Using DEXi functions

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General information

This document explains how to use the DEXi_fct R code in order to work with DEXi-tree models under R (DEXi_fct) The code is in constant evolution. For more information, contact Jacques-Eric Bergez at INRA: jbergez@toulouse.inra.fr
In this code, the Tree is view as a set of Nodes.
A **Tree** is a R object made of:
- nbAttributes="numeric", #number of attributes
- nbLeaves="numeric", #number of leaves
- Depth="numeric", #Maximum depth of the tree
- Attributes="character", #List of names of attributes - Leaves="character", #List of names of leaves
- Aggregated="character", #List of names of aggregated nodes
- isMultiple="logical", #a simple tag to know if multiple leaves
- Multiple="data.frame", #List of the multiple leaves and number of occurence
- isLeafAggregated="logical", #a simple tag to know if leaf-aggregated nodes
- LeafAggregated="character", #List of names of leaf-aggregated nodes
- Paths="list", #Path from root to leaf
- Nodes="list", #List of nodes
- EvalOrder="numeric", #Evaluation order in case of LeafAggregated nodes
- rootName="character" #name of the root node

A **Node** is a R object made of
- id="numeric", #unique sequential id of the node
- name="character", #name of the node
- isLeaf="logical", #is it a leaf?
- isLeafAndAggregated="logical", #is this leaf also an aggregated node !
- children="character", #list of the names of the node's children
- sisters="character", #list of the names of the node's sisters
- mother="character", #name of the node's mother
- aggregation="matrix", #if aggregated node, table of aggregation
- Proba="numeric", #Estimated weight of aggregation. If Leaf set basically to uniform
- Depth="numeric", #Depth of the node
- Twin="numeric", #In case of multiple leaves, give the id of the other leaves
- CondiProbaList="list",
- rangeScale="numeric", #range scale
- scaleLabel="character", #Labels of the different scales
- nodePath="character" #Node path from root to leaf

To access an attribute Y of the object X under R use "@" : X@Y e.g. aNode@name give you the name of the node aNode

Basic functions

To create a DEXi tree under R

```
modelName<-"MASC2.0.dxi" #The name of the DEXi file
version <- "DEXi_fct_1.9.r" #The name of the current file of function
#Load the functions to read and manipulate the DEXi model
source(paste("functions",version,sep="/")) #Depends of the structure of
your directory

## Creating a generic function for 'print' from package 'base' in the
global environment

#read the structure of the model
MT<-xmlTreeParse(paste("data",modelName,sep="/"),useInternalNodes=T)
listDEXi<-createTree(MT)
DEXi <- listDEXi[[1]]
```

The function createTree returns a list in case of multiple trees (for example when integrating the satellite trees in the model). Then one choose the tree he wants to work with

To view the tree: three possibilities: print, show, describe

- print(aTree): gives a short summary of the tree

```
print(DEXi)

## Root name:  Contribution au developpement durable
## Number of attributes:  65
## Number of aggregated attributes:  26
## Number of true leaves (no multiple, no aggregated):  39
## Maximum depth:  6
## List of repeated aggregated nodes:  Non
## No multiple leaves
## No Leaf-Aggregated Leaf
```

