# Package 'openMSE'

September 24, 2024

**Title** Easily Install and Load the 'openMSE' Packages

**Version** 1.0.1

**Description** The 'openMSE' package is designed for building operating models, doing simulation modelling and management strategy evaluation for fisheries. 'openMSE' is an umbrella package for the 'MSEtool' (Management Strategy Evaluation toolkit), 'DLMtool' (Data-Limited Methods toolkit), and SAMtool (Stock Assessment Methods toolkit) packages. By loading and installing 'openMSE', users have access to the full functionality contained within these packages. Learn more about 'openMSE' at <https://openmse.com/>.

**License** GPL-3

**URL** https://openmse.com/, https://github.com/Blue-Matter/openMSE, https://openMSE.openMSE.com

**BugReports** https://github.com/Blue-Matter/openMSE/issues

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.3.2

**Depends** R (>= 4.0.0), MSEtool (>= 3.7.0), DLMtool (>= 6.0.0), SAMtool

**Imports** crayon, dplyr, purrr, ggplot2, grid, tidyr

**NeedsCompilation** no

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**Repository** CRAN

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## Contents

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`At_Age_TS_Variables` *At-Age Time Series Variables*

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## Description

At-Age Time Series Variables

## Usage

```
At_Age_TS_Variables
```

## Format

An object of class `data.frame` with 6 rows and 3 columns.

---

`demo` *Run an example MSE*

---

## Description

Run an example MSE using three data-limited management procedures from `DLMtool` and one stock assessment model from `SAMtool`.

## Usage

```
demo()
```

## Details

The MSE is run and three example performance metrics plots are produced: a trade-off plot, a projection plot, and a Kobe plot.

An MSE about is invisibly returned, and can be explored further (e.g., `summary(MSE)`).

## Value

Invisibly returns an MSE object, and produces example plots of performance metrics.

## Examples

```
MSE <- demo()
```

---

# get_Assess_Estimates *Create a data.frame with estimated values from a* SAMtool *assessment method used in an MSE*

---

## Description

Create a data.frame with estimated values from a SAMtool assessment method used in an MSE

## Usage

```
get_Assess_Estimates(x, model = "Model 1")

## S3 method for class 'MSE'
get_Assess_Estimates(x, model = "Model 1")

## S3 method for class 'list'
get_Assess_Estimates(x, model = NULL)

## S3 method for class 'MMSE'
get_Assess_Estimates(x, model = NULL)
```

## Arguments

| | |
|---|---|
| x | An object of class MSE or a list of MSE objects, where MSE includes management procedures that use SAMtool stock assessment functions that return estimated values in MSE@PPD. |
| model | An optional name for the model. If x is a list of objects, model will be taken from names(x). If names(x) is NULL, model will be given sequential numerical values (e.g., Model 1, Model 2, ...) |

## Value

A data.frame with columns:

| | |
|---|---|
| Year_assess | The year the assessment was run in the MSE |
| Year_est | The year corresponding with the estimated value |
| Variable | The estimated variable |
| Value | The estimated value |
| MP | The name of the management procedure |
| Simulation | The simulation number |
| Model | The name of model |

---

# get_at_Age *Create a data.frame with at-age schedules by simulation and year*

---

## Description

Note that the Selectivity and Retention curves in these plots are from the operating model. If an MP changes the selectivity/retention, this is not shown in these plots.

## Usage

```
get_at_Age(x, model = "Model 1", ...)

## S3 method for class 'Hist'
get_at_Age(x, model = "Model 1", ...)

## S3 method for class 'list'
get_at_Age(x, model = "Model 1", ...)

## S3 method for class 'MSE'
get_at_Age(x, model = "Model 1", ...)

## S3 method for class 'multiHist'
get_at_Age(x, model = "Model 1", ...)

## S3 method for class 'MMSE'
get_at_Age(x, model = "Model 1", ...)
```

## Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| model | An optional name for the model. If x is a list of objects, model will be taken from names(x). If names(x) is NULL, model will be given sequential numerical values (e.g., Model 1, Model 2, ...) |
| ... | additional arguments |

## Value

A data.frame

---

`get_at_age_ts` *Create a data.frame with time-series information by simulation and year*

