Lab 04 Matlab Conversion

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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 4 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
- init03.m
- MLIAM03.m
- CobbDouglas.m
- invest.m
- init04.m
- MLIAM04.m

Overview - the MLIAM04.m script

```
# 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)
#   temp <- ST(atmtemp[i - 1], oceantemp[i - 1], RF[i], STpar)
#   atmtemp[i] <- temp[1]
#   oceantemp[i] <- temp[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) * (1 - relabcost[i - 
#     consumption[i, ] <- (1 - savings) * output[i, ]
#   }
#
#   if (t >= 2015) {
#
#   }
#
#   if (t > 2010) {
#     energyint[i, ] <- AEEI * energyint[i - 1, ]
#     emissint[i, ] <- ACEI * emissint[i - 1, ]
#     energy[i, ] <- energyint[i, ] * output[i, ]
#     CO2emitbau[i, ] <- emissint[i, ] * energy[i, ]
#
#     permitprice[i] <- 1000 * emitalloc[i, ] %*% CO2emitbau[i, ] / sum(0.5 * CO2emitbau[i, ]^2 / unita
#     emred[i, ] <- 0.5 * 0.001 * permitprice[i] * CO2emitbau[i, ] / unitabcost / output[i, ]
#     permittrade[i, ] <- (emitalloc[i, ] - emred[i, ]) * CO2emitbau[i, ]
#
#     CO2emit[i, ] <- CO2emitbau[i, ] * (1 - emred[i, ])
#     CO2global[i] <- CO2global[i - 1] * sum(CO2emit[i, ]) / sum(CO2emit[i - 1, ])
#
#     discountrate[i, ] <- PRTP + RRA * (consumption[i, ] / consumption[i - 1, ] - 1)
#     globalDR[i] <- PRTP + RRA * (sum(consumption[i, ]) / sum(consumption[i - 1, ]) - 1)
#   }
#
#   if (t > 2015) {
#     relabcost[i, ] <- unitabcost * emred[i, ]^2 + 0.001 * permitprice[i] * permittrade[i, ] / output[
#     totabcost[i, ] <- relabcost[i, ] * output[i, ]
#     margabcost[i, ] <- 2 * unitabcost * emred[i, ] * output[i, ] / CO2emit[i, ] * 1000
#   }
# }
```

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 init01.m script, MRHparam, RFparam, STparam

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

# %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
```

```r
# %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, Popparam, Outparam, and CO2param

```r
consumption <- matrix(0, nrow = NYear, ncol = NReg)

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

# %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

# %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, Cobb-Douglas and invest functions

```
### MRH - Maier-Reimer Hasselmann model
MRH <- function(CO2concold, CO2emit, CO2life, CO2share, CO2convert) {
  CO2concnew = (1-CO2life)*CO2concold + CO2convert*CO2share*CO2emit
  CO2concnew
}

### 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
}

### 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 - run init03 and init04

```
## init03
unitabcost <- c(0.1, 0.1, 0.1)
emred <- matrix(0, nrow = NYear, ncol = NReg)
relabcost <- matrix(0, nrow = NYear, ncol = NReg)
totabcost <- matrix(0, nrow = NYear, ncol = NReg)
margabcost <- matrix(0, nrow = NYear, ncol = NReg)

PRTP <- 0.03
RRA <- 1

discountrate <- matrix(0, nrow = NYear, ncol = NReg)
globalDR <- matrix(0, nrow = NYear, ncol = 1)

## init04
```

```
emitalloc <- matrix(0, nrow = NYear, ncol = NReg)
emitalloc[266:NYear, ] <- emitalloc[266:NYear, ] + 0.05
permittrade <- matrix(0, nrow = NYear, ncol = NReg)
permitprice <- matrix(0, nrow = NYear, ncol = 1)
```

Step 6 - the main script, MLIAM04

```
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)
  temp <- ST(atmtemp[i - 1], oceantemp[i - 1], RF[i], STpar)
  atmtemp[i] <- temp[1]
  oceantemp[i] <- temp[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) * (1 - relabcost[i - 1,
    consumption[i, ] <- (1 - savings) * output[i, ]
  }

  if (t >= 2015) {

  }

  if (t > 2010) {
    energyint[i, ] <- AEEI * energyint[i - 1, ]
    emissint[i, ] <- ACEI * emissint[i - 1, ]
    energy[i, ] <- energyint[i, ] * output[i, ]
    CO2emitbau[i, ] <- emissint[i, ] * energy[i, ]

    permitprice[i] <- 1000 * emitalloc[i, ] %*% CO2emitbau[i, ] / sum(0.5 * CO2emitbau[i, ]^2 / unitabco
    emred[i, ] <- 0.5 * 0.001 * permitprice[i] * CO2emitbau[i, ] / unitabcost / output[i, ]
    permittrade[i, ] <- (emitalloc[i, ] - emred[i, ]) * CO2emitbau[i, ]

    CO2emit[i, ] <- CO2emitbau[i, ] * (1 - emred[i, ])
    CO2global[i] <- CO2global[i - 1] * sum(CO2emit[i, ]) / sum(CO2emit[i - 1, ])

    discountrate[i, ] <- PRTP + RRA * (consumption[i, ] / consumption[i - 1, ] - 1)
    globalDR[i] <- PRTP + RRA * (sum(consumption[i, ]) / sum(consumption[i - 1, ]) - 1)
  }
```

```
  if (t > 2015) {
    relabcost[i, ] <- unitabcost * emred[i, ]^2 + 0.001 * permitprice[i] * permittrade[i, ] / output[i,
    totabcost[i, ] <- relabcost[i, ] * output[i, ]
    margabcost[i, ] <- 2 * unitabcost * emred[i, ] * output[i, ] / CO2emit[i, ] * 1000
  }
}
```