Package 'EnviroPRA'

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Type Package

Title Environmental Probabilistic Risk Assessment Tools

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Description Methods to perform a Probabilistic Environmental Risk assessment from exposure to toxic substances - i.e. USEPA (1997) <https://www.epa.gov/risk/guiding-principles-monte-carlo-analysis> -.

License GPL

Imports MASS, kSamples, stats, fitdistrplus, truncdist

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R topics documented:

EnviroPRA-package 2
AD 5
ADboot 6
AIR 7
AIRboot 8
condition 9
DWIR 10
DWIRboot 11
extr_par 12
Fit_dist_parameter 12
fit_dist_test 13
HI 15
HIdermal 15
HIinhal 16
INH 17

plot_fit_dist 18
random_number_generator 19
RISK 20
RISKdermal 21
RISKInhal 22
sampler 22
sig 23
SIR 24
SIRboot 25
VI 26
VIboot 27

Index **28**

`EnviroPRA-package` *Environmental Probabilistic Risk Assessment Tools*

Description

A collection of functions employed in environmental risk assessment to model exposure to a toxicant and predicting health effects, allowing to characterize variability and uncertainty in risk estimations

Details

The DESCRIPTION file:

Package:	EnviroPRA
Type:	Package
Title:	Environmental Probabilistic Risk Assessment Tools
Version:	1.0
Date:	2017-02-22
Author:	F. Barrio-Parra, with contributions from A. Dominguez-Castillo.
Maintainer:	Fernando Barrio-Parra <fernando.barrio@upm.es>
Description:	Methods to perform a Probabilistic Environmental Risk assessment from exposure to toxic substances - i.e. US
License:	GPL
Imports:	MASS, kSamples, stats, fitdistrplus, truncdist

Index of help topics:

```
AD                      Dermal conctact with chemicals in soil
ADboot                  Dermal conctact with chemicals in soil by
                        bootstrap
AIR                     Inhalation of airborne chemicals
AIRboot                 Inhalation of airborne chemicals by bootstrap
DWIR                    Chemical intake by Drinking Water
DWIRboot                Chemical intake by Drinking Water by bootstrap
```

EnviroPRA-package	Environmental Probabilistic Risk Assessment Tools
Fit_dist_parameter	Returns adjusted distribution parameters
HI	Hazard Index
HIdermal	Hazard Index for dermal contact
HIinhal	Hazard Index for inhalation of vapors
INH	Inhalation of resuspended soil particles
RISK	Risk
RISKInhal	Risk for inhalation of vapors
RISKdermal	Risk for dermal contact
SIR	Chemical intake by accidental soil ingestion
SIRboot	Chemical intake by accidental soil ingestion by bootstrap
VI	Chemical intake by ingestion of vegetables
VIboot	Chemical intake by ingestion of vegetables by bootstrap
condition	p-value significance checking function
extr_par	Extracts the fitted distribution parameters to be introduced in other function
fit_dist_test	Summary of Godness-of-fit tests
plot_fit_dist	Graphical representation of data fitting to a distribution
random_number_generator	Random number generator
sampler	Execute sampling with replacement
sig	Significance level cheking function

~~ An overview of how to use the package, including the most important functions ~~

Author(s)

