

# Package ‘JPSurv’

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**Title** Joinpoint Model for Relative and Cause-Specific Survival

**Description** Contains functions for fitting a joinpoint proportional hazards model to relative survival or cause-specific survival data, including estimates of joinpoint years at which survival trends have changed and trend measures in the hazard and cumulative survival scale. See Yu et al.(2009) <[doi:10.1111/j.1467-985X.2009.00580.x](https://doi.org/10.1111/j.1467-985X.2009.00580.x)>.

**License** GPL (>= 2)

**Imports** ggplot2,ggrepel, scales

**Depends** R (>= 3.5.0)

**NeedsCompilation** no

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|                |                                                                 |
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| JPSurv-package | <i>Joinpoint Model for Relative and Cause-Specific Survival</i> |
|----------------|-----------------------------------------------------------------|

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## Description

This package is to analyze trends in survival with respect to year of diagnosis using joinpoint model.

## Details

Survival data includes two temporal dimensions that are important to consider: the calendar year of diagnosis and the time since diagnosis. The JPSurv model is an extension of Cox proportional hazard model and of Hakulinen and Tenkanen in the case of relative survival, and fits a proportional hazard joinpoint model to survival data on the log hazard scale. Joinpoint models consist of linear segments connected through joinpoints. The probability (hazard) of cancer death is specified as the product of a baseline hazard (on time since diagnosis) and a multiplicative factor describing the effect of year of diagnosis and possibly other covariates. The effect of year of diagnosis is modeled as joined linear segments on the log scale. The number and location of joinpoints are estimated from data and represent the times at which trends changed. This model implies that the probability of cancer death as a function of time since diagnosis is proportional for individuals diagnosed in different calendar years. The software uses discrete-time survival data, i.e. survival data grouped by years since diagnosis in the life table format. The package accommodates both relative survival and cause-specific survival.

## References

- Yu B, Huang L, Tiwari RC, Feuer EJ, Johnson KA. Modelling population-based cancer survival trends by using join point models for grouped survival data. *Journal of the Royal Statistical Society Series a-Statistics in Society*. 2009;172:405-25.
- Hakulinen T, Tenkanen L. Regression Analysis of Relative Survival Rates. *Applied Statistics*. 1987;36(3):309-17.
- H. Wickham. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York, 2009.

aapc

*Trend summary measures for joinpoint relative survival model***Description**

Get the trend summary measures for joinpoint relative survival model quickly using default interval=5 (if available). A function that returns the trend summary measures including the Absolute Change in Survival (ACS), the Relative Change in Survival (RCS) . and the Relative Change in Hazard (RCH) for each joinpoint segment

**Usage**

```
aapc(fit, type="AbsChgSur", interval=5)
```

**Arguments**

|          |                                                                                                                                                                                                        |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fit      | Joinpoint object with predicted values and joinpoint model selections.                                                                                                                                 |
| type     | Type of trend summary measure. Supported measures are: RelChgHaz - Hazard of cancer death, AbsChgSur - Absolute change in survival. RelChgSur - Relative change in survival. The default is AbsChgSur. |
| interval | The number of years since diagnosis (follow-up years).                                                                                                                                                 |

**Value**

A data frame with columns start.year, end.year, estimate, std.error, lowCI, upCI containing the estimates, standard errors, and confidence interval of the trend summary measure.

**Examples**

```
data("fit2", package="JPSurv")

# Get the estimate, standard error, and confidence interval of
# the annual changes of cumulative relative survival for interval=5.
aapc(fit2, type="RelChgHaz")
```

aapc.multiints

*Trend summary measures for multiple selected intervals***Description**

A function that returns the trend summary measures including the Absolute Change in Survival (ACS), the Relative Change in Survival (RCS) and the Relative Change in Hazard (RCH) for each joinpoint segment given multiple selected intervals. It can also return the Weighted Average Absolute Change in Survival for the user-specified ACS year range.

