Package ‘AMPLE’

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Title  Shiny Apps to Support Capacity Building on Harvest Control Rules
Version  1.0.1
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Description  Three Shiny apps are provided that introduce Harvest Control Rules (HCR) for fisheries management.
 'Introduction to HCRs' provides a simple overview to how HCRs work. Users are able to select their own HCR and step through its performance, year by year. Biological variability and estimation uncertainty are introduced.
 'Measuring performance' builds on the previous app and introduces the idea of using performance indicators to measure HCR performance.
 'Comparing performance' allows multiple HCRs to be created and tested, and their performance compared so that the preferred HCR can be selected.
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AMPLE: A package of Shiny apps that introduce Harvest Control Rules (HCR) for fisheries management.

Description

AMPLE provides three Shiny apps that introduce Harvest Control Rules (HCR) for fisheries management. 'Introduction to HCRs' provides a simple overview to how HCRs work. Users are able to select their own HCR and step through its performance, year by year. Biological variability and estimation uncertainty are introduced. 'Introduction to indicators' builds on the previous app and introduces the idea of using performance indicators to evaluate HCR performance. 'Comparing performance' allows multiple HCRs to be created and tested, and their performance compared so that the preferred HCR can be selected.

Harvest Control Rules are used as part of a fishery harvest strategy. This package was put together as part of capacity building efforts by the Pacific Community (SPC) to develop fishery harvest strategies for tuna stocks in the western and central Pacific Ocean (WCPO), working with the Western and Central Pacific Fisheries Commission (WCPFC). For more information on tuna harvest strategies in the WCPO please see LINKs.

AMPLE functions

Too launch the apps use the functions: intro_hcr(), measuring_performance() and comparing_performance().

Acknowledgement

With thanks to Andre Punt. Also thanks to Winston Chang for help with the R6 class / Shiny reactivity.
assessments

Description

Function used by `get_hcr_ip()` to generate input data for an assessment based HCR. The input to the HCR is depletion (i.e. Biomass / K).

Usage

```r
assessment(stock, mp_params, yr, iters = 1:dim(stock$biomass)[1])
```

Arguments

- `stock`: The stock object
- `mp_params`: A named list of MP parameters (with `est_sigma` and `est_bias` elements)
- `yr`: The timestep that the biomass is taken from.
- `iters`: Numeric vector of iters. Default is all of them.

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comparing_performance  'Comparing HCR Performance' app launcher

Description

Launches the Comparing Performance Shiny app. See the 'Information' tab in the app for more information. Also see the package vignette (`vignette("comparing_performance", package="AMPLE")`) for a tutorial.

Usage

```r
comparing_performance(...)  
```

Arguments

- `...`: Not used

Examples

```
## Not run: comparing_performance()
```
constant

Evaluates a constant harvest control rule

Description
Evaluates a constant harvest control rule, i.e. one that ignores the stock status and just returns the constant level (catch or effort). Used by the hcr_op function.

Usage
constant(mp_params, ...)

Arguments
mp_params The HCR / management procedure parameters used to evaluate the HCR (as a list).
... Unused

estimation_error

Description
Estimation error applied to the 'true' stock status to generate an 'observed' stock status used in the HCR. The error is a combination of bias and lognormally distributed noise.

Usage
estimation_error(input, sigma, bias)

Arguments
input A vector of the 'true' stock status
sigma Observation error standard deviation
bias Observation error bias
get_hcr_ip

Get the input to the HCR

Description
Run the MP analyses function to generate the input to the HCR i.e. observed stock status. For example, estimated biomass from an assessment.

Usage
get_hcr_ip(stock, mp_params, yr, ...)

Arguments
stock The stock object
mp_params The HCR / management procedure parameters used to evaluate the HCR (as a list).
yr The time step of the true stock status used to generate the HCR IP.
... Other arguments, including iters

get_hcr_op Evaluates the harvest control rule.

Description
Evaluates the harvest control rule in a single year (timestep).

Usage
get_hcr_op(stock, mp_params, yr, iters = 1:dim(stock$biomass)[1])

Arguments
stock The stock object
mp_params The HCR / management procedure parameters used to evaluate the HCR (as a list).
yr The timestep.
iters A numeric vector of iters.