- show(aTree): represents the hierarchy of the tree and give information on repeated leaves. In case of multiple leaves or leaf-aggregated nodes ID of similar nodes are provided

```
show(DEXi)

## < 1 >   Z:  Contribution au developpement durable
## < 2 >  - Y :  Dimension economique
## < 3 >  - - Y :  Resultats economiques
## < 4 >  - - - X :  Rentabilite
## < 5 >  - - - Y :  Autonomie economique
## < 6 >  - - - - X :  Independance economique
## < 7 >  - - - - X :  Efficience economique
## < 8 >  - - - X :  Surcout en materiel
## < 9 >  - - Y :  Capacite productive a long terme
## < 10 >  - - - Y :  Maitrise de la fertilite physico-chimique
## < 11 >  - - - - X :  Maitrise du statut acido-basique du sol
## < 12 >  - - - - X :  Maitrise de l etat structural du sol
## < 13 >  - - - - X :  Maitrise de la fertilite phosphopotassique
## < 14 >  - - - Y :  Maitrise des bioagresseurs
## < 15 >  - - - - X :  Maitrise des maladies et ravageurs
```

```
## < 16 >  - - - - X :  Maitrise des adventices
## < 17 >  - - Y :  Contribution au developpement economique
## < 18 >  - - - Y :  Qualite des produits
## < 19 >  - - - - X :  Qualite sanitaire
## < 20 >  - - - - X :  Qualite technonologique et esthetique des produits
## < 21 >  - - - X :  Contribution a l emergence de filieres
## < 22 >  - Y :  Dimension sociale
## < 23 >  - - Y :  Satisfaction des attentes de la societe
## < 24 >  - - - X :  Contribution a l emploi
## < 25 >  - - - X :  Fourniture de matieres premieres
## < 26 >  - - Y :  Satisfaction des attentes de l agriculteur
## < 27 >  - - - Y :  Facilite de mise en oeuvre
## < 28 >  - - - - X :  Complexite des itineraires techniques
## < 29 >  - - - - X :  Temps de veille technico-economique
## < 30 >  - - - Y :  Qualite des conditions de travail
## < 31 >  - - - - X :  Surcharge de travail
## < 32 >  - - - - X :  Risque pour la sante de l applicateur
## < 33 >  - - - - X :  Difficulte physique
## < 34 >  - Y :  Dimension environnementale
## < 35 >  - - Y :  Contribution a la qualite du milieu
## < 36 >  - - - Y :  Contribution a la qualite de l eau
## < 37 >  - - - - Y :  Maitrise des pertes de pesticides Eaux
## < 38 >  - - - - - X :  Maitrise pertes dans les eaux profondes
## < 39 >  - - - - - X :  Maitrise pertes dans les eaux superficielles
## < 40 >  - - - - X :  Maitrise des pertes de NO3
## < 41 >  - - - - X :  Maitrise des pertes de P
## < 42 >  - - - Y :  Contribution a la qualite air
## < 43 >  - - - - X :  Maitrise des emissions de NH3
## < 44 >  - - - - X :  Maitrise des emissions de N2O
## < 45 >  - - - - X :  Maitrise des emissions de pesticides Air
## < 46 >  - - - Y :  Preservation de la qualite du sol
## < 47 >  - - - - X :  Maitrise de l accumulation d elements toxiques
## < 48 >  - - - - X :  Maitrise du statut organique
## < 49 >  - - - - X :  Maitrise de l erosion
## < 50 >  - - Y :  Pression sur les ressources abiotiques
## < 51 >  - - - Y :  Pression Eau
## < 52 >  - - - - X :  Conso. en eau d irrigation en periode critique
## < 53 >  - - - - X :  Dependance vis a vis de la ressource en eau
## < 54 >  - - - Y :  Pression Energie
## < 55 >  - - - - X :  Consommation en energie
## < 56 >  - - - - X :  Efficience energetique
## < 57 >  - - - X :  Pression Phosphore
## < 58 >  - - Y :  Conservation de la biodiversite
## < 59 >  - - - Y :  Conservation de la macrofaune
## < 60 >  - - - - X :  Conservation des insectes volants
## < 61 >  - - - - X :  Conservation de la macrofaune du sol
## < 62 >  - - - Y :  Conservation de la flore
## < 63 >  - - - - X :  Abondance floristique
## < 64 >  - - - - X :  Diversite floristique
## < 65 >  - - - X :  Conservation des micro-organismes du sol
```

- describe(aTree): gives full information on the tree and nodes
- To view a given node: **print(aNode)**

```
print(DEXi@Nodes[[1]])
```

```
## Node name:  Contribution au developpement durable
## ID:  1
## Node depth:  1
## From root to node:  Contribution au developpement durable ->
## Is it a leaf:  FALSE
## Is is a leaf-aggregated:  FALSE
## Mother:  Root
## Sisters:  None
## Children:  Dimension economique Dimension sociale Dimension
environnementale
## Estimated weights:  33.33 33.33 33.33
```

To manipulate the tree

You can create subtree: createSubTree <- function(aTree,nodeName)
- aTree: the name of the main tree
- nodeName: the name of the node to cut the tree

```
subTree <- createSubTree(DEXi,"Dimension economique")
print(subTree)
```

```
## Root name:  Dimension economique
## Number of attributes:  20
## Number of aggregated attributes:  8
## Number of true leaves (no multiple, no aggregated):  12
## Maximum depth:  4
## List of repeated aggregated nodes:  Non
## No multiple leaves
## No Leaf-Aggregated Leaf
```