**Usage**

```
aapc.multiints(fit, type = "AbsChgSur", int.select = NULL,
               ACS.range = NULL, ACS.out = NULL)
```

**Arguments**

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>fit</code>        | Joinpoint object with predicted values and joinpoint model selections.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <code>type</code>       | Type of trend summary measure. Supported measures are: RelChgHaz - Hazard of cancer death, AbsChgSur - Cumulative Relative Survival Average Annual Absolute Change. RelChgSur - Cumulative Relative Survival Average Annual Relative Change. The default is AbsChgSur.                                                                                                                                                                                                                                                                                                                                                                       |
| <code>int.select</code> | The single or multiple interval values selected for the trend measures calculation. The default is NULL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <code>ACS.range</code>  | It is needed for <code>type="AbsChgSur"</code> only. The minimum and maximum of the year range specified for the Average Absolute Change in Survival trend measure. The default is NULL. If <code>ACS.range=NULL</code> , the average absolute change in survival for joinpoint segments will be returned. Otherwise, the weighted average absolute change in survival for the desired range of years along with the the average absolute change in survival for joinpoint segments will be produced. Note that, the <code>ACS.range</code> should be within the entire range of data.                                                       |
| <code>ACS.out</code>    | It is used to specify which ACS trend results will be returned when <code>type="AbsChgSur"</code> . <code>ACS.out</code> can be defined as "user" or "both". If <code>ACS.range=NULL</code> , <code>ACS.out</code> should always be NULL and the ACS trend results between joinpoints will be returned. If <code>ACS.range</code> is the year range, the ACS trend measure results between the selected years will be returned when <code>ACS.out="user"</code> and the ACS trend results for both between joinpoints and user-selected years will be returned when <code>ACS.out="both"</code> . The default is <code>ACS.out=NULL</code> . |

**Value**

A list of data frames corresponding to each interval from `int.select`. Each data frame contains the columns `start.year`, `end.year`, `estimate`, `std.error`, `lowCI`, `upCI` for the estimates, standard errors, and confidence interval of the trend summary measure.

**Author(s)**

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**See Also**

[aapc](#)

**Examples**

```
data("fit1", package="JPSurv")

aapc.multiints(fit1, type="RelChgHaz", int.select=c(1,3,5))
```

---

|                |                          |
|----------------|--------------------------|
| breast.example | <i>Data for examples</i> |
|----------------|--------------------------|

---

**Description**

Data frame containing breast cancer data used in examples.

**Examples**

```
data("breast.example", package="JPSurv")

# Display first two rows
breast.example[1:2,]
```

---

|                     |                                     |
|---------------------|-------------------------------------|
| dictionary.overview | <i>SEERStat Dictionary Overview</i> |
|---------------------|-------------------------------------|

---

**Description**

Reads the dictionary file and returns a parsed overview.

**Usage**

```
dictionary.overview(DICfilename)
```

**Arguments**

DICfilename      File name/path for dictionary (.dic) file corresponding to SEERStat data file.

**Value**

A list which contains the parsed information stored in the dictionary file.

---

|               |                                   |
|---------------|-----------------------------------|
| download.data | <i>Combine inputs and outputs</i> |
|---------------|-----------------------------------|

---

### Description

A function that returns a merged data set including the selected cohort input data and the accompanying data for plot.surv.year/plot.dying.year for the download feature in the JPSurv web app.

### Usage

```
download.data(input, fit, nJP, yearvar, downloadtype, subset = NULL,
              interval = "Interval", int.select = NULL)
```

### Arguments

|              |                                                                                             |
|--------------|---------------------------------------------------------------------------------------------|
| input        | The input dataset read in by function joinpoint.seerdata.                                   |
| fit          | The joinpoint object containing the model output.                                           |
| nJP          | The number of joinpoints in the model.                                                      |
| yearvar      | The variable name for year of diagnosis used in argument 'year' of the function joinpoint.  |
| downloadtype | Either "graph" for graph data or "full" for full data.                                      |
| subset       | An optional string specifying a subset of observations used in the fitting process.         |
| interval     | The variable name for year since diagnosis. The default is 'Interval'.                      |
| int.select   | The interval values selected for the plot if the downloadtype="graph". The default is NULL. |

### Value

A data frame containing the selected cohort input data and the below predicted columns.

|                            |                                                                     |
|----------------------------|---------------------------------------------------------------------|
| Predicted_Survival_Int     | The predicted interval survival.                                    |
| Predicted_ProbDeath_Int    | The predicted probability of Dying of Cancer.                       |
| Predicted_Survival_Cum     | The predicted cumulative survival.                                  |
| Predicted_Survival_Int_SE  | The standard error of the predicted interval survival.              |
| Predicted_Survival_Cum_SE  | The standard error of the predicted probability of Dying of Cancer. |
| Predicted_ProbDeath_Int_SE | The standard error of the predicted cumulative survival.            |

**Author(s)**

Fanni Zhang <zhangf@imsweb.com>

**References**

The JPSurv web app <https://analysisistools.nci.nih.gov/jpsurv/>.

