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Jacques-Eric Bergez

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# Using DEXi functions

JE Bergez

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**Current version 1.9**

## *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](mailto: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 occurrence
- 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,ifers=50)

- aNode: the node that will be modified
- expectedWeight: an array of weights
- nbTables: the number of matrix to be returned
- popSize and ifers: 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] <- "Indepondance 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
## Indepondance economique  3    4    2
## Efficiencie 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
Indepondance economique,3
Efficiencie 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)

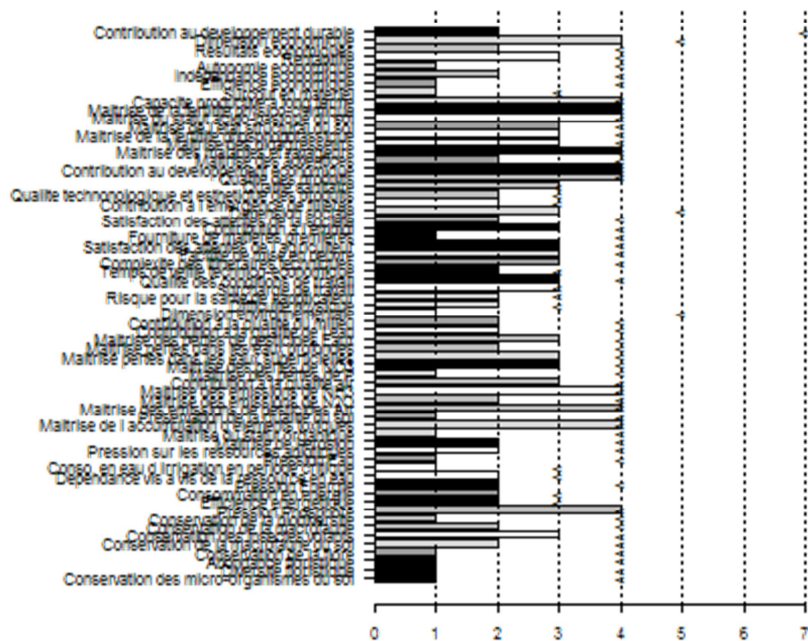
##           [,1] [,2] [,3] [,4] [,5] [,6] [,7]
## Contribution au developpement durable      2      5      3      4      1      1      2
## Dimension economique                       4      4      4      3      1      1      3
## Resultats economiques                      2      3      4      3      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

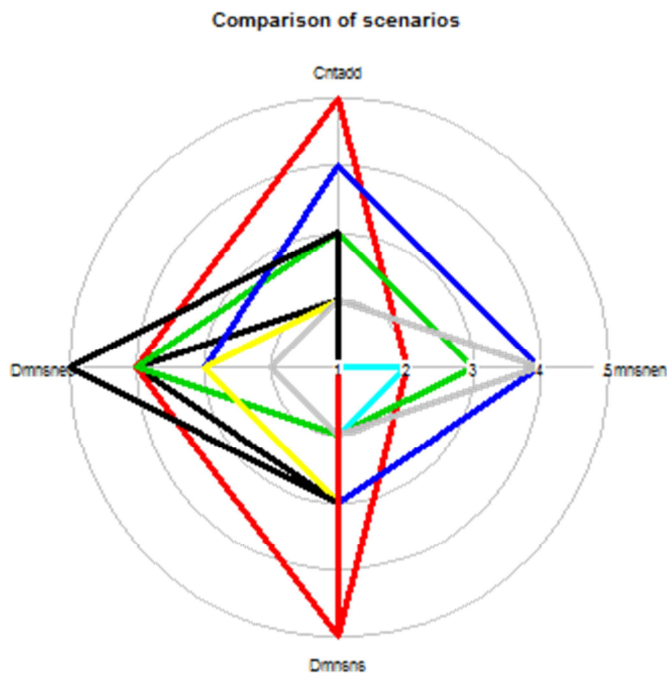
```
showScenario(as.matrix(scenarios[,1]),DEXi)
```



**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 développement durable","Dimension économique","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
```

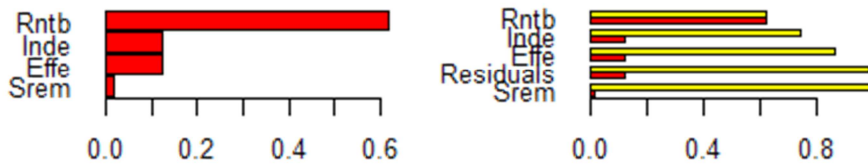
```