You can get the estimated weights of an aggregation table: getEstimatedWeights <- function(aNode)

```
getEstimatedWeights(DEXi@Nodes[[1]])
```

```
##       xDimension economique          xDimension sociale
##                      0.3358                      0.3321
## xDimension environnementale
##                      0.3321
```

You can change the aggregation table: createAggregationMatrix <- function(aNode,expectedWeight,nbTables=1,popSize=50,iters=50)
- aNode: the node that will be modified
- expectedWeight: an array of weights
- nbTables: the number of matrix to be returned
- popSize and iters: parameters for the algogen

```
myWeights <- c(0.2,0.2,0.6)
newAggregation <- createAggregationMatrix(DEXi@Nodes[[1]],myWeights,5)
newTree <- DEXi
newTree@Nodes[[1]]@aggregation <- newAggregation[[1]]
getEstimatedWeights(newTree@Nodes[[1]])
```

```
##       xDimension economique          xDimension sociale
##                         0.2                         0.2
## xDimension environnementale
##                         0.6
```

You can change the uniformity of the leaf modalities: changeLeavesUniformity<-function(aTree,aDistributionList)

```
DEXi@Nodes[[4]]@Proba
```

```
## [1] 0.25 0.25 0.25 0.25
```

```
DEXi@Nodes[[6]]@Proba
```

```
## [1] 0.25 0.25 0.25 0.25
```

```
myDistributionList <- list()
myDistributionList[[1]] <- c(0.5,0.2,0.2,0.1) ;
names(myDistributionList)[1] <- "Rentabilite"
myDistributionList[[2]] <- c(0.1,0.2,0.3,0.4) ;
names(myDistributionList)[2] <- "Independance economique"
newTree<-changeLeavesUniformity(DEXi,myDistributionList)
```

To simulate

You can create options: createOptions <- function(aTree,nbOptions=1,aSeed=-1)
- aTree: the name of the Tree
- nbOptions: the number of option to be created
- aSeed: in case one wants to create the same series of option unless random values are choses

```
option <- createOptions(DEXi,nbOptions=3)
head(option)
```

```
##                                       [,1] [,2] [,3]
## Rentabilite                              2    3    4
## Independance economique                  3    4    2
## Efficience economique                    2    1    3
## Surcout en materiel                      2    2    1
## Maitrise du statut acido-basique du sol  2    1    1
## Maitrise de l etat structural du sol     3    3    1
```

You can read options from DEXi output: loadOptions <- function(aFileName)
- aFileName: the name of the file created by DEXi using ...

The file structure is as

```
"",option
Rentabilite,1
Independance economique,3
Efficience economique,3
Surcout en materiel,2
Maitrise du statut acido-basique du sol,4
```

You can save options to be read by DEXi (File/Import/Import options/type csv): saveOptions <- function(options,file="options.csv")

The file structure is then

```
,V1,V2,V3
Rentabilite,4,1,3
Independance economique,3,2,4
Efficience economique,4,3,1
Surcout en materiel,1,2,2
Maitrise du statut acido-basique du sol,2,1,3
```

You can run the simulation: EvaluateScenario<-function(aTree,anOption)

