R use Apply, Sapply and dplyr Mutate to Evaluate one Function Across Rows of a Matrix

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Go back to fan's REconTools Package, R4Econ Repository, or Intro Stats with R Repository.

Issue and Goal

- r apply matrix to function row by row
- r evaluate function on grid
- Apply a function to every row of a matrix or a data frame
- r apply
- r sapply
- sapply over matrix row by row
- apply dplyr vectorize
- function as parameters using formulas
- do

We want evaluate linear function f(x__i, y__i, ar__x, ar__y, c, d), where c and d are constants, and ar__x and ar__y are arrays, both fixed. x__i and y__i vary over each row of matrix. More specifically, we have a functions, this function takes inputs that are individual specific. We would like to evaluate this function concurrently across N individuals.

The function is such that across the N individuals, some of the function parameter inputs are the same, but others are different. If we are looking at demand for a particular product, the prices of all products enter the demand equation for each product, but the product's own price enters also in a different way.

The objective is either to just evaluate this function across N individuals, or this is a part of a nonlinear solution system.

What is the relationship between apply, lapply and vectorization? see Is the "*apply" family really not vectorized?.

Set Up

```
rm(list = ls(all.names = TRUE))
options(knitr.duplicate.label = 'allow')
```

```
library(tidyverse)
library(knitr)
library(kableExtra)
# file name
st_file_name = 'fs_applysapplymutate'
# Generate R File
purl(paste0(st_file_name, ".Rmd"), output=paste0(st_file_name, ".R"), documentation = 2)
# Generate PDF and HTML
# rmarkdown::render("C:/Users/fan/R4Econ/support/function/fs_funceval.Rmd", "pdf_document")
# rmarkdown::render("C:/Users/fan/R4Econ/support/function/fs_funceval.Rmd", "html_document")
```

Set up Input Arrays

There is a function that takes $M = Q + P$ inputs, we want to evaluate this function N times. Each time, there are M inputs, where all but Q of the M inputs, meaning P of the M inputs, are the same. In particular, $P = Q * N$.

$$M = Q + P = Q + Q * N$$

```
# it_child_count = N, the number of children
it_N_child_cnt = 5
# it_heter_param = Q, number of parameters that are heterogeneous across children
it_Q_hetpa_cnt = 2

# P fixed parameters, nN is N dimensional, nP is P dimensional
ar_nN_A = seq(-2, 2, length.out = it_N_child_cnt)
ar_nN_alpha = seq(0.1, 0.9, length.out = it_N_child_cnt)
ar_nP_A_alpha = c(ar_nN_A, ar_nN_alpha)

# N by Q varying parameters
mt_nN_by_nQ_A_alpha = cbind(ar_nN_A, ar_nN_alpha)

# display
kable(mt_nN_by_nQ_A_alpha) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

ar_nN_A	ar_nN_alpha
-2	0.1
-1	0.3
0	0.5
1	0.7
2	0.9

Using apply

First we use the apply function, we have to hard-code the arrays that are fixed for each of the N individuals. Then apply allows us to loop over the matrix that is N by Q, each row one at a time, from 1 to N.

```
# Define Implicit Function
ffi_linear_hardcode <- function(ar_A_alpha){
  # ar_A_alpha[1] is A
  # ar_A_alpha[2] is alpha

  fl_out = sum(ar_A_alpha[1]*ar_nN_A + 1/(ar_A_alpha[2] + 1/ar_nN_alpha))

  return(fl_out)
}

# Evaluate function row by row
ar_func_apply = apply(mt_nN_by_nQ_A_alpha, 1, ffi_linear_hardcode)
```

Using sapply

- r convert matrix to list
- Convert a matrix to a list of vectors in R

Sapply allows us to not have tohard code in the A and alpha arrays. But Sapply works over List or Vector, not Matrix. So we have to convert the N by Q matrix to a N element list Now update the function with sapply.