F. Barrio-Parra, with contributions from A. Dominguez-Castillo.

Maintainer: Fernando Barrio-Parra <fernando.barrio@upm.es>

Examples

```
#### Performs Deterministic Environmental Risk Assessment #####

# Example of dermal contact with a chemical in swiming water

# Estimate the dermal absorbed dose during swiming in waters with a carcinogenic chemical
# (water concentration of 250 mg/m^3)

DWIR ( CW = 250)

# For a systemic effect:

DWIR ( CW= 250, AT=24*365)
```

```
# Specifying all the parameters for the carcinogenic case

I = DWIR ( CW=250, IR=1.5, EF = 300, ED = 24, BW = 85)

# Chemical Slope factor

SFAs = 1.5

# Dermal Absorption Factor

ABSAs = 3e-02

# Gastrointestinal Absorption Factor

GIAs = 1

# Risk Estimation

RISKdermal (AD = I, SF = SFAs, GI = GIAs)

#### Perform a test to assess the fitness of a theorical distribution to empirical data ####

set.seed(123)

a <- rnorm(n=100, mean =1.5, sd = 0.25)

b <- rnorm(n = 15, mean = 300, sd = 15)

fit_dist_test(a)

fit_dist_test(b)

# Graphical representation of data fitting to a distribution

plot_fit_dist(a, "norm")

plot_fit_dist(b, "norm")

####  Perform a Probabilistic Environmental Risk Assessment ####

Fita <- Fit_dist_parameter(a)

Fitb <- Fit_dist_parameter(b)

IRr <-random_number_generator(n = 10000, Fited = Fita,
                              dist = "norm", a =0.8, b = 2.1)

EFr <-random_number_generator(n = 10000, Fited = Fitb,
                              dist = "norm", a =250, b = 330)

I = DWIR ( CW=250, IR=IRr, EF = EFr, ED = 24, BW = 85)

# Risk Estimation
```

```
Risk <- RISKdermal (AD = I, SF = SFAs, GI = GIAs)

hist (Risk)

quantile (Risk, c (0.05, 0.25, 0.5, 0.75, 0.95))
```

AD *Dermal conctact with chemicals in soil*

Description

Estimates the Absorbed dose [mg/Kg*day] of chemicals through dermal contact with a soil

Usage

```
AD(CS = 1, SA = 2800, AF = 0.2, ABS = 0.001, EF = 350, ED = 24, BW = 70, AT = 365 * 70)
```

Arguments

CS	Chemical concentration in soil [mg/Kg]
SA	Skin surface area available for contact [cm^2]
AF	Skin adherence factor [mg/cm^2]
ABS	Absorption factor (Chemical specific) [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical Absorbed dose [mg/Kg*day]

Author(s)

F. Barrio-Parra

References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
## Estimated absorbed dose for the estimation of carcinogenic effects using
# the default variables (EPA 2011) for a chemical soil concentration of
# 0.2 mg/Kg

AD( CS=0.2)

# For a systemic effect:

AD( CS=0.2, AT=24*365)

# Specifying all the parameters for the carcinogenic case

AD( CS=0.2, SA=2300, AF=0.25, ABS=0.01, EF=150, ED=10, BW=80)
```

ADboot *Dermal conctact with chemicals in soil by bootstrap*

Description

Dermal conctact with chemicals in soil by bootstrap

Usage

```
ADboot(n, CS, SA, AF, ABS, EF, ED, BW, AT)
```

Arguments

n	Output vector length
CS	Chemical concentrtion in soil [mg/Kg]
SA	Skin surface area available for contact [cm^2]
AF	Skin adherence factor [mg/cm^2]
ABS	Absorption factor (Chemical specific) [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical Absorbed dose [mg/Kg*day]

Author(s)

F. Barrio-Parra

Examples

```
# Carcinogenic effects

c <- rnorm( n= 10, mean = 0.2, sd = 0.05 )

b <- rnorm( n= 100, mean = 20, sd = 5 )

ADboot (n = 1000, SA=2300, AF=0.25, ABS=0.01,CS = c, BW = b, ED = 10, EF = 250)
```

AIR *Inhalation of airborne chemicals*

Description

Estimates the Intake rate by inhalation of airborne chemicals (vapor phase) [mg/Kg*day]

Usage

```
AIR(CA = 1, IR = 20, ET = 24, EF = 350, ED = 24, BW = 70, AT = 365 * 70)
```

Arguments

CA	Chemical concentrtion in air [mg/m^3]
IR	Inhalation Rate [m^3/hour]
ET	Exposure time [hours/day]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Intake rate by inhalation of airborne chemicals (vapor phase) I [mg/Kg*day]

Author(s)

F. Barrio-Parra

References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
## Estimated absorbed dose for the estimation of carcinogenic effects using
# the default variables (EPA 2011) for a chemical air concentration
# of 0.2 mg/m^3

AIR ( CA=0.2)

# For a systemic effect:

AIR ( CA=0.2, AT=24*365)

# Specifying all the parameters for the carcinogenic case

AIR ( CA=0.2, IR=25, ET = 24, EF = 300, ED = 24, BW = 85)
```