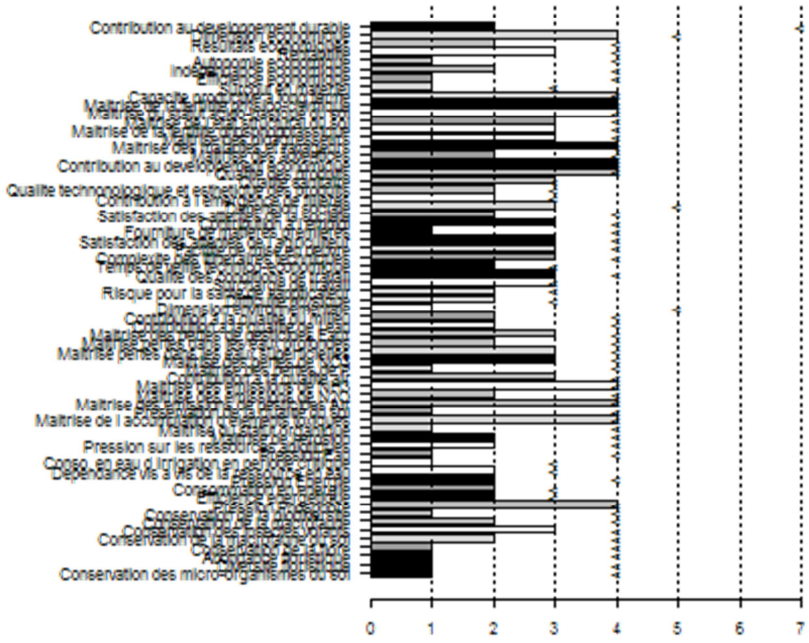
```
option <- createOptions(DEXi,nbOptions=10)
#Evaluate an option: function EvaluateScenario
scenarios <-
sapply(1:dim(option)[2],function(x)EvaluateScenario(DEXi,as.matrix(option[,
x])))
dim(scenarios)

## [1] 65 10

head(scenarios)

##                                      [,1] [,2] [,3] [,4] [,5] [,6] [,7]
## Contribution au developpement durable    2    5    3    4    1    1    2
## Dimension economique                     4    4    4    3    1    1    3
## Resultats economiques                    2    3    4    3    1    1    3
## Rentabilite                              3    3    4    4    1    1    2
## Autonomie economique                     1    3    3    2    2    2    3
## Independance economique                  2    2    2    3    1    1    4
##                                      [,8] [,9] [,10]
## Contribution au developpement durable    2    3     1
## Dimension economique                     2    5     1
## Resultats economiques                    1    3     1
## Rentabilite                              2    3     1
## Autonomie economique                     1    2     2
## Independance economique                  1    3     1
```

You can save the scenarios: saveScenarios <- function(scenarios,file="scenarios.csv")
The structure of the created file is:

```
"" "V1" "V2" "V3" "V4" "V5" "V6" "V7" "V8" "V9" "V10"
"Contribution au developpement durable" 1 1 2 1 1 2 3 4 2 2
"Dimension economique" 2 2 3 2 2 2 3 5 2 3
"Resultats economiques" 3 4 2 3 2 1 3 4 2 2
"Rentabilite" 3 4 2 3 3 1 3 4 1 1
"Autonomie economique" 2 3 3 3 1 2 3 3 4 4
"Independance economique" 1 4 2 4 2 1 2 3 4 4
```

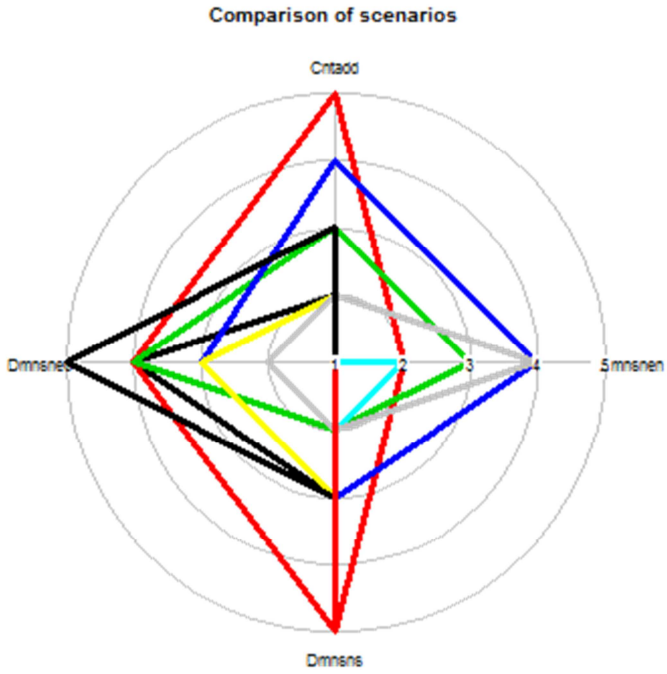
You can view a scenario (barplot): showScenario<-
function(aScenario,aTree,isLabelY=TRUE,isPar=T)
- aScenario: scenario to be shown
- aTree: the tree
- isLabelY: a boolean to draw the Y-axis
- isPAR: a boolean to format the graph

```
showScenario(as.matrix(scenarios[,1]),DEXi)
```



