Package 'aedseo'

November 27, 2023

Title Automated and Early Detection of Seasonal Epidemic Onset

Version 0.1.2

Description A powerful tool for automating the early detection of seasonal epidemic
onsets in time series data. It offers the ability to estimate growth rates
for consecutive time intervals and calculate the sum of cases (SoC) within
those intervals. It is particularly useful for epidemiologists, public
health professionals, and researchers seeking to identify and respond to
seasonal epidemics in a timely fashion.
For reference on growth rate estimation, see Walling and Lipstich (2007)
<doi:10.1098/rspb.2006.3754> and Obadia et al. (2012) <doi:10.1186/1472-6947-12-147>.

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URL https://github.com/ssi-dk/aedseo, https://ssi-dk.github.io/aedseo/

BugReports https://github.com/ssi-dk/aedseo/issues

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R topics documented:

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aedseo   *Automated and Early Detection of Seasonal Epidemic Onset*

Description

[Stable]

This function performs automated and early detection of seasonal epidemic onsets (aedseo) on a time series dataset. It estimates growth rates for consecutive time intervals and calculates the sum of cases (sum_of_cases).

Usage

```
aedseo(
  tsd,
  k = 5,
  level = 0.95,
  disease_threshold = NA_integer_,
  family = c("poisson", "quasipoisson")
)
```

Arguments

tsd	A `aedseo_tsd` object containing time series data with 'time' and 'observed.'
k	An integer specifying the window size for modeling growth rates.
level	The confidence level for parameter estimates, a numeric value between 0 and 1.
disease_threshold	
	An integer specifying the threshold for considering a disease outbreak.
family	A character string specifying the family for modeling. Choose between "poisson," or "quasipoisson".

Value

A aedseo object containing:

- 'reference_time': The time point for which the growth rate is estimated.

- 'observed': The observed value in the reference time point.

- 'growth_rate': The estimated growth rate.

- 'lower_growth_rate': The lower bound of the growth rate's confidence interval.

- 'upper_growth_rate': The upper bound of the growth rate's confidence interval.

- 'growth_warning': Logical. Is the growth rate significantly higher than zero?

- 'sum_of_cases': The sum of cases within the time window.

- 'sum_of_cases_warning': Logical. Does the Sum of Cases exceed the disease threshold?

- 'seasonal_onset_alarm': Logical. Is there a seasonal onset alarm?

- 'converged': Logical. Was the IWLS judged to have converged?

Examples

```
# Create a tsibble object from sample data
tsd_data <- tsd(
  observed = c(100, 120, 150, 180, 220, 270),
  time = as.Date(c(
    "2023-01-01",
    "2023-01-02",
    "2023-01-03",
    "2023-01-04",
    "2023-01-05",
    "2023-01-06"
  )),
  time_interval = "day"
)

# Calculate AEDSEO with a 3-day window and a Poisson family model
aedseo_results <- aedseo(
  tsd = tsd_data,
  k = 3,
  level = 0.95,
  disease_threshold = 200,
  family = "poisson"
)

# Print the AEDSEO results
print(aedseo_results)
```

---

autoplot   *Create a complete 'ggplot' appropriate to a particular data type*

Description

[Stable]

This function generates a complete 'ggplot' object suitable for visualizing time series data in an `aedseo_tsd` object. It creates a line plot connecting the observations and adds points at each data point.

Usage

```
autoplot(object, ...)

## S3 method for class 'aedseo_tsd'
autoplot(object, ...)

## S3 method for class 'aedseo'
autoplot(object, linewidth = 0.7, size = 2, alpha = 0.3, width = 0.2, ...)
```

Arguments

`object`	An `aedseo_tsd` or `aedseo` object
`...`	Additional arguments (not used).
`linewidth`	Numeric, the width of the line for the growth rate
`size`	Numeric, size of observational points.
`alpha`	Numeric, the alpha (transparency) for the observations with a significantly positive growth rate.
`width`	Numeric, the width of the error bar employed to show the confidence interval of the growth rate estimate.

Value

A 'ggplot' object for visualizing the time series data.