AIRboot *Inhalation of airborne chemicals by bootstrap*

Description

Estimates the Intake rate by inhalation of airborne chemicals (vapor phase) [mg/Kg*day]

Usage

```
AIRboot(n, CA, IR, ET, EF, ED, BW, AT)
```

Arguments

n	Output vector length
CA	Chemical concentrtion in air [mg/m^3]
IR	Inhalation Rate [m^3/hour]
ET	Exposure time [hours/day]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Intake rate by inhalation of airborne chemicals (vapor phase) I [mg/Kg*day]

Author(s)

F. Barrio-Parra

Examples

```
# Carcinogenic effects

c <- rnorm( n= 10, mean = 0.2, sd = 0.05 )

b <- rnorm( n= 100, mean = 20, sd = 5 )

AIRboot (n = 1000, CA=c, IR=25, ET = 24, EF = 300, ED = 24, BW = b)
```

---

condition *p-value significance checking function*

Description

Auxiliar function to check p-value significance

Usage

```
condition(n)
```

Arguments

n	p-value

Value

Return "Significant" or "Not-significant"

Examples

```
condition ( 0.001)

condition (0.1)
```

DWIR *Chemical intake by Drinking Water*

Description

Estimates the chemical Intake rate by Drinking Water [mg/Kg*day]

Usage

```
DWIR(CW = 1, IRW = 2, EF = 350, ED = 24, BW = 80, AT = 365 * 70)
```

Arguments

CW	Chemical concentrtion in water [mg/L]
IRW	Water Ingestion Rate [L/Day]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical intake rate by drinking water I [mg/Kg*day]

Author(s)

F. Barrio-Parra

References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
# Estimate the dermal absorbed dose during swiming in waters with a carcinogenic chemical
# (water concentration of 250 mg/m^3)

DWIR ( CW = 250)

# For a systemic effect:

DWIR ( CW= 250, AT=24*365)

# Specifying all the parameters for the carcinogenic case

DWIR ( CW=250, IR=1.5, EF = 300, ED = 24, BW = 85)
```

DWIRboot *Chemical intake by Drinking Water by bootstrap*

Description

Estimates the chemical Intake rate by Drinking Water [mg/Kg*day]

Usage

```
DWIRboot(n, CW, IRW, EF, BW, ED, AT)
```

Arguments

n	Output vector length
CW	Chemical concentrtion in water [mg/L]
IRW	Water Ingestion Rate [L/Day]
EF	Exposure frequency [day/yr]
BW	Body weight [Kg]
ED	Exposure duration [yr]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical intake rate by drinking water I [mg/Kg*day]

Author(s)

F. Barrio-Parra

Examples

```
# Carcinogenic effects

c <- rnorm( n= 10, mean = 250, sd = 15 )

b <- rnorm( n= 100, mean = 20, sd = 5 )

DWIRboot (n = 1000, CW=c, IR=1.5, EF = 300, ED = 24, BW = b)
```

`extr_par` *Extracts the fitted distribution parameters to be introduced in other function*

Description

Auxiliar function

Usage

```
extr_par(x, dist)
```

Arguments

`x`	List of parameters obtained by the aplication of the Fit_dist_parameter function
`dist`	Name of the distribution we would like to stract the parameters ("norm", "lnorm", "geom", "exp", "pois", "gamma", "cauchy", "logis", "weibull", "nbinom", "beta", "chisq", "t", "f")

Author(s)

F. Barrio-Parra

Examples

```
a <- rnorm(n=100, mean =10, sd = 1)

b <- Fit_dist_parameter(a)

extr_par(x = b, dist ="norm")
```

`Fit_dist_parameter` *Returns adjusted distribution parameters*

Description

Returns the distribution parameters adjusted for by maximum likelihood (mle) for the following distributions: "normal","log-normal","geometric","exponential","Poisson", "cauchy" , "logistic" and "weibull"

Usage