You can compare some scenario (radar plot): compareScenario <- function(aTree,theScenarios,listNodes)
- aTree: the tree
- theScenarios: the scenarios to be compared
- listNodes: the variables to be represented

```
compareScenario(DEXi,scenarios,c("Contribution au developpement
durable","Dimension economique","Dimension sociale","Dimension
environnementale"))
```



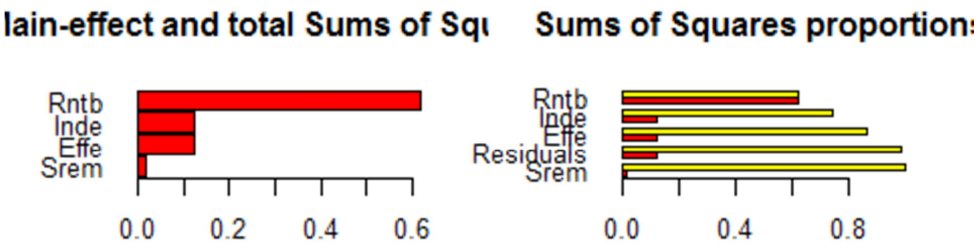
To perform sensitivity analysis of the tree

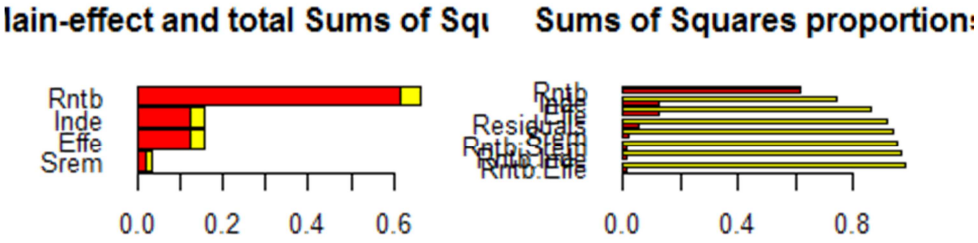
You can run an ANOVA
- First check the requested time: infoAOV <- function(aTree,iTest=50)
- Then if "adequate" run the anova AOV_DEXi<-function(aTree): two models are tested: additif and power 2
- And then show results: showAOV <- function(aAOV_DEXi, main.show=T, nb.plot=8, beside=T,las=1,...)

```
infoAOV(DEXi)

##
##  39  factors
##  Approximative required time to run the  9.574e+21  modalities 2.158e+19
minutes

petitArbre<-createSubTree(DEXi,"Resultats economiques")
infoAOV(petitArbre)

##
##  4  factors
##  Approximative required time to run the  192  modalities 0.004544
minutes

AOV_out<-AOV_DEXi(petitArbre)
AOV_out

## [[1]]
##      df     ss ss.ratio main.ss.ratio     cm      F
## Rntb  3 131.69    0.618         0.618 43.896 311.00
## Inde  3  26.19    0.123         0.123  8.729  61.84
## Effe  3  26.19    0.123         0.123  8.729  61.84
```

```
## Srem  2   3.51    0.016         0.016  1.755  12.44
##
## [[2]]
##              df     ss ss.ratio     cm      F
## Rntb          3 131.69    0.618 43.896 311.00
## Inde          3  26.19    0.123  8.729  61.84
## Effe          3  26.19    0.123  8.729  61.84
## Residuals   180  25.41    0.119  0.141   1.00
## Srem          2   3.51    0.016  1.755  12.44
##
## [[3]]
##      df      ss ss.ratio main.ss.ratio    cm      F
## Rntb 27 141.510    0.664         0.618 5.241 58.963
## Inde 27  32.885    0.154         0.123 1.218 13.702
## Effe 27  32.885    0.154         0.123 1.218 13.702
## Srem 20   7.104    0.033         0.016 0.355  3.996
##
## [[4]]
##              df      ss ss.ratio     cm       F
## Rntb          3 131.688    0.618 43.896 493.828
## Inde          3  26.187    0.123  8.729  98.203
## Effe          3  26.187    0.123  8.729  98.203
## Residuals   135  12.000    0.056  0.089   1.000
## Srem          2   3.510    0.016  1.755  19.746
## Rntb:Srem     6   3.281    0.015  0.547   6.152
## Rntb:Inde     9   3.271    0.015  0.363   4.089
## Rntb:Effe     9   3.271    0.015  0.363   4.089
## Inde:Effe     9   3.271    0.015  0.363   4.089
## Effe:Srem     6   0.156    0.001  0.026   0.293
## Inde:Srem     6   0.156    0.001  0.026   0.293
```

```
showAOV(AOV_out)
```