Value
A vector of outputs from the HCR.
### intro_hcr  Introduction to HCRs app launcher

**Description**

Launches the introduction to HCRs Shiny app. See the 'Information' tab in the app for more information. Also see the package vignette (vignette("intro_hcr", package="AMPLE")) for a tutorial.

**Usage**

```r
intro_hcr(...)
```

**Arguments**

...  Not used

**Examples**

```r
## Not run: intro_hcr()
```

---

### measuring_performance  Measuring performance app launcher

**Description**

Launches the 'Measuring Performance' Shiny app. See the 'Information' tab in the app for more information. Also see the package vignette (vignette("measuring_performance", package="AMPLE")) for a tutorial.

**Usage**

```r
measuring_performance(...)
```

**Arguments**

...  Not used

**Examples**

```r
## Not run: measuring_performance()
```
Description

The interface for the HCR options. The parameter selection inputs shown in the app are conditional on the selected type of HCR. Some of the inputs have initial values that can be set using the function arguments.

Does the setting part of the MP params module. Returns a list of MP params based on the MP inputs.

Creates the MP params list based on the MP selection from the Shiny UI. Defined outside of a reactive environment above so we can use it non-reactively (helpful for testing).

Usage

```r
mpParamsSetterUI(
  id,
  mp_visible = NULL,
  title = "Select the type of HCR you want to test.",
  init_thresh_max_catch = 140,
  init_thresh_below = 0.5,
  init_constant_catch = 50,
  init_constant_effort = 1
)
```

```r
mpParamsSetterServer(id, get_stoch_params = NULL)
```

```r
mp_params_switcheroo(input, est_sigma = 0, est_bias = 0)
```

Arguments

- **id** The id (shiny magic)
- **mp_visible** Which HCR types to show.
- **title** The title.
- **init_thresh_max_catch** Initial value of the maximum catch for the catch threshold HCR.
- **init_thresh_below** Initial value of the below for the catch threshold HCR.
- **init_constant_catch** Initial value of constant catch for the constant catch HCR.
- **init_constant_effort** Initial value of constant effort for the constant effort HCR.
- **get_stoch_params** Reactive expression that gets the parameters from the stochasticity setter. Otherwise est_sigma and est_bias are set to 0.
Stochasticity module

input
List of information taken from the Shiny UI (mpParamsSetterUI)

est_sigma
Standard deviation of the estimation variability (default = 0).

est_bias
Estimation bias as a proportion. Can be negative (default = 0).

Value
A taglist
A list of HCR options.

Stochasticity module  stochParamsSetterUI

Description
stochParamsSetterUI() is the UI part for the stochasticity options. Stochasticity is included in the projections in two areas: biological variability (e.g. recruitment) and estimation error (to represent the difference between the ‘true’ status of the stock and the estimated status that is used by the HCR). Estimation error includes bias and variability. The arguments to this function allow only some of these elements to be shown.

stochParamSetterServer() does the server side stuff for the stochasticity options.

set_stoch_params() sets up default values for the stochasticity parameters. Defined as a separate function so it can be used for testing outside of a reactive environment.

Usage
stochParamsSetterUI(
  id,
  show_var = FALSE,
  show_biol_sigma = TRUE,
  show_est_sigma = TRUE,
  show_est_bias = TRUE,
  init_biol_sigma = 0,
  init_est_sigma = 0,
  init_est_bias = 0
)

stochParamsSetterServer(id)

set_stoch_params(input)

Arguments
id
The id (shiny magic)
show_var
Show the variability options when app opens (default is FALSE).
show_biol_sigma
Show the biological productivity variability option (default is TRUE).
show_est_sigma  Show the estimation variability option (default is TRUE).
show_est_bias   Show the estimation bias option (default is TRUE).
init_biol_sigma Default value for biological productivity variability (ignored if not shown).
init_est_sigma  Default value for estimation variability (ignored if not shown).
init_est_bias   Default value for estimation bias (ignored if not shown).
input          A list of stochasticity parameters.

Value
A taglist
A list of stochasticity options.

---

Stock  
R6 Class representing a stock

Description
A stock object has life history parameters, fields and methods for a biomass dynamic model.

Details
A stock has biomass, effort, catch and hcr_ip and hcr_op fields as well as the life history parameters. The population dynamics are a simple biomass dynamic model. The Stock class is used for the Shiny apps in the AMPLE package.

