Package 'FoRDM'

May 7, 2026

Type Package

Title Forest Many-Objective Robust Decision Making ('FoRDM')

Version 1.0.2

Maintainer Marc Djahangard <marc.djahangard@ife.uni-freiburg.de>

Description Forest Many-Objective Robust Decision Making ('FoRDM') is a R toolkit for supporting robust forest management under deep uncertainty.
It provides a forestry-focused application of Many-Objective Robust Decision Making ('MORDM') to forest simulation outputs, enabling users to evaluate robustness using regret- and 'satisficing'-based measures. 'FoRDM' identifies robust solutions, generates Pareto fronts, and offers interactive 2D, 3D, and parallel-coordinate visualizations.

License MIT + file LICENSE

Encoding UTF-8

Imports dplyr (>= 1.0.0), ggplot2 (>= 3.3.0), magrittr (>= 2.0.0), tidyr (>= 1.1.0), rlang (>= 0.4.0), tibble (>= 3.0.0), plotly (>= 4.10.0), emoa (>= 0.5.0), RColorBrewer (>= 1.1.0), stats

Suggests testthat (>= 3.0.0)

RoxygenNote 7.3.3

Config/testthat/edition 3

NeedsCompilation no

Author Marc Djahangard [aut, cre], Rasoul Yousefpour [aut]

Repository CRAN

Date/Publication 2026-04-07 07:00:02 UTC

Contents

`build_fordm_table` *Build FoRDM Table*

Description

Transfers the provided data table into the format for FoRDM analysis. The columns that represent management, sow (state-of-the-world, scenarios), and time have to be defined. All other columns are treated as objectives.

Usage

```
build_fordm_table(data, management, sow, time)
```

Arguments

`data`	A data.frame containing the input data.
`management`	The name of the management column.
`sow`	The name of the state-of-the-worlds (SOW) column.
`time`	The name of the time column.

Value

A list with the processed data for further use in the FoRDM analysis, including the input data, mapping for identification of columns and objective columns.

`build_objectives_regret`
Build Objectives Data Frame for Regret Analysis

Description

Specify for which objectives regret-based FoRDM analysis should be applied. For each objective, define its name, direction, weight, time aggregation method (mean, sum, min or max), and discount rate.

Usage

```
build_objectives_regret(
  names,
  direction = rep("maximize", length(names)),
  weights = rep(1/length(names), length(names)),
  time_aggregation = rep("mean", length(names)),
  discount_rate = rep(0, length(names))
)
```

Arguments

names	Names of objectives as the column names in the provided data.
direction	Direction of objective function: 'maximize' or 'minimize'.
weights	Relative weights (0-1) for each objective, must sum to 1.
time_aggregation	Time aggregation across objectives: 'mean', 'sum', 'min' or 'max'.
discount_rate	Annual discount rates for each objective (e.g., 0.02 means 2% per year), applied during time aggregation.

Value

A data frame specifying objectives, directions, weights, time aggregation methods, and discount rates for use in FoRDM analysis.

---

build_objectives_satisficing

Build Objectives Data Frame for Satisficing Analysis

Description

Specify information for satisficing-based FoRDM analysis. For each objective, define its name, time aggregation method (mean, sum, min or max), discount rate, threshold and direction.

Usage

```
build_objectives_satisficing(
  names,
  time_aggregation = rep("mean", length(names)),
  discount_rate = rep(0, length(names)),
  threshold,
  direction = rep("above", length(names))
)
```

Arguments

names	Names of objectives as the column names in the provided data.
time_aggregation	Time aggregation across objectives: 'mean', 'sum', 'min' or 'max'.
discount_rate	Discount rates for each objective (e.g., 0.02 means 2% per time step), applied during time aggregation.
threshold	Numeric value(s) defining the satisficing level for each objective.
direction	'above' if values should meet or exceed the threshold, 'below' if they should be lower.

Value

A data frame specifying objectives name, time aggregation method, discount rate, threshold and direction for use in satisficing FoRDM analysis.

FoRDM *Forest Many-Objective Robust Decision Making (FoRDM)*

Description

This package provides a toolkit for supporting robust forest management under deep uncertainty. It provides a forestry-focused application of Many-Objective Robust Decision Making (MORDM) to forest simulation outputs, enabling users to evaluate robustness using regret- and satisficing-based measures. FoRDM identifies robust solutions, generates Pareto fronts, and offers interactive 2D, 3D, and parallel-coordinate visualizations.

Details

Main features:

- Create FoRDM input tables from forest simulation outputs.
- Calculate robustness measures based on Regret and Satisficing approaches.
- Visualize results using 2D, 3D, or parallel-coordinate plots.
- Explore trade-offs between robustness and performance.

Author(s)

Marc Djahangard <marc.djahangard@ife.uni-freiburg.de> (author, maintainer)

Rasoul Yousefpour (author)

See Also

browseVignettes(package = "FoRDM")

`fordm_analysis_regret` *FoRDM Regret-Based many-objective Robust Decision-Making Analysis*

Description

Performs a regret-based (Type II or cVaR) many-objective robustness analysis for the provided data and objectives, providing a optimal robust management and the Pareto front.