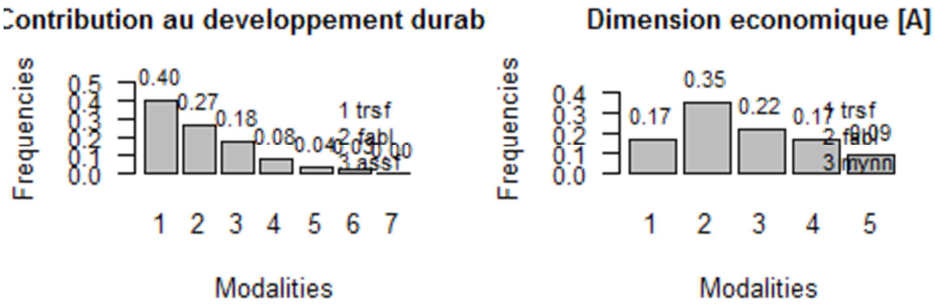

```
##               df      ss ss.ratio     cm       F
## Rntb           3 131.688    0.618 43.896 493.828
## Inde           3  26.187    0.123  8.729  98.203
## Effe           3  26.187    0.123  8.729  98.203
## Residuals    135  12.000    0.056  0.089   1.000
## Srem           2   3.510    0.016  1.755  19.746
## Rntb:Srem      6   3.281    0.015  0.547   6.152
## Rntb:Inde      9   3.271    0.015  0.363   4.089
## Rntb:Effe      9   3.271    0.015  0.363   4.089
## Inde:Effe      9   3.271    0.015  0.363   4.089
## Effe:Srem      6   0.156    0.001  0.026   0.293
## Inde:Srem      6   0.156    0.001  0.026   0.293
```

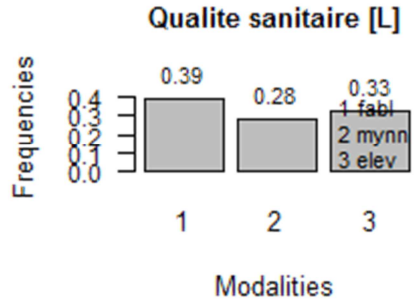
You can run a Monte-Carlo analysis

- First check the requested time: infoMC<- function(aTree,nbRuns,iTest=50)
- Then if adequate run the MC: MonteCarlo<-function(aTree,nbRuns,isFile=F)
- Then show results: ShowMC<-function(aNode,aMC)

```
nbRuns<-100
infoMC(DEXi,nbRuns)

##
##  Approximative required time to run MC with  100  simulations 0.2202
minutes

MC<-MonteCarlo(DEXi,nbRuns)

##
##  Time in:  Mon Sep 29 14:46:45 2014
##  Time out:  Mon Sep 29 14:46:59 2014
```

```
par(mfrow=c(2,2))
ShowMC(DEXi@Nodes[[1]],MC)

##    1    2    3    4    5    6    7
## 0.40 0.27 0.18 0.08 0.04 0.03 0.00

ShowMC(DEXi@Nodes[[2]],MC)

##    1    2    3    4    5
## 0.17 0.35 0.22 0.17 0.09

ShowMC(DEXi@Nodes[[19]],MC)

##    1    2    3
## 0.39 0.28 0.33

#Write a file that contain all the results obtained analysing the random
options selected for the MC analysis
write.table(MC,file=paste("output/","MC
results_.csv",sep=""),sep=",",row.names=T,col.names=NA)
```