```
ls_ar_nN_by_nQ_A_alpha = as.list(data.frame(t(mt_nN_by_nQ_A_alpha)))

# Define Implicit Function
ffi_linear_sapply <- function(ar_A_alpha, ar_A, ar_alpha){
  # ar_A_alpha[1] is A
  # ar_A_alpha[2] is alpha

  fl_out = sum(ar_A_alpha[1]*ar_nN_A + 1/(ar_A_alpha[2] + 1/ar_nN_alpha))

  return(fl_out)
}

# Evaluate function row by row
ar_func_sapply = sapply(ls_ar_nN_by_nQ_A_alpha, ffi_linear_sapply,
                        ar_A=ar_nN_A, ar_alpha=ar_nN_alpha)
```

Using dplyr mutate rowwise

- dplyr mutate own function
- dplyr all row function
- dplyr do function
- apply function each row dplyr
- applying a function to every row of a table using dplyr
- dplyr rowwise

```
# Convert Matrix to Tibble
ar_st_col_names = c('fl_A', 'fl_alpha')
tb_nN_by_nQ_A_alpha <- as_tibble(mt_nN_by_nQ_A_alpha) %>% rename_all(~c(ar_st_col_names))
# Show
kable(tb_nN_by_nQ_A_alpha) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

fl_A	fl_alpha
-2	0.1
-1	0.3
0	0.5
1	0.7
2	0.9

```
# Define Implicit Function
ffi_linear_dplyrdo <- function(fl_A, fl_alpha, ar_nN_A, ar_nN_alpha){
  # ar_A_alpha[1] is A
  # ar_A_alpha[2] is alpha

  print(paste0('cur row, fl_A=', fl_A, ', fl_alpha=', fl_alpha))
  fl_out = sum(fl_A*ar_nN_A + 1/(fl_alpha + 1/ar_nN_alpha))

  return(fl_out)
}
```

```r
# Evaluate function row by row of tibble
# fl_A, fl_alpha are from columns of tb_nN_by_nQ_A_alpha
tb_nN_by_nQ_A_alpha_show <- tb_nN_by_nQ_A_alpha %>% rowwise() %>%
                    mutate(dplyr_eval = ffi_linear_dplyrdo(fl_A, fl_alpha, ar_nN_A, ar_nN_alpha))
```

```
## [1] "cur row, fl_A=-2, fl_alpha=0.1"
## [1] "cur row, fl_A=-1, fl_alpha=0.3"
## [1] "cur row, fl_A=0, fl_alpha=0.5"
## [1] "cur row, fl_A=1, fl_alpha=0.7"
## [1] "cur row, fl_A=2, fl_alpha=0.9"
```

```r
# Show
kable(tb_nN_by_nQ_A_alpha_show) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

fl_A	fl_alpha	dplyr_eval
-2	0.1	2.346356
-1	0.3	2.094273
0	0.5	1.895316
1	0.7	1.733708
2	0.9	1.599477

same as before, still rowwise, but hard code some inputs:

```r
# Define function, fixed inputs are not parameters, but defined earlier as a part of the function
# ar_nN_A, ar_nN_alpha are fixed, not parameters
ffi_linear_dplyrdo_func <- function(fl_A, fl_alpha){
  fl_out <- sum(fl_A*ar_nN_A + 1/(fl_alpha + 1/ar_nN_alpha))
  return(fl_out)
}

# Evaluate function row by row of tibble
tbfunc_A_nN_by_nQ_A_alpha_rowwise = tb_nN_by_nQ_A_alpha %>% rowwise() %>%
                    mutate(dplyr_eval = ffi_linear_dplyrdo_func(fl_A, fl_alpha))
# Show
kable(tbfunc_A_nN_by_nQ_A_alpha_rowwise) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

fl_A	fl_alpha	dplyr_eval
-2	0.1	2.346356
-1	0.3	2.094273
0	0.5	1.895316
1	0.7	1.733708
2	0.9	1.599477

Using Dplyr Mutate with Pmap

Apparently *rowwise()* is not a good idea, and *pmap* should be used, below is the *pmap* solution to the problem. Which does seem nicer. Crucially, don't have to define input parameter names, automatically I think they are matching up to the names in the function

- dplyr mutate pass function
- r function quosure string multiple
- r function multiple parameters as one string