Public fields
- biomass  Array of biomass
- catch    Array of catches
- effort   Array of fishing effort
- hcr_ip   Array of HCR input signals
- hcr_op   Array of HCR output signals
- msy      MSY (default = 100).
- r        Growth rate (default = 0.6). Set by the user in the app.
- k        Carrying capacity (default = NULL - set by msy and r when object is initialised).
- p        Shape of the production curve (default = 1).
- q        Catchability (default = 1).
- lrp      Limit reference point, expressed as depletion (default = 0.2).
- trp      Target reference point, expressed as depletion (default = 0.5).
- b0       Virgin biomass (default = NULL - set by msy and r when object is initialised).
- current_corrnoise Stores the current values of the correlated noise (by iteration).
- biol_sigma Standard deviation of biological variability (default = 0).
- last_historical_timestep The last historical timestep of catch and effort data.
Methods

**Public methods:**

- `Stock$new()`
- `Stock$reset()`
- `Stock$reactive()`
- `Stock$fill_history()`
- `Stock$fill_catch_history()`
- `Stock$fill_biomass()`
- `Stock$as_data_frame()`
- `Stock$project()`
- `Stock$relative_cpue()`
- `Stock$relative_effort()`
- `Stock$replicate_table()`
- `Stock$time_periods()`
- `Stock$performance_indicators()`
- `Stock$pi_table()`
- `Stock$clone()`

**Method new():** Create a new stock object, with fields of the right dimension and NA values (by calling the `reset()` method. See the `reset()` method for more details.

*Usage:*

```r
Stock$new(stock_params, mp_params, niters = 1)
```

*Arguments:*

- `stock_params` A list of stock parameters with essential elements: `r` (growth rate, numeric), `stock_history` (string: "fully", "over", "under") initial_year (integer), last_historical_timestep (integer), nyears (integer), biol_sigma (numeric).
- `mp_params` A list of the MP parameters. Used to fill HCR ip and op.
- `niters` The number of iters in the stock (default = 1).

*Returns:* A new Stock object.

**Method reset():** Resets an existing stock object, by remaking all fields (possibly with different dimensions for the array fields). Fills up the catch, effort and biomass fields in the historical period based on the stock history and life history parameters in the `stock_params` argument. This is a reactive method which invalidates a reactive instance of this class after it is called.

*Usage:*

```r
Stock$reset(stock_params, mp_params, niters)
```

*Arguments:*

- `stock_params` A list with essential elements: `r` (growth rate, numeric, default=6), `stock_history` (string: "fully", "over", "under", default="fully") initial_year (integer, default=2000), last_historical_timestep (integer, default=10), nyears (integer, default=30), biol_sigma (numeric, default = 0).
- `mp_params` A list of the MP parameters. Used to fill HCR ip and op.
- `niters` The number of iters in the stock (default = 1).
Returns: A new Stock object.

**Method** `reactive()`: Method to create a reactive instance of a Stock.

*Usage:*

```
Stock$reactive()
```

*Returns:* a reactiveExpr.

**Method** `fill_history()`: Fills the historical period of the stock

*Usage:*

```
Stock$fill_history(stock_params, mp_params)
```

*Arguments:*

- `stock_params` Named list with last_historical_timestep and stock_history elements.
- `mp_params` A list of the MP parameters. Used to fill HCR ip and op.

**Method** `fill_catch_history()`: Fill up the historical period of catches with random values to simulate a catch history

*Usage:*

```
Stock$fill_catch_history(stock_params)
```

*Arguments:*

- `stock_params` A list with essential elements: r (growth rate, numeric), stock_history (string: "fully", "over", "under") initial_year (integer), last_historical_timestep (integer), nyears (integer).
- `stock_history` Character string of the exploitation history (default = "fully", alternatives are "under" or "over").

**Method** `fill_biomass()`: Fills the biomass in the next timestep based on current biomass and catches. The surplus production model has the general form: $B_{t+1} = B_t + f(B_t) - C_t$ Where the production function $f()$ is a Pella & Tomlinson model with shape $f(B_t) = r/p \times B_t \times (1 - (B_t/k)^p)$ Here p is fixed at 1 to give a Schaefer model $cpue = C_t / E_t = qB_t$

*Usage:*

```
Stock$fill_biomass(ts, iters = 1:dim(self$biomass)[1])
```

*Arguments:*

- `ts` The biomass time step to be filled (required catch etc in ts - 1).
- `iters` The iterations to calculate the biomass for (optional - default is all of them).