Examples

```
# Create an example aedseo_tsd object
aedseo_tsd_object <- tsd(
  observed = c(100, 120, 150, 180, 220, 270),
  time = as.Date(c(
    "2023-01-01",
    "2023-01-02",
    "2023-01-03",
    "2023-01-04",
    "2023-01-05",
```

```
      "2023-01-06"
    )),
    time_interval = "day"
)

# Create a ggplot visualization for the aedseo_tsd object
autoplot(aedseo_tsd_object)

# Create an aedseo object
aedseo_object <- aedseo(
  tsd = aedseo_tsd_object,
  k = 3,
  level = 0.95,
  family = "quasipoisson"
)

# Create a ggplot visualization of growth rates with confidence intervals
autoplot(aedseo_object, linewidth = 1, alpha = 0.2)
```

---

epi_calendar	*Determine Epidemiological Season*

Description

[Stable]

This function identifies the epidemiological season to which a given date belongs. The epidemiological season is defined by a start and end week, where weeks are numbered according to the ISO week date system.

Usage

```
epi_calendar(date, start = 40, end = 20)
```

Arguments

date	A date object representing the date to check.
start	An integer specifying the start week of the epidemiological season.
end	An integer specifying the end week of the epidemiological season.

Value

A character vector indicating the season:

- "out_of_season" if the date is outside the specified season,
- If within the season, the function returns a character string indicating the epidemiological season.

Examples

```
# Check if a date is within the epidemiological season
epi_calendar(as.Date("2023-09-15"), start = 40, end = 20)
# Expected output: "2022/2023"

epi_calendar(as.Date("2023-05-01"), start = 40, end = 20)
# Expected output: "out_of_season"

epi_calendar(as.Date("2023-01-15"), start = 40, end = 20)
# Expected output: "2022/2023"

epi_calendar(as.Date("2023-12-01"), start = 40, end = 20)
# Expected output: "2023/2024"
```

---

fit_growth_rate   *Fit a growth rate model to time series observations.*

Description

[Stable]

This function fits a growth rate model to time series observations and provides parameter estimates along with confidence intervals.

Usage

```
fit_growth_rate(
  observations,
  level = 0.95,
  family = c("poisson", "quasipoisson")
)
```

Arguments

observations   A numeric vector containing the time series observations.

level   The confidence level for parameter estimates, a numeric value between 0 and 1.

family   A character string specifying the family for modeling. Choose between "poisson," or "quasipoisson".

Value

A list containing:

- 'fit': The fitted growth rate model.
- 'estimate': A numeric vector with parameter estimates, including the growth rate and its confidence interval.
- 'level': The confidence level used for estimating parameter confidence intervals.

Examples

```
# Fit a growth rate model to a time series of counts
# (e.g., population growth)
data <- c(100, 120, 150, 180, 220, 270)
growth_rate_model <- fit_growth_rate(
  observations = data,
  level = 0.95,
  family = "poisson"
)

# Print the estimated growth rate and confidence interval
print(growth_rate_model$estimate)
```

---

plot.aedseo_tsd   *Create a complete 'ggplot' appropriate to a particular data type*

Description

[Stable]

This function generates a complete 'ggplot' object suitable for visualizing time series data in an
`aedseo_tsd` object. It creates a line plot connecting the observations and adds points at each data
point.

Usage

```
## S3 method for class 'aedseo_tsd'
plot(x, ...)

## S3 method for class 'aedseo'
plot(x, ...)
```

Arguments

x	An `aedseo_tsd` or aedseo object
...	Additional arguments passed to specific methods.

Value

A 'ggplot' object for visualizing the time series data.

See Also

autoplot()

Examples

```
# Create an example aedseo_tsd object
aedseo_tsd_object <- tsd(
  observed = c(100, 120, 150, 180, 220, 270),
  time = as.Date(c(
    "2023-01-01",
    "2023-01-02",
    "2023-01-03",
    "2023-01-04",
    "2023-01-05",
    "2023-01-06"
  )),
  time_interval = "day"
)

# Create a ggplot visualization for the aedseo_tsd object
plot(aedseo_tsd_object)

# Create an aedseo object
aedseo_object <- aedseo(
  tsd = aedseo_tsd_object,
  k = 3,
  level = 0.95,
  family = "quasipoisson"
)

# Create a ggplot visualization of growth rates with confidence intervals
plot(aedseo_object, linewidth = 1, alpha = 0.2)
```

---

predict.aedseo   *Predict Growth Rates for Future Time Steps*

Description

[Stable]

This function is used to predict future growth rates based on a model object created using the 'aedseo' package. It takes the model object and the number of future time steps (n_step) for which you want to make predictions and returns a prediction tibble.