- dplyr mutate anonymous function
- quosure style lambda
- pmap tibble rows
- dplyr pwalk

```
# Define function, fixed inputs are not parameters, but defined earlier as a part of the function
# Rorate fl_alpha and fl_A name compared to before to make sure pmap tracks by names
ffi_linear_dplyrdo_func <- function(fl_alpha, fl_A){
  fl_out <- sum(fl_A*ar_nN_A + 1/(fl_alpha + 1/ar_nN_alpha))
  return(fl_out)
}

# Evaluate a function row by row of dataframe, generate list, then to vecotr
tb_nN_by_nQ_A_alpha %>% pmap(ffi_linear_dplyrdo_func) %>% unlist()
```

```
## [1] 2.346356 2.094273 1.895316 1.733708 1.599477
```

```
# Same as above, but in line line and save output as new column in dataframe
# note this ONLY works if the tibble only has variables that are inputs for the function
# if tibble contains additional variables, those should be droppd, or only the ones needed
# selected, inside the pmap call below.
tbfunc_A_nN_by_nQ_A_alpha_pmap <- tb_nN_by_nQ_A_alpha %>%
          mutate(dplyr_eval_pmap =
                   unlist(
                     pmap(tb_nN_by_nQ_A_alpha, ffi_linear_dplyrdo_func)
                     )
                 )

# Show
kable(tbfunc_A_nN_by_nQ_A_alpha_pmap) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

fl_A	fl_alpha	dplyr_eval_pmap
-2	0.1	2.346356
-1	0.3	2.094273
0	0.5	1.895316
1	0.7	1.733708
2	0.9	1.599477

DPLYR Three Types of INputs ROWWISE

Now, we have three types of parameters, for something like a bisection type calculation. We will supply the program with a function with some hard-coded value inside, and as parameters, we will have one parameter which is a row in the current matrix, and another parameter which is a sclar values. The three types of parameters are dealt with sparately:

1. parameters that are fixed for all bisection iterations, but differ for each row
   - these are hard-coded into the function
2. parameters that are fixed for all bisection iterations, but are shared across rows
   - these are the first parameter of the function, a list
3. parameters that differ for each iteration, but differ acoss iterations
   - second scalar value parameter for the function

- dplyr mutate function applow to each row dot notation
- note rowwise might be bad according to Hadley, should use pmap?

```
ffi_linear_dplyrdo_fdot <- function(ls_row, fl_param){
  # Type 1 Param = ar_nN_A, ar_nN_alpha
  # Type 2 Param = ls_row$fl_A, ls_row$fl_alpha
  # Type 3 Param = fl_param

  fl_out <- (sum(ls_row$fl_A*ar_nN_A + 1/(ls_row$fl_alpha + 1/ar_nN_alpha))) + fl_param
  return(fl_out)
}

cur_func <- ffi_linear_dplyrdo_fdot
fl_param <- 0
dplyr_eval_flex <- tb_nN_by_nQ_A_alpha %>% rowwise() %>%
                              do(dplyr_eval_flex = cur_func(., fl_param)) %>%
                              unnest(dplyr_eval_flex)
tbfunc_B_nN_by_nQ_A_alpha <- tb_nN_by_nQ_A_alpha %>% add_column(dplyr_eval_flex)
# Show
kable(tbfunc_B_nN_by_nQ_A_alpha) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

fl_A	fl_alpha	dplyr_eval_flex
-2	0.1	2.346356
-1	0.3	2.094273
0	0.5	1.895316
1	0.7	1.733708
2	0.9	1.599477

Compare Results

```
# Show overall Results
mt_results <- cbind(ar_func_apply, ar_func_sapply,
                    tb_nN_by_nQ_A_alpha_show['dplyr_eval'],
                    tbfunc_A_nN_by_nQ_A_alpha_rowwise['dplyr_eval'],
                    tbfunc_A_nN_by_nQ_A_alpha_pmap['dplyr_eval_pmap'],
                    tbfunc_B_nN_by_nQ_A_alpha['dplyr_eval_flex'],
                    mt_nN_by_nQ_A_alpha)
colnames(mt_results) <- c('eval_lin_apply', 'eval_lin_sapply',
                          'eval_dplyr_mutate',
                          'eval_dplyr_mutate_hcode',
                          'eval_dplyr_mutate_pmap',
                          'eval_dplyr_mutate_flex',
                          'A_child', 'alpha_child')
kable(mt_results) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "responsive"))
```

	eval_lin_apply	eval_lin_sapply	eval_dplyr_mutate	eval_dplyr_mutate_hcode	eval_dplyr_mutate_pmap
X1	2.346356	2.346356	2.346356	2.346356	2.346356
X2	2.094273	2.094273	2.094273	2.094273	2.094273
X3	1.895316	1.895316	1.895316	1.895316	1.895316
X4	1.733708	1.733708	1.733708	1.733708	1.733708
X5	1.599477	1.599477	1.599477	1.599477	1.599477