(atmtemp[i - 1], oceantemp[i - 1], RF[i], STpar)[2]

  if (t > 2010) {
    population[i, ] <- population[i - 1, ] * (1 + popgrowth)
    popgrowth <- popdecline * popgrowth
    TFPgrowth <- TFPdecline * TFPgrowth
  }

  if (t > 1960) {
    capital[i, ] <- invest(capital[i - 1, ], output[i - 1, ], savings, depreciation)
    TFP[i, ] <- TFP[i - 1, ] * (1 + TFPgrowth)
  }

  if (t >= 1960) {
    output[i, ] <- CobbDouglas(TFP[i, ], capital[i, ], population[i, ], lambda)
  }

  if (t > 2010) {
    energyint[i, ] <- AEEI * energyint[i - 1, ]
  }
}

```

```
    emissint[i, ] <- ACEI * emissint[i - 1, ]  
    energy[i, ] <- energyint[i, ] * output[i, ]  
    CO2emit[i, ] <- emissint[i, ] * energy[i, ]  
    CO2global[i] <- CO2global[i - 1] * sum(CO2emit[i, ]) / sum(CO2emit[i - 1, ])  
  }  
}
```