---

## Description

Create a data.frame with time-series information by simulation and year

## Usage

```
get_at_age_ts(
  x,
  variable = "Spawning Biomass",
  model = "Model 1",
  scale = NULL
)
```

## Arguments

| | |
|---|---|
| `x` | An object of class `Hist`, `MSE`, or a list of `Hist` or `MSE` objects |
| `variable` | A character string with a valid name for a time-series variable. Use `valid_ts_variables()` for valid variable names. |
| `model` | An optional name for the model. If `x` is a list of objects, `model` will be taken from `names(x)`. If `names(x)` is `NULL`, `model` will be given sequential numerical values (e.g., `Model 1`, `Model 2`, ...) |
| `scale` | An optional function with a single numeric argument that returns transformed or scaled numeric values. See `lb2kg` and `kg2lb` for example. Can be a list of functions for list objects (NA for no transformation) |

---

`get_at_Length` *Create a data.frame with at-length selectivity and retention schedules by simulation and year*

---

## Description

Note that the Selectivity and Retention curves in these plots are from the operating model. If an MP changes the selectivity/retention, this is not shown in these plots.

### Usage

```
get_at_Length(x, model = "Model 1", ...)

## S3 method for class 'multiHist'
get_at_Length(x, model = "Model 1", ...)
```

### Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| model | An optional name for the model. If x is a list of objects, model will be taken from names(x). If names(x) is NULL, model will be given sequential numerical values (e.g., Model 1, Model 2, ...) |
| ... | additional arguments |

### Value

A data.frame

---

## get_LifeHistory *Get Life History Parameters*

---

### Description

Extracts the life-history parameters: Linf, K, L50, and ageM

### Usage

```
get_LifeHistory(x, model = "Model 1", ...)

## S3 method for class 'Hist'
get_LifeHistory(x, model = "Model 1", ...)

## S3 method for class 'list'
get_LifeHistory(x, model = "Model 1", ...)

## S3 method for class 'MSE'
get_LifeHistory(x, model = "Model 1", ...)

## S3 method for class 'MMSE'
get_LifeHistory(x, model = "Model 1", ...)
```

### Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| model | An optional name for the model. If x is a list of objects, model will be taken from names(x). If names(x) is NULL, model will be given sequential numerical values (e.g., Model 1, Model 2, ...) |
| ... | additiona arguments (not used) |

### Value

A data.frame

---

`get_Metadata` *Extract the meta-data from a* `Hist` *or* `MSE` *object*

---

### Description

Extract the meta-data from a `Hist` or `MSE` object

### Usage

```
get_Metadata(x)

## S3 method for class 'Hist'
get_Metadata(x)

## S3 method for class 'MSE'
get_Metadata(x)

## S3 method for class 'list'
get_Metadata(x)

## S3 method for class 'MMSE'
get_Metadata(x)
```

### Arguments

| | |
|---|---|
| `x` | An object of class `Hist`, `MSE`, or a list of `Hist` or `MSE` objects |

### Details

If `x` is a list of objects, each object must have identical structure, i.e., same number of simulations, same number of age-classes, historical and projection years, management procedures, etc

### Value

A named list with elements:

| | |
|---|---|
| `nsim` | The number of simulations |
| `nage` | The number of age classes |
| `Ages` | The age classes |
| `nyear` | The number of historical years |
| `Hist.Years` | A data.frame with the historical years in the `Year` column |
| `proyears` | The number of projection years |
| `Pro.Years` | A data.frame with the projection years in the `Year` column |
| `All.Years` | A data.frame with the historical and the projection years in the `Year` column |

| | |
|---|---|
| nMPs | The number of MPs (if x is an object of class MSE) |
| MPs | The MPs (if x is an object of class MSE) |

---

`get_ts` *Create a data.frame with time-series information by simulation and year*

---

## Description

Create a data.frame with time-series information by simulation and year

## Usage

```
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

valid_ts_variables()

valid_at_age_ts_variables()

## S3 method for class 'Hist'
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

## S3 method for class 'MSE'
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

## S3 method for class 'list'
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

## S3 method for class 'multiHist'
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

## S3 method for class 'MMSE'
get_ts(x, variable = "Spawning Biomass", model = "Model 1", scale = NULL)

get_Biomass(x, model = "Model 1", ...)

get_Landings(x, model = "Model 1", ...)

get_Removals(x, model = "Model 1", ...)

get_Recruits(x, model = "Model 1", ...)

get_SSB(x, model = "Model 1", ...)

get_SB_SBMSY(x, model = "Model 1", ...)
```

```
get_F(x, model = "Model 1", ...)

get_Biomass_at_Age(x, model = "Model 1", ...)

get_Number_at_Age(x, model = "Model 1", ...)

get_SSB_at_Age(x, model = "Model 1", ...)
```

## Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| variable | A character string with a valid name for a time-series variable. Use valid_ts_variables() for valid variable names. |
| model | An optional name for the model. If x is a list of objects, model will be taken from names(x). If names(x) is NULL, model will be given sequential numerical values (e.g., Model 1, Model 2, ...) |
| scale | An optional function with a single numeric argument that returns transformed or scaled numeric values. See lb2kg and kg2lb for example. Can be a list of functions for list objects (NA for no transformation) |
| ... | named arguments passed to get_ts |

---

# get_Years *Create a data.frame with Historical and Projection years*

---

## Description

Create a data.frame with Historical and Projection years

## Usage

```
get_Years(x)

## S3 method for class 'MSE'
get_Years(x)

## S3 method for class 'MMSE'
get_Years(x)

## S3 method for class 'Hist'
get_Years(x)

## S3 method for class 'multiHist'
get_Years(x)
```

## Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |

## Value

A data.frame with years and period (Historical or Projection)

---

# lb2kg *Convert numeric values to a different scale*

---

## Description

Convert numeric values to a different scale

## Usage

```
lb2kg(x)

lb2mt(x)

kg2lb(x)

kg2_1000lb(x)

kg2mt(x)

inch2mm(x)

inch2cm(x)

mm2inch(x)

cm2inch(x)

divide_1000(x)

divide_100(x)

divide_10(x)

multiply_1000(x)

multiply_100(x)

multiply_10(x)
```

### Arguments

| | |
|---|---|
| x | A vector of numeric values |

### Value

The vector of numeric values converted to the appropriate scale

### Functions

- `lb2kg()`: Convert from pounds to kilograms
- `lb2mt()`: Convert from pounds to metric tons
- `kg2lb()`: Convert from kilograms to pounds
- `kg2_1000lb()`: Convert from kilograms to 1000 pounds
- `kg2mt()`: Convert from kilograms to metric tons
- `inch2mm()`: Convert from inches to millimeters
- `inch2cm()`: Convert from inches to centimeters
- `mm2inch()`: Convert from millimeters to inches
- `cm2inch()`: Convert from centimeters to inches
- `divide_1000()`: Divide values by 1000
- `divide_100()`: Divide values by 100
- `divide_10()`: Divide values by 10
- `multiply_1000()`: Multiply values by 1000
- `multiply_100()`: Multiply values by 100
- `multiply_10()`: Multiply values by 10

### Examples

```
lb2kg(1:10)
kg2lb(1:10)
```

---

## `plot_at_Age` *Plot at-Age schedules*

---

### Description

Plots Length, Weight, Maturity, Natural-Mortality, Selectivity, and Retention-at-Age schedules.

## Usage

```
plot_at_Age(
  x,
  quantiles = c(0.025, 0.975),
  scale = NULL,
  variable = "Length",
  xlab = "Age (Year)",
  ylab = NULL,
  title = "",
  years = NULL,
  alpha = 0.1,
  lwd = 1,
  use_theme = NULL,
  colpalette = "Dark2",
  print = TRUE
)

plot_Length(x, ...)

plot_Weight(x, ...)

plot_Maturity(x, ...)

plot_N.Mortality(x, ...)

plot_Select(x, ...)

plot_Retention(x, ...)

plot_Select_Maturity(x, ...)
```

## Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| quantiles | Lower and upper quantiles to calculate. Numeric vector of length 2. |
| scale | An optional function with a single numeric argument that returns transformed or scaled numeric values. See lb2kg and kg2lb for example. Can be a list of functions for list objects (NA for no transformation) |
| variable | String. One of 'Length', 'Weight', 'N.Mortality','Maturity', 'Select', 'Retention' |
| xlab | X-axis label (default 'Age (Year)') |
| ylab | Y-axes label |
| title | Optional title |
| years | Optional numeric vector specifying the years to plot. Default is the first and last historical year, and the last projection year |
| alpha | Transparency parameter |

| | |
|---|---|
| lwd | Line width |
| use_theme | Optional ggplot theme |
| colpalette | Color palette from RColorBrewer |
| print | Logical. Print the plot? |
| ... | Named arguments passed to plot_at_Age |

## Details

Note that the Selectivity and Retention curves in these plots are from the operating model. If an MP changes the selectivity/retention, this is not shown in these plots.