```
Fit_dist_parameter(x)
```

Arguments

x	A numeric vector of length at least one containing only finite values (non-censored data)

Value

normal	Fitted Mean and sd for a normal distribution
‘log-normal‘	Fitted Meanlog and sdlog for a log-normal distribution
geometric	Fitted prob for a geometric distribution
exponential	Fitted rate for a exponential distribution
Poisson	Fitted lambda for a exponential distribution
cauchy	Fitted location and scale for a Cauchy distribution
logistic	Fitted location and scale for a Logistic distribution
weibull	Fitted shape and scale for a weibull distribution

Author(s)

F. Barrio-Parra

See Also

Function fitdistr in Library (MASS)

Examples

```
a <- rnorm(n=100, mean =10, sd = 1)

b <- Fit_dist_parameter(a)

# Examples of result extraction

b$normal

b$weibull
```

---

fit_dist_test *Summary of Godness-of-fit tests*

Description

Returns a data frame with the summary of Fiting distribution tests for the following distributions: "normal","log-normal","geometric","exponential","Poisson", "cauchy" , "logistic" and "weibull".

The considered Godness-of-fit tests are: Bayesian Information Criterium (BIC), Akaike Information Criterium (AIC), Kolmogorov-Smirnov test and Anderson-Darling test.

Usage

```
fit_dist_test(x)
```

Arguments

x	A numeric vector of length at least one containing only finite values

Value

Distribution	Name of the tested distribution
BayesianIC	Bayesian Information Criterium (BIC)
AkaikeIC	Akaike Information Criterium (AIC)
Kol-SmirD	The value of the Kolmogorov-Smirnov test statistic
Kol-SmirPvalue	The value of the Kolmogorov-Smirnov test p-value
Signigicance KS	A column to check the significance of the Kolmogorov-Smirnov test
And-Darl	The value of the nderson-Darling test statistic
And-DarlPvalue	The value of the Anderson-Darling test p-value
Signigicance AD	A column to check the significance of the Anderson-Darling test

Author(s)

F. Barrio-Parra

See Also

ad.test library(kSamples), AIC library(stats), BIC library(stats), ks.test library(stats),

Examples

```
set.seed(123)

a <- rnorm(n=100, mean =10, sd = 1)

fit_dist_test(a)

b<- rexp(n = 100,rate = 1)

fit_dist_test(b)
```

HI *Hazard Index*

Description

Returns the Hazard Index (non carcinogenic effects)

Usage

```
HI(I, RFD)
```

Arguments

I	Intake Rate [mg/Kg*day]
RFD	Reference dose [mg/Kg*day]

Value

Hazard Index [-]

Author(s)

F. Barrio-Parra

Examples

```
# Assessing if there is systemic risk for an adult receptor that drinks water with 1000 ug/L
# of hexaclorobence (Reference Dose (IRIS data base) = 8e-04 [mg/Kg*day]) in a residencial
# scenario (default EPA Maximum Reasonable Exposure parameters)


HI (I = DWIR( CW=1, AT=24*365), RFD = 8e-04)
```

HIdermal *Hazard Index for dermal contact*

Description

Returns the Hazard Index for dermal exposure with chemicals (non carcinogenic effects)

Usage

```
HIdermal(AD, RFD, GI)
```

Arguments

AD	Absorbed dose [mg/Kg*day]
RFD	Reference dose [mg/Kg*day]
GI	Gastrointestinal Absorption factor (chemical specific) [-]

Value

Hazard Index [-]

Author(s)

F. Barrio-Parra

See Also

AD EnviroPRA

Examples

```
# Assess if there is non-carcinogenic risk for an dadult thorug dermal
# contact exposed to a soil that contains 45 mg/Kg of As in a residencial
# scenario (default EPA Maximum Reasonable Exposure parameters)

RfDAs = 3e-04

# Dermal Absorption Factor

ABSAs = 3e-02

# Gastrointestinal Absorption Factor

GIAs = 1

I = AD (CS = 45,ABS = ABSAs, AT= 24*365)