**See Also**

[Plot.dying.year.annotate](#), [Plot.surv.year.annotate](#), [Plot.surv.int.multiyears](#).

**Examples**

```
data("breast.example", package="JPSurv")
data("fit1", package="JPSurv")

nJP<-2
data.graph135<-download.data(breast.example,fit1,nJP,"Year_of_diagnosis_1975","graph",
                             subsetStr1,interval="Interval",int.select=c(1,3,5))
data.full<-download.data(breast.example,fit1,nJP,"Year_of_diagnosis_1975","full",subsetStr1)
```

---

|      |                                                  |
|------|--------------------------------------------------|
| fit1 | <i>Fitted joinpoint object and subset string</i> |
|------|--------------------------------------------------|

---

**Description**

An object of class "joinpoint" used in examples.

---

|      |                                                  |
|------|--------------------------------------------------|
| fit2 | <i>Fitted joinpoint object and subset string</i> |
|------|--------------------------------------------------|

---

**Description**

An object of class "joinpoint" used in examples.

---

|      |                                                  |
|------|--------------------------------------------------|
| fit3 | <i>Fitted joinpoint object and subset string</i> |
|------|--------------------------------------------------|

---

**Description**

An object of class "joinpoint" used in examples.

---

|             |                              |
|-------------|------------------------------|
| input.valid | <i>Input data validation</i> |
|-------------|------------------------------|

---

### Description

A function that validates the selected cohort data and returns an indicator along with a warning message if the selected cohort is not valid.

### Usage

```
input.valid(input, subset = NULL)
```

### Arguments

|        |                                                                                     |
|--------|-------------------------------------------------------------------------------------|
| input  | Input dataset imported by function joinpoint.seerdata.                              |
| subset | An optional string specifying a subset of observations used in the fitting process. |

### Value

If the cohort selection is available, value 1 will be returned; otherwise, value 0 will be returned and a warning message printed.

---

|           |                                                     |
|-----------|-----------------------------------------------------|
| joinpoint | <i>Fitting a join point relative survival model</i> |
|-----------|-----------------------------------------------------|

---

### Description

Fitting a joinpoint relative survival model

### Usage

```
joinpoint(data, subset=NULL, na.action = na.fail,
year="Year", interval="Interval",
number.event="Died", number.alive="Alive_at_Start",
          number.loss="Lost_to_Followup",
expected.rate="Expected_Survival_Interval", observedrelsurv = NULL,
model.form = NULL, maxnum.jp = 0, proj.year.num=5,
op=list(),
delLastIntvl=FALSE, add.data.cols="_ALL_")
```