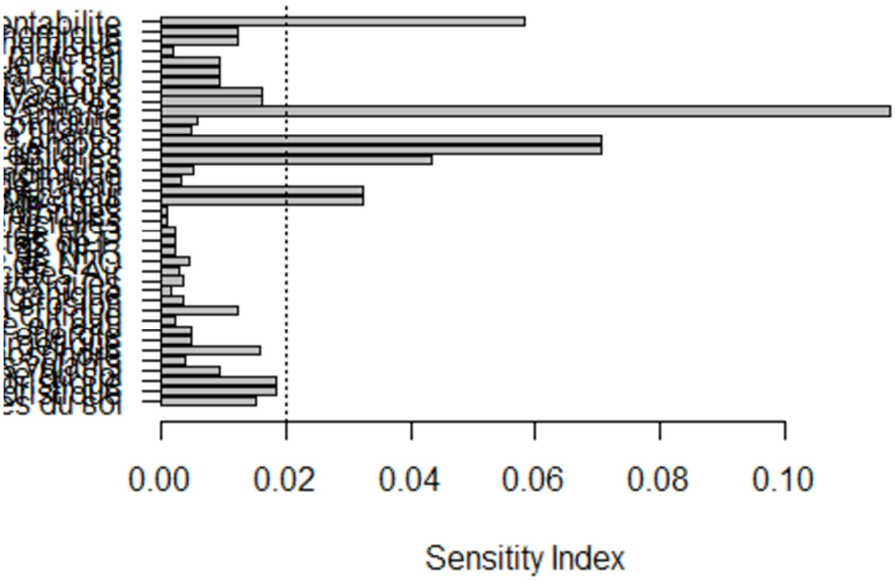
You can run a Sensitivity index computation

- Perform the analysis and save the file (to be used with Excel macro):SI_DEXi <- function(aTree,fileName="SI_out.csv",isFile=T)
- And then show the results for a given aggregated node showSI<-function(aTree,aSI)

```
SI <- SI_DEXi(DEXi,paste("output","SI_out.csv",sep="/"),TRUE)
SI[[1]]

##                                                    SI Leaf Depth
## Dimension economique                        0.3431348    0     2
## Resultats economiques                       0.0967172    0     3
## Rentabilite                                 0.0582635    1     4
```

```
## Autonomie economique                                    0.0257173    0     4
## Independance economique                                 0.0120880    1     5
## Efficience economique                                   0.0120880    1     5
## Surcout en materiel                                     0.0018553    1     4
## Capacite productive a long terme                        0.0717316    0     3
## Maitrise de la fertilite physico-chimique               0.0313068    0     4
## Maitrise du statut acido-basique du sol                 0.0092107    1     5
## Maitrise de l etat structural du sol                    0.0092107    1     5
## Maitrise de la fertilite phosphopotassique              0.0092107    1     5
## Maitrise des bioagresseurs                              0.0349783    0     4
## Maitrise des maladies et ravageurs                      0.0160998    1     5
## Maitrise des adventices                                 0.0160998    1     5
## Contribution au developpement economique                0.1398459    0     3
## Qualite des produits                                    0.1288367    0     4
## Qualite sanitaire                                       0.1169551    1     5
## Qualite technonologique et esthetique des produits      0.0057667    1     5
## Contribution a l emergence de filieres                  0.0048905    1     4
## Dimension sociale                                       0.3230152    0     2
## Satisfaction des attentes de la societe                 0.1538876    0     3
## Contribution a l emploi                                 0.0704336    1     4
## Fourniture de matieres premieres                        0.0704336    1     4
## Satisfaction des attentes de l agriculteur              0.1587331    0     3
## Facilite de mise en oeuvre                              0.0558515    0     4
## Complexite des itineraires techniques                   0.0432873    1     5
## Temps de veille technico-economique                     0.0050795    1     5
## Qualite des conditions de travail                       0.0911074    0     4
## Surcharge de travail                                    0.0030127    1     5
## Risque pour la sante de l applicateur                   0.0323120    1     5
## Difficulte physique                                     0.0323120    1     5
## Dimension environnementale                              0.1994813    0     2
## Contribution a la qualite du milieu                     0.0400211    0     3
## Contribution a la qualite de l eau                      0.0075263    0     4
## Maitrise des pertes de pesticides Eaux                  0.0017726    0     5
## Maitrise pertes dans les eaux profondes                 0.0008203    1     6
## Maitrise pertes dans les eaux superficielles            0.0008203    1     6
## Maitrise des pertes de NO3                              0.0022530    1     5
## Maitrise des pertes de P                                0.0022530    1     5
## Contribution a la qualite air                           0.0119380    0     4
## Maitrise des emissions de NH3                           0.0023570    1     5
## Maitrise des emissions de N2O                           0.0045663    1     5
## Maitrise des emissions de pesticides Air                0.0028191    1     5
## Preservation de la qualite du sol                       0.0123782    0     4
## Maitrise de l accumulation d elements toxiques          0.0034428    1     5
## Maitrise du statut organique                            0.0016544    1     5
## Maitrise de l erosion                                   0.0034428    1     5
## Pression sur les ressources abiotiques                  0.0506309    0     3
## Pression Eau                                            0.0155722    0     4
## Conso. en eau d irrigation en periode critique          0.0123105    1     5
## Dependance vis a vis de la ressource en eau             0.0022086    1     5
## Pression Energie                                        0.0109334    0     4
## Consommation en energie                                 0.0047787    1     5
## Efficience energetique                                  0.0047787    1     5
## Pression Phosphore                                      0.0158774    1     4
## Conservation de la biodiversite                         0.0829204    0     3
```