## 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

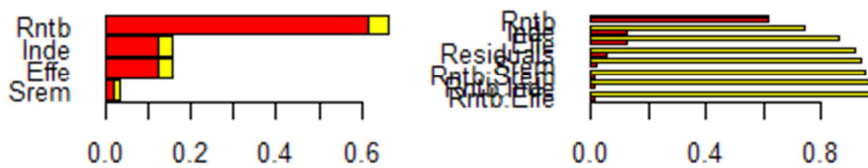
```

`showAOV(AOV_out)`

**lain-effect and total Sums of Sq**    **Sums of Squares proportion:**



**lain-effect and total Sums of Sq**    **Sums of Squares proportion:**



##	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

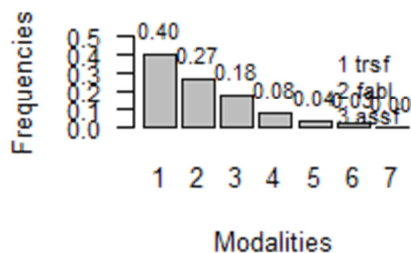
ShowMC(DEXi@Nodes[[19]],MC)

##      1      2      3
## 0.39 0.28 0.33

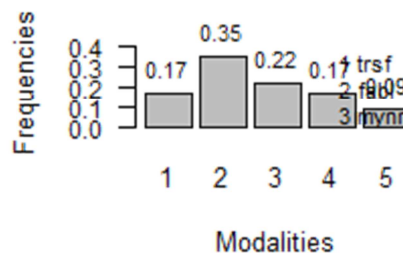
#Write a file that contain all the results obtained analysing the random
options selected for the MC analysis
write.table(MC,file=paste("output/","MC
results_.csv",sep=""),sep="," ,row.names=T,col.names=NA)

```

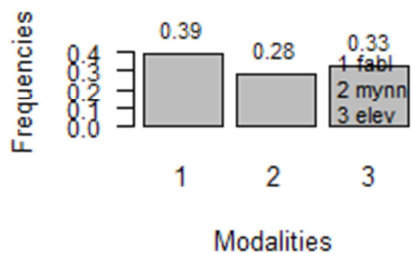
Contribution au developpement durab



Dimension economique [A]



Qualite sanitaire [L]



### 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]]

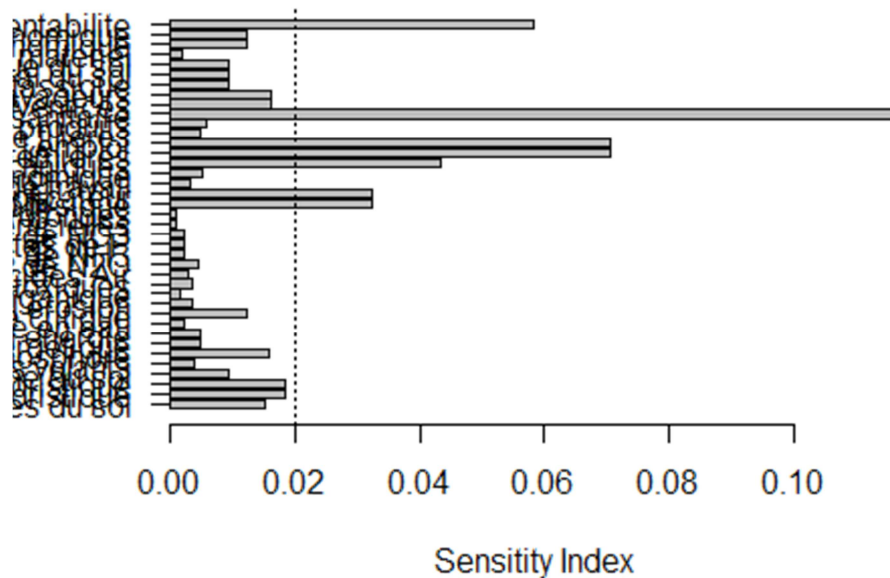
##
## Dimension economique          0.3431348    0    2
## Resultats economiques        0.0967172    0    3
## Rentabilite                   0.0582635    1    4

```

## 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)
```