Usage

```
## S3 method for class 'aedseo'
predict(object, n_step = 3, ...)
```

Arguments

object   A model object created using the aedseo package, typically the result of the
                aedseo() function.

n_step   An integer specifying the number of future time steps for which you want to
                predict growth rates. Default is 3.

...   Additional arguments (not used).

Value

A tibble S3 object called aedseo containing the predicted growth rates, including time, estimated
growth rate, lower confidence interval, and upper confidence interval for the specified number of
future time steps.

Examples

```
# Analyze the data using the aedseo package
tsd_data <- tsd(
  observed = c(100, 120, 150, 180, 220, 270),
  time = as.Date(c(
    "2023-01-01",
    "2023-01-02",
    "2023-01-03",
    "2023-01-04",
    "2023-01-05",
    "2023-01-06"
  )),
  time_interval = "day"
)

aedseo_results <- aedseo(
  tsd = tsd_data,
  k = 3,
  level = 0.95,
  family = "poisson"
)

# Predict growth rates for the next 5 time steps
prediction <- predict(object = aedseo_results, n_step = 5)

# Print the prediction
print(prediction)
```

---

summary.aedseo   *Summary method for aedseo objects*

Description

[Stable]

Summarize the results of an aedseo analysis, including the latest growth rate estimate, the confidence interval, and information about growth warnings.

Usage

```
## S3 method for class 'aedseo'
summary(object, ...)
```

Arguments

object   An object of class 'aedseo' containing the results of an aedseo analysis.

...   Additional arguments (not used).

Value

This function is used for its side effect, which is printing a summary message to the console.

Examples

```
# Create a tsibble object from sample data
tsd_data <- tsd(
  observed = c(100, 120, 150, 180, 220, 270),
  time = as.Date(c(
    "2023-01-01",
    "2023-01-02",
    "2023-01-03",
    "2023-01-04",
    "2023-01-05",
    "2023-01-06"
  )),
  time_interval = "day"
)

# Calculate aedseo with a 3-day window and a Poisson family model
aedseo_results <- aedseo(
  tsd = tsd_data,
  k = 3,
  level = 0.95,
  family = "poisson"
)
# Print the summary of the aedseo_results to the console
summary(aedseo_results)
```

---

tsd   *Create a S3* aedseo_tsd *(time-series data) object from observed data*
                             and corresponding dates.

Description

[Stable]

This function takes observed data and the corresponding date vector and converts it into a aedseo_tsd
object, which is a time series data structure that can be used for time series analysis.

Usage

```
tsd(observed, time, time_interval = c("day", "week", "month"))
```

Arguments

observed	A numeric vector containing the observations.
time	A date vector containing the corresponding dates.
time_interval	A character vector specifying the time interval. Choose between "day," "week," or "month."

Value

A aedseo_tsd object containing:

- 'time': The time point for for where the observations is observed.
- 'observed': The observed value at the time point.

Examples

```
# Create a `aedseo_tsd` object from daily data
daily_tsd <- tsd(
  observed = c(10, 15, 20, 18),
  time = as.Date(
    c("2023-01-01", "2023-01-02", "2023-01-03", "2023-01-04")
  ),
  time_interval = "day"
)

# Create a `aedseo_tsd` object from weekly data
weekly_tsd <- tsd(
  observed = c(100, 120, 130),
  time = as.Date(
    c("2023-01-01", "2023-01-08", "2023-01-15")
  ),
  time_interval = "week"
)

# Create a `aedseo_tsd` object from monthly data
monthly_tsd <- tsd(
  observed = c(500, 520, 540),
  time = as.Date(
    c("2023-01-01", "2023-02-01", "2023-03-01")
  ),
  time_interval = "month"
)
```

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