Usage

```
fordm_analysis_regret(
  fordm_table,
  objectives,
  robustness = 0.9,
  method = "regretII"
)
```

Arguments

`fordm_table`	Output from build_fordm_table().
`objectives`	Output from build_objectives_regret().
`robustness`	Numeric (0-1) specifying the quantile of regret used to define robustness, e.g., 0.9 evaluates management performance that is at least as good as in 90% of SOWs.
`method`	the method used to evaluate robustness • `"regretII"`: Regret type II (regret to best performing alternative) approach using the robustness quantile of scenario regrets. • `"CVaR"`: Conditional Value at Risk, using the mean of the worst (1 - robustness) fraction of weighted regrets for risk-aware selection.

Value

A list containing the results of the FoRDM analysis:

- `optimal`: The management strategy identified as most robust given the regret metrics.
- `pareto_front`: The Pareto front of robust management strategies.

`fordm_analysis_satisficing` *FoRDM Satisficing-Based many-objective Robust Decision-Making Analysis*

Description

Performs a satisficing-based many-objective robustness analysis for the provided data and objectives, providing a optimal robust management and the Pareto front.

Usage

```
fordm_analysis_satisficing(fordm_table, objectives, robustness = 0.9)
```

Arguments

`fordm_table`	Output from build_fordm_table().
`objectives`	Output from build_objectives_satisficing().
`robustness`	Numeric (0-1) specifying the robustness level across SOWs, e.g., 0.9 evaluates management performance that meets objectives in at least 90% of SOWs.

Value

A list containing the FoRDM analysis results:

- `optimal`: The management strategy that balances all objectives (Euclidean distance) while meeting the robustness threshold.
- `pareto_front`: The Pareto front of robust management strategies.

`robustness_tradeoff_analysis` *Robustness Trade-Off Analysis (Regret-based)*

Description

Analyzes what happens when you sacrifice robustness for better performance. Shows marginal benefits and losses for each objective when switching between management strategies across different robustness levels.

Usage

```
robustness_tradeoff_analysis(
  fordm_table,
  objectives,
  robustness_min = 0,
  robustness_max = 1,
  robustness_step = 0.05
)
```

Arguments

fordm_table	Output from build_FoRDM_table().
objectives	Output from build_objectives_regret().
robustness_min	Minimum robustness level (default: 0.0 = 0%).
robustness_max	Maximum robustness level (default: 1.0 = 100%).
robustness_step	Step size for robustness levels (default: 0.05 = 5%-steps).

Value

List containing the list of optimal managements at certain robustness levels, and a plot

---

visualize_fordm_2d *Visualize 2D Pareto Front*

Description

Plots a 2D plot of the Pareto front of management alternatives from FoRDM_analysis output.

Usage

```
visualize_fordm_2d(analysis_output, x, y, fordm_method)
```

Arguments

analysis_output	Output list from FoRDM_analysis_regret() or FoRDM_analysis_satisficing().
x	Name of the objective for the x-axis (string).
y	Name of the objective for the y-axis (string).
fordm_method	Either "regret" or "satisficing".

Value

A ggplot2 object showing the 2D Pareto front for the selected objectives.

`visualize_fordm_3d` *Visualize 3D Pareto Front*

Description

Plots a 3D plot of the Pareto front of management alternatives from FoRDM_analysis output.

Usage

```
visualize_fordm_3d(analysis_output, x, y, z, fordm_method)
```

Arguments

`analysis_output`	Output from FoRDM_analysis_regret or FoRDM_analysis_satisficing.
`x`	Name of the objective for the x-axis (string).
`y`	Name of the objective for the y-axis (string).
`z`	Name of the objective for the z-axis (string).
`fordm_method`	Either "regret" or "satisficing".

Value

A plotly object showing the 3D Pareto front for the selected objectives.

`visualize_fordm_parcoord` *Visualize a Parallel Coordinates plot of the Pareto Front for FoRDM Analysis Results*

Description

Creates a parallel coordinates plot showing the Pareto front from FoRDM analysis.

Usage

```
visualize_fordm_parcoord(analysis_output, fordm_method)
```

Arguments

`analysis_output`	Output from fordm_analysis_regret() or fordm_analysis_satisficing().
`fordm_method`	Either "regret" or "satisficing".

Value

A parallel coordinates plot object.

`visualize_fordm_parcoord_management` *Visualize Parallel Coordinates Plot for a single selected management across all SOWs*

Description

Creates a parallel coordinates plot showing SOW performance across objectives for a selected management strategy.

Usage

```
visualize_fordm_parcoord_management(
  fordm_table,
  objectives,
  fordm_method,
  management
)
```

Arguments

`fordm_table`	Output from build_fordm_table().
`objectives`	Output from build_objectives_regret() or build_objectives_satisficing().
`fordm_method`	Either "regret" or "satisficing".
`management`	Character string specifying which management to visualize.

Value

A parallel coordinates plot object.

Index