HIdermal (AD = I, RFD = RfDAs, GI = GIAs)
```

HIinhal *Hazard Index for inhalation of vapors*

Description

Returns the Hazard Index (systemic effects) for inhalation of vapors

Usage

```
HIinhal(INH, RFC)
```

Arguments

INH	Inhalated dose (mg/m^3)
RFC	Reference concentration (mg/m^3)

Value

Hazard Index (non carcinogenic effects) [-]

Author(s)

F. Barrio-Parra

See Also

AIR EnviroPRA

Examples

```
# Assess if there is systemic risk for the exposure of an adult
# (Reasonable Maximum Exposure) to a Toluene air concentration of 2 mg/ m^3

HIinhal (INH = AIR (CA = 2, AT = 365*24), RFC = 5)
```

INH *Inhalation of resuspended soil particles*

Description

Estimates the Intake rate of chemicals by inhalation of resuspended soil particles [mg/Kg*day]

Usage

```
INH(C = 10, EF = 350, ED = 24, PEF = 1.36^9, AT = 365 * ED)
```

Arguments

C	Concentration of chemicals in soil(mg/kg)
EF	Exposure frequency (day/year)
ED	Exposure duration (years)
PEF	Particle emision factor meaning resuspended particles(m^3/kg)
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical intake rate by inhalation of soil particles I [mg/Kg*day]

Author(s)

F. Barrio-Parra

References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
# Estimated dose for the estimation of carcinogenic effects due to the
# inhalation of soil particles  that contains 45 mg/Kg of As in a residencial
# scenario (default EPA Maximum Reasonable Exposure parameters)

INH(C= 45, AT = 365*70)

# For non-carcinogenic effects:

INH(C= 45)
```

---

plot_fit_dist *Graphical representation of data fitting to a distribution*

Description

A function to help assessing the distribution that best fit a data vector

Usage

```
plot_fit_dist(x, dist)
```

Arguments

x	A numeric vector of length at least one containing only finite values (values must be >= 0)
dist	Character vector indicating the distribution to be ploted:"norm", "lnorm", "geom", "exp", "pois", "cauchy", "logis", "weibull"

Value

Returns: Empirical and theoretical density plots, Empirical and theoretical CDFs, Q-Q plot, P-P plot

Author(s)

F. Barrio-Parra

See Also

plotdist from Library (fitdstrplus)

Examples

```
set.seed(123)
a <- rnorm(n = 100, mean = 10, sd = 1)
plot_fit_dist(a, "norm")
```

---

random_number_generator

Random number generator

Description

Return a vector of n random numbers following a truncated distribution (dist) in agreement with a fitted parameters "Fited"

Usage

```
random_number_generator(n, Fited, dist, a, b)
```

Arguments

n	The number of desired generated numbers
Fited	A list contaning the parameters obtained by application of Fit_dist_parameter
dist	Character vector indicating the distribution to be applied:"norm", "lnorm", "geom", "exp", "pois", "cauchy", "logis", "weibull"
a	Truncation Lower limit
b	Truncation Upper limit

Value

A vector of n random numbers

Author(s)

F. Barrio-Parra

See Also

Fit_dist_parameter

Examples

```
set.seed(123)
a <- rnorm(n = 100, mean = 10, sd = 1)
Fit <- Fit_dist_parameter(a)

b <-random_number_generator(n = 10000, Fited = Fit,
                            dist = "norm", a =8, b = 12)

par(mfrow=c(2,1))

hist(a,xlim= c(7,14))
hist(b,xlim= c(7,14))
```

RISK *Risk*

Description

Returns the Risk estimation (carcinogenic effects)

Usage

```
RISK(I, SF)
```

Arguments

I	Intake Rate [mg/Kg*day]
SF	Slope Factor [(mg/Kg*day)^-1] (chemical specific)

Value

Risk [-]

Author(s)

F. Barrio-Parra

Examples

```
# Assessing if there is carcinogenic risk for an adult receptor that drinks water with 1000 ug/L
# of hexaclorobence (Oral Slope Factor (IRIS data base) = 1.6 [mg/Kg*day]^-1) in a residencial
# scenario (default EPA Maximum Reasonable Exposure parameters)


RISK (I = DWIR( CW=1), SF = 1.6)
```