**Method** `as_data_frame()`: Produces a data.frame of some of the array-based fields, like biomass. Just used for testing purposes.

*Usage:*

```
Stock$as_data_frame()
```

**Method** `project()`: Projects the stock over the time steps given and updates the biomass, HCR ip / op and catches. It uses a simple biomass dynamic model where the catches or fishing effort are set every time step by the harvest control rule.

*Usage:*

```
``
Stock$project(timesteps, mp_params, iters = 1:dim(self$biomass)[1])

Arguments:
- **timesteps** The timesteps to project over. A vector of length 2 (start and end).
- **mp_params** A vector of management procedure parameters.
- **iters** A vector of iterations to be projected. Default is all the iterations in the stock

Returns: A stock object (a reactiveValues object with bits for the stock)

**Method relative_cpue():** The catch per unit effort (CPUE, or catch rate) relative to the CPUE in the last historical period.

Usage:
Stock$relative_cpue()

Returns: An array of same dims as the catch and effort fields.

**Method relative_effort():** The effort relative to the effort in the last historical period.

Usage:
Stock$relative_effort()

Returns: An array of same dims as the effort field.

**Method replicate_table():** Summarises the final year of each iteration. Only used for the Measuring Performance app.

Usage:
Stock$replicate_table(iters = 1, quantiles = c(0.05, 0.95))

Arguments:
- **iters** The iterations to calculate the table values for (default is iteration 1).
- **quantiles** Numeric vector of the quantile range. Default values are 0.05 and 0.95.

**Method time_periods():** Calculates the short, medium and long term periods to calculate the performance indicators over, based on the last historic year of data and the number of years in the projection.

Usage:
Stock$time_periods()

**Method performance_indicators():** Gets the performance indicators across all indicators, for three time periods. Used in the Measuring Performance and Comparing Performance apps.

Usage:
Stock$performance_indicators(
    iters = 1:dim(self$biomass)[1],
    quantiles = c(0.05, 0.95)
)

Arguments:
- **iters** The iterations to calculate the table values for (default is all of them).
- **quantiles** Numeric vector of the quantile range. Default values are 0.05 and 0.95.

Returns: A data.frame
Method pi_table(): Makes a table of the performance indicators.

Usage:
Stock$pi_table(iters = 1:dim(self$biomass)[1], quantiles = c(0.05, 0.95))

Arguments:
iters  The iterations to calculate the table values for (default is all of them).
quantiles Numeric vector, length 2, of the low and high quantiles.

Method clone(): The objects of this class are cloneable with this method.

Usage:
Stock$clone(deep = FALSE)

Arguments:
deep  Whether to make a deep clone.

<table>
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<tr>
<th>Stock module</th>
<th>stockParamsSetterUI</th>
</tr>
</thead>
</table>

Description

stockParamsSetterUI() is the interface for the stock options (e.g. life history and exploitation status).
stockParamsSetterServer() does the setting of the stock parameters in the server.
get_stock_params() Sets up default values for the stock, including year range. It’s a separate function so it can be used and tested outside of a reactive environment.

Usage

stockParamsSetterUI(id)

stockParamsSetterServer(id, get_stoch_params = NULL)

get_stock_params(input, biol_sigma = 0)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>Shiny magic</td>
</tr>
<tr>
<td>get_stoch_params</td>
<td>Reactive expression that accesses the stochasticity module server.</td>
</tr>
<tr>
<td>input</td>
<td>List of stock parameters taken from the shiny UI (stockParamsSetterUI()).</td>
</tr>
<tr>
<td>biol_sigma</td>
<td>Standard deviation of the biological variability (default = 0).</td>
</tr>
</tbody>
</table>

Value

A taglist
A list of stock options.
threshold  

Evaluates a threshold harvest control rule

Description

Evaluates a threshold (i.e. hockey stick) harvest control rule. Used by the hcr_op function.

Usage

threshold(input, mp_params, ...)

Arguments

input  
A vector of the 'true' stock status

mp_params  
The HCR / management procedure parameters used to evaluate the HCR (as a list).

...  
Unused

Value

A vector of the same dimension as the input.
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