Package 'SPORTSCausal'

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Type Package

Title Spillover Time Series Causal Inference

Version 1.0

Imports CausalImpact, keras, stats, graphics, grDevices

Date 2021-03-13

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Description A time series causal inference model for Randomized Controlled Trial (RCT) under spillover effect. 'SPORTSCausal' (Spillover Time Series Causal Inference) separates treatment effect and spillover effect from given responses of experiment group and control group by predicting the response without treatment. It reports both effects by fitting the Bayesian Structural Time Series (BSTS) model based on 'CausalImpact', as described in Brodersen et al. (2015) <doi:10.1214/14-AOAS788>.

License GPL-2

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R topics documented:

SPORTSCausal-package *Spillover Time Series Causal Inference*

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Details

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sportscausal	Time series causal inference of Randomized Controlled Trial (RCT) under spillover effect

Author(s)

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References

Brodersen et al. *Inferring causal impact using Bayesian structural time-series models*. Annals of Applied Statistics, 2015

See Also

http://google.github.io/CausalImpact/CausalImpact.html

Examples

```
## For more detail of the package, try ?sportscausal and ?ad_cost
```

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ad_cost *Advertising cost: a real experimental data under spillover effect*

Description

This dataset comes from an A/Btest, which is to evaluate how a newly-proposed algorithm will affect the cost of advertising. Assuming that the bidding environment of an advertising market is stable in a short period of time, there will be no net increase or decrease of cost. When a treatment is applied, the mutual interference between the experiment group and the control group can not be ignored. For example, the difference in cost between the experiment group and the control group might not only come from the increase of experiment group, caused by treatment effect, but also from the potential decrease in control group. That is the typical situation for spillover causal inference to be implemented.

Usage

```
data("ad_cost")
```

Format

A data frame with 49 observations on the following 3 variables.

`y.exp` A numeric vector of responses in experiment group.

`y.con` A numeric vector of responses in control group.

`time` A numeric vector indicating time period before/after the treatment, `time = 1` represents post treatment period.

Details

This data has been linearly transformed for confidential issue.

Examples

```
### load data

data(ad_cost)

### define variables and visualize

y.exp = ad_cost$y.exp

y.con = ad_cost$y.con

plot(y.exp, col = "red", type = "l",
     xlab = "time", ylab = "response")
```

```
lines(y.con, col = "blue")

### fit the model and return treatment/spillover effect

# notice that day-34 is the first day of treatment

fit = sportscausal(y.exp = y.exp, y.con = y.con,
                   pre.period = c(1:33), post.period = c(34:49), is.plot = FALSE)

fit$est.treatment

fit$est.spillover
```

`sportscausal` *Time series causal inference of Randomized Controlled Trial (RCT) under spillover effect*

Description

'SPORTSCausal' produces treatment effect and spillover effect estimation from responses of experiment group and control group.

Usage

```
sportscausal(y.exp, y.con, pre.period, post.period, is.plot = TRUE,
  model.select = "AIC", max.p = 3, max.d = 3, max.q = 3, feature = NULL)
```

Arguments

`y.exp`	Response of experiment group, from pre-treatment to post-treatment
`y.con`	Response of control group, from pre-treatment to post-treatment
`pre.period`	Time period before the treatment
`post.period`	Time period during the treatment
`is.plot`	If `is.plot = TRUE`, by default, a pdf containing summary figures will be returned to the current working directory as `getwd()`
`model.select`	Model used to predict the time series without treatment. If `model.select = "AIC"`, by default, the ARIMA model using AIC selection would be applied. If `model.select = "CV"`, the ARIMA model using cross validation would be applied. If `model.select = "lstm"`, the Long Short-Term Memory model would be applied
`max.p`	The max number of autoregressive terms in ARIMA model, by default `max.p = 3`
`max.d`	The max number of nonseasonal differences needed for stationarity in ARIMA model, by default `max.d = 3`

`max.q`	The max number of lagged forecast errors in the prediction equation in ARIMA model, by default `max.p = 3`
`feature`	The covariate matrix associated with the response. By default, `feature = NULL` but can be non-null when `model.select = "lstm"`

Details

In the presense of spillover effect, the response of control group could be interferenced by the treatment. In order to seprate the treatment effect and spillover effect, `sportscausal` uses ARIMA model or LSTM model to predict the response behavior without treatment. The point estimator and significance of both effect follow using Bayesian Structrual Time Series (BSTS) model.

Value

`est.treatment`	Information of treatment effect estimation, containing point estimation, confidence interval and p-value
`est.spillover`	Information of spillover effect estimation, containing point estimation, confidence interval and p-value

Author(s)

Zihao Zheng and Feiyu Yue

References

Brodersen et al. *Inferring causal impact using Bayesian structural time-series models*. Annals of Applied Statistics, 2015

See Also

See also `?ad_cost`

Examples

```
## simulate data

set.seed(1)

y0 = 100 + arima.sim(model = list(ar = 0.3), n = 125)

y.con = y0 + rnorm(125)
y.con[101:125] = y.con[101:125] - 10 ## -10 as spillover effect

y.exp = y0 + rnorm(125)
y.exp[101:125] = y.exp[101:125] + 10 ## 10 as treatment effect

pre.period = c(1:100)
post.period = c(101:125)

## visualize
```

```
plot(y.exp, col = "red", type = "l", ylab = "response",
   ylim = c(80, 120))

lines(y.con, col = "blue")

abline(v = 101, col = "grey", lty = 2, lwd = 2)

legend("topleft", legend = c("exp", "con"), col = c("red", "blue"),
     cex = 1, lty = 1)

## try SPORTSCausal with ARIMA + AIC

fit.aic = sportscausal(y.exp = y.exp, y.con = y.con,
          pre.period = pre.period, post.period = post.period, is.plot = FALSE)

fit.aic$est.treatment
fit.aic$est.spillover

## you can also try model.select = "CV" or "lstm"
```

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