RISKdermal *Risk for dermal contact*

Description

Returns the Risk for dermal exposure with chemicals (carcinogenic effects)

Usage

```
RISKdermal(AD, SF, GI)
```

Arguments

AD	Absorbed dose [mg/Kg*day]
SF	Slope Factor [(mg/Kg*day)^-1] (chemical specific)
GI	Gastrointestinal Absorption factor (chemical specific) [-]

Value

Risk [-]

Author(s)

F. Barrio-Parra

See Also

AD EnviroPRA

Examples

```
# Assess if there is carcinogenic risk for an dadult thorug dermal
# contact exposed to a soil that contains 45 mg/Kg of As in a residencial
# scenario (default EPA Maximum Reasonable Exposure parameters)

SFAs = 1.5

# Dermal Absorption Factor

ABSAs = 3e-02

# Gastrointestinal Absorption Factor

GIAs = 1

I = AD (CS = 45,ABS = ABSAs)

RISKdermal (AD = I, SF = SFAs, GI = GIAs)
```

RISKInhal *Risk for inhalation of vapors*

Description

Returns the risk (carcinogenic effects) for inhalation of vapors

Usage

```
RISKInhal(URi, I)
```

Arguments

URi	Inhalation Unit risk [(ug/m^3)^-1]
I	Inhalated dose (mg/m^3)

Value

Risk [-]

Examples

```
# Assess if there is cancer risk for the exposure of an adult
# (Reasonable Maximum Exposure) to a benzene air concentration of 2 mg/ m^3

RISKInhal ( I = AIR (CA = 2), URi = 7.8e-06)
```

sampler *Execute sampling with replacement*

Description

Auxiliar function

Usage

```
sampler(n, a)
```

Arguments

n	Number of sampling iterations
a	data vector

Value

Resampled vector of length n

Author(s)

F. Barrio-Parra

Examples

```
a <- rnorm (n = 20, mean = 0, sd = 1)

b <- sampler (n = 100, a = a)
```

`sig` *Significance level cheking function*

Description

Function that return if the p-value allows to accept H0 in a Kolmogorov Smirnov or Anderson Darling test

Usage

```
sig(n)
```

Arguments

`n`	p-value

Value

Text string ("Significant"" / "Not Significant"")

Examples

```
sig ( 0.001 )

sig ( 0.1 )
```

SIR *Chemical intake by accidental soil ingestion*

Description

Estimates the chemical Intake rate by accidental soil ingestion [mg/Kg*day]

Usage

```
SIR(CS = 1, IR = 100, FI = 1, EF = 350, ED = 24, BW = 80, AT = 365 * 70)
```

Arguments

CS	Chemical concentrtion in soil [mg/Kg]
IR	Soil Ingestion Rate [mg/Day]
FI	Fraction ingested from contaminated source [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical intake rate by soil ingestion I [mg/Kg*day]

Author(s)

F. Barrio-Parra

References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
# Ingestion rate for a children weighing 20 Kg who ingest 200 mg
# of soil every day, 250 days per year during 10 years. 95-UCL of
# Arsenic in soil is 25 mg/Kg

# Carcinogenic effects

SIR ( CS = 25, BW = 20, IR = 200, ED = 10, EF = 250)

# Systemic effects
```

```
SIR ( CS = 25, BW = 20, IR = 200, ED = 10, EF = 250, AT = 365*10)
```

SIRboot *Chemical intake by accidental soil ingestion by bootstrap*

Description

Estimates the chemical Intake rate by accidental soil ingestion [mg/Kg*day]

Usage

```
SIRboot(n, CS, IR, FI, EF, ED, BW, AT)
```

Arguments

n	Output vector length
CS	Chemical concentrtion in soil [mg/Kg]
IR	Soil Ingestion Rate [mg/Day]
FI	Fraction ingested from contaminated source [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight [Kg]
AT	Averaging time [day] (Note that for No carcinogenic effects AT should be equal to 365*ED)

Value

Chemical intake rate by soil ingestion I [mg/Kg*day]

Examples