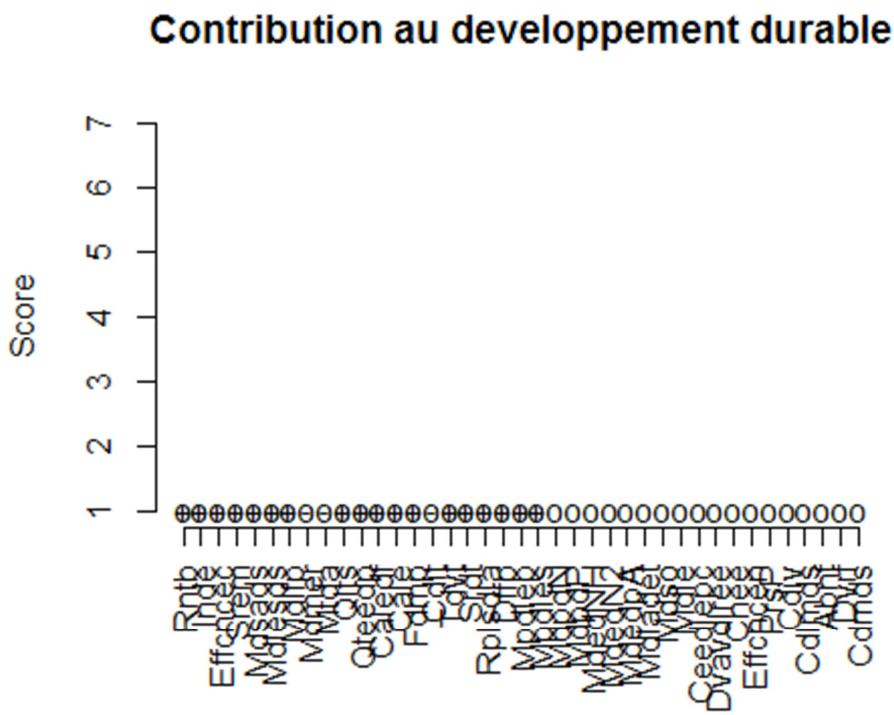
```
## Conservation de la macrofaune                          0.0150686    0     4
## Conservation des insectes volants                      0.0039362    1     5
## Conservation de la macrofaune du sol                   0.0093427    1     5
## Conservation de la flore                               0.0396258    0     4
## Abondance floristique                                  0.0185345    1     5
## Diversite floristique                                  0.0185345    1     5
## Conservation des micro-organismes du sol               0.0151833    1     4

showSI(DEXi,SI[[1]])
```



You can perform a One-At-a-Time analysis

- Perform the analysis: OAT<-function(aTree,option)
- And then show the results: showOAT<-function(nodeName,aResults,aTree)

```
optionOAT<-createOptions(DEXi,1)
results<-OAT(DEXi, optionOAT)
showOAT("Contribution au developpement durable",results,DEXi)
```


Contribution au developpement durable
Score
1
2
3
4
5
6
7