## Value

A named list with:

| | |
|---|---|
| p | The ggplot object |
| df | Data.frame with the summary statistics (median and quantiles) |

## Functions

- plot_Length(): Plot Length-at-Age
- plot_Weight(): Plot Weight-at-Age
- plot_Maturity(): Plot Maturity-at-Age
- plot_N.Mortality(): Plot N.Mortality-at-Age
- plot_Select(): Plot Selectivity-at-Age
- plot_Retention(): Plot Retention -at-Age
- plot_Select_Maturity(): Plot Selectivity-, Retention-, and Maturity-at-Age

---

# plot_TS *Plots the median and quantiles of a time-series*

---

## Description

Plots the median and quantiles of a time-series

## Usage

```
plot_TS(
  x,
  xlab = "Year",
  ylab = "Spawning Biomass",
  title = "",
  quantiles = c(0.025, 0.975),
```

```
  scale = NULL,
  alpha = 0.1,
  lwd = 1,
  use_theme = NULL,
  colpalette = "Dark2",
  facet = TRUE,
  inc.Legend = !facet,
  inc.Hist = FALSE,
  print = TRUE,
  get_function = get_SSB,
  years = NULL,
  ...
)

plot_SSB(x, ...)

plot_Biomass(x, ylab = "Biomass", ...)

plot_Landings(x, ylab = "Landings", ...)

plot_Removals(x, ylab = "Removals", ...)

plot_Recruits(x, ylab = "Recruits", ...)

plot_F(x, ylab = "Fishing Mortality (F)", ...)

plot_LifeHistory(
  x,
  xlab = "Year",
  ylab = "Median (quantiles)",
  title = "",
  quantiles = c(0.025, 0.975),
  scale = NULL,
  alpha = 0.1,
  lwd = 1,
  use_theme = NULL,
  colpalette = "Dark2",
  facet = TRUE,
  inc.Legend = !facet,
  inc.Hist = FALSE,
  print = TRUE
)
```

## Arguments

| | |
|---|---|
| x | An object of class Hist, MSE, or a list of Hist or MSE objects |
| xlab | X-axis label (default 'Year') |
| ylab | Y-axes label |

| | |
|---|---|
| title | Optional title |
| quantiles | Lower and upper quantiles to calculate. Numeric vector of length 2. |
| scale | An optional function with a single numeric argument that returns transformed or scaled numeric values. See lb2kg and kg2lb for example. Can be a list of functions for list objects (NA for no transformation) |
| alpha | Transparency parameter |
| lwd | Line width |
| use_theme | Optional ggplot theme |
| colpalette | Color palette from RColorBrewer |
| facet | Logical. Facet the plot? |
| inc.Legend | Logical. Include legend? |
| inc.Hist | Logical. For MSE results, include the historical period? |
| print | Logical. Print the plot? |
| get_function | get_ function to extract time-series information from x |
| years | Optional numeric vector specifying the years to plot. Default is all years. |
| ... | Named arguments passed to plot_TS |

## Value

A named list with:

| | |
|---|---|
| p | The ggplot object |
| df | Data.frame with the summary statistics (median and quantiles) |

## Functions

- plot_SSB(): Plot the Spawning Biomass
- plot_Biomass(): Plot the Total Biomass
- plot_Landings(): Plot the Landings (biomass)
- plot_Removals(): Plot the Removals (biomass)
- plot_Recruits(): Plot the Recruits (numbers)
- plot_F(): Plot the Recruits (numbers)
- plot_LifeHistory(): Plot the Life-History parameters

## theme_default *A ggplot2 theme*

### Description

A simple theme for ggplot2 that loosely resembles nicely themed plots from base graphics.

### Usage

```
theme_default(
  base_size = 11,
  base_family = "",
  text_col = "grey20",
  panel_border_col = "grey70"
)
```

### Arguments

| | |
|---|---|
| base_size | Base font size. |
| base_family | Base font family. |
| text_col | Color for text. |
| panel_border_col | Color for panel borders. |

### Examples

```
p <- ggplot2::ggplot(mtcars) +
  ggplot2::geom_point(ggplot2::aes(x = wt, y = mpg, colour = factor(gear))) +
  ggplot2::facet_wrap(~am)
p + theme_default()
```

## TS_Variables *Time Series Variables*

### Description

Time Series Variables

### Usage

```
TS_Variables
```

### Format

An object of class `data.frame` with 21 rows and 3 columns.

`userguide` *Open the openMSE Documentation website*

## Description

Opens the openMSE Documentation website (requires internet connection)

## Usage

```
userguide()
```

## Value

Nothing is returned. Opens the 'openMSE.com' in the web browser

## Examples

```
userguide()
```

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