```
# Carcinogenic effects

c <- rnorm( n= 10, mean = 22, sd = 2 )

b <- rnorm( n= 100, mean = 20, sd = 5 )

SIRboot (n = 1000, CS = c, BW = b, IR = 200, ED = 10, EF = 250)
```

VI *Chemical intake by ingestion of vegetables*

Description

Estimates the chemical Intake rate by ingestion of contaminated fruits and vegetables [mg/Kg*day]

Usage

```
VI(CF = 1, IR = 210, FI = 1, EF = 350, ED = 24, BW = 80, AT = 365 * 70)
```

Arguments

CF	Chemical concentration in food [mg/Kg]
IR	Vegetables Ingestion Rate [g / Kg * Day]
FI	Fraction ingested from contaminated source [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body weight (kg)
AT	Averaging time [day] (For No carcinogenic effects AT = 365*ED)

Value

Chemical intake rate by vegetable ingestion I [mg/Kg*day]

Author(s)

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References

US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. U.S. Environmental Protection Agency, EPA/600/R-(September), pp 1466.

Examples

```
# Assess the chemical intake by an adult that eats lettuce with a concentration of 2 mg/ Kg
# in a maximum reasonable exposure scenario for non- carcinogenic effects

VI (CF = 2, AT = 365*24)
```

VIboot *Chemical intake by ingestion of vegetables by bootstrap*

Description

Estimates the chemical Intake rate by ingestion of contaminated fruits and vegetables [mg/Kg*day]

Usage

```
VIboot( n, CF, IR, FI, EF, ED, BW, AT)
```

Arguments

n	Output vector length
CF	Chemical concentrtion in food [mg/Kg]
IR	Vegetables Ingestion Rate [g / Kg * Day]
FI	Fraction ingested from contaminated source [-]
EF	Exposure frequency [day/yr]
ED	Exposure duration [yr]
BW	Body Weight [Kg]
AT	Averaging time [day] (For No carcinogenic effects AT = 365*ED)

Value

A vector of Chemical intake rate by vegetable ingestion I [mg/Kg*day]

Examples

```
# Assess the chemical intake by an adult that eats lettuce with a concentration of 2 mg/ Kg of a
# chemical with non- carcinogenic effects in a maximum reasonable exposure scenario
# Figure out 10 data of Chemical concentration following a normal distribution (mean = 2, sd= 2)
# and 100 Body weight data that follow a normal distribution (mean = 70, sd = 15)

c <- rnorm( n= 10, mean = 2, sd = 2 )

b <- rnorm( n= 100, mean = 70, sd = 5 )

VIboot (n = 1000, CF = c, BW = b, AT = 365*24)
```

Index

∗Topic **graphs**
plot_fit_dist, 18
∗Topic **mehtods**
AD, 5
∗Topic **methods**
AIR, 7
AIRboot, 8
condition, 9
DWIR, 10
DWIRboot, 11
extr_par, 12
Fit_dist_parameter, 12
fit_dist_test, 13
HI, 15
HIdermal, 15
HIinhal, 16
INH, 17
random_number_generator, 19
RISK, 20
RISKdermal, 21
RISKInhal, 22
sampler, 22
sig, 23
SIR, 24
SIRboot, 25
VI, 26
VIboot, 27
∗Topic **package**
EnviroPRA-package, 2

AD, 5
ADboot, 6
AIR, 7
AIRboot, 8

condition, 9

DWIR, 10
DWIRboot, 11

EnviroPRA *(*EnviroPRA-package*)*, 2
EnviroPRA-package, 2
extr_par, 12

Fit_dist_parameter, 12
fit_dist_test, 13

HI, 15
HIdermal, 15
HIinhal, 16

INH, 17

plot_fit_dist, 18

random_number_generator, 19
RISK, 20
RISKdermal, 21
RISKInhal, 22

sampler, 22
sig, 23
SIR, 24
SIRboot, 25

VI, 26
VIboot, 27