**Arguments**

|                              |                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>data</code>            | an optional data frame, list or environment (or object coercible by <code>as.data.frame</code> to a data frame) containing the variables in the model. If not found in data, the variables are taken from <code>environment(formula)</code> .                                                                                                                                     |
| <code>subset</code>          | an optional string specifying a subset of observations to be used in the fitting process.                                                                                                                                                                                                                                                                                         |
| <code>na.action</code>       | how NAs are treated. The default is first, any <code>na.action</code> attribute of data, second a <code>na.action</code> setting of options, and third <code>na.fail</code> if that is unset. The "factory-fresh" default is <code>na.omit</code> . Another possible value is <code>NULL</code> . The default is <code>na.fail</code>                                             |
| <code>year</code>            | It is about the year or time values and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Year'.                                                                                                                                                                                                         |
| <code>interval</code>        | It is about the time elapsed from start to the event and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Interval'.                                                                                                                                                                                    |
| <code>number.event</code>    | It is the number of events or died and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Died'.                                                                                                                                                                                                          |
| <code>number.alive</code>    | It is about the number of alive and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Alive_at_Start'.                                                                                                                                                                                                   |
| <code>number.loss</code>     | It is about the number of Lost_to_Followup and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Lost_to_Followup'.                                                                                                                                                                                      |
| <code>expected.rate</code>   | It is about the interval expected survival and could be a vector of numeric or a character string giving a column name of the argument 'data'. The default is the string 'Expected_Survival_Interval'. If this column does not exist, then a column of ones will be created for <code>expected.rate</code> .                                                                      |
| <code>observedrelsurv</code> | It is about the observed cumulative relative survival and could be a vector of numeric or a character string giving a column name of the argument 'data'. If <code>NULL</code> , then no observed values. The default is <code>NULL</code> .                                                                                                                                      |
| <code>model.form</code>      | an object of class "formula": a symbolic description of covariates. Example: <code>~1+age+as.factor(stage)</code>                                                                                                                                                                                                                                                                 |
| <code>maxnum.jp</code>       | The maximum number of join points allowed. The default is zero, which is equivalent to a proportional hazard relative survival model.                                                                                                                                                                                                                                             |
| <code>proj.year.num</code>   | The number of projection years for use in the prediction step. Default value is 5 years, with a valid range of 0 to 30 years.                                                                                                                                                                                                                                                     |
| <code>op</code>              | List of more options. Details — <ul style="list-style-type: none"> <li>• <b>numbetwn</b>: integer value, number of skipped obs between joinpoints exclusive (not count for the joinpoints). Default is 2.</li> <li>• <b>numfromstart</b>: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 3.</li> </ul> |

- **numtoend**: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 4.
- `dellastIntvl` an logical value indicating whether or not deleting records of last intervals of all years. The default is false.
- `add.data.cols` Character vector of column names in data to add onto the returned data frames of results. Use `"_ALL_"` to add all columns and use `NULL` to not add any columns. The default is `"_ALL_"`.

## Value

An object of class "joinpoint" will be returned with attributes:

- `coefficients` a named vector of coefficients and standard errors
- `jp` the estimates of the join points
- `converged` convergence status
- `predicted` the fitted relative survival rates
- `fullpredicted` the full output matrix, with all year/interval combinations and projections
- `xbeta` the linear predictor
- `ll` log likelihood
- `aic` AIC
- `bic` BIC
- `FitList` a list that contains fitting results for the number of joinpoints = 0,1,...,numJPoints respectively.

## References

Yu, B., Huang, L., Tiwari, R. C., Feuer, E. J. and Johnson, K. A. (2009), Modeling population-based cancer survival trends by using join point models for grouped survival data. *Journal of the Royal Statistical Society: Series A*, 172, 405-425.

## Examples

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

subsetStr="Year_of_diagnosis_1975 >= 1975 & Age_groups == '00-49' & Breast_stage == 'Localized'"
# Fit the survival join point model with zero join points,
# i.e., fit the proportional hazard relative survival model.
fit = joinpoint(data=breast.example,
               subset = subsetStr,
               year="Year_of_diagnosis_1975",
               observedrelsurv="Relative_Survival_Cum",
               model.form = NULL,
               maxnum.jp = 0)
```

---

joinpoint.choose.cutpoint

*Choose cutpoint from joinpoint.relaxProp results*


---

## Description

Choose the cutpoint from the joinpoint.relaxProp returned object

## Usage

```
joinpoint.choose.cutpoint(obj, cutpoint)
```

## Arguments

|          |                                                                                                                                           |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| obj      | Returned object from <a href="#">joinpoint.relaxProp</a> .                                                                                |
| cutpoint | The cutpoint to choose. It should correspond to a set of results in <code>obj\$all.results</code> . If not, then an error will be thrown. |

## Value

A list of class with the following objects:

|               |                                                                                          |
|---------------|------------------------------------------------------------------------------------------|
| predicted     | The fitted relative survival rates                                                       |
| fullpredicted | The full output matrix, with all year/interval combinations and projections              |
| fit.uncond    | The fitted model from the (unconditional) joinpoint model corresponding to the cutpoint. |
| fit.cond      | The fitted model from the conditional joinpoint model corresponding to the cutpoint.     |

## References

Yu, B., Huang, L., Tiwari, R. C., Feuer, E. J. and Johnson, K. A. (2009), Modeling population-based cancer survival trends by using join point models for grouped survival data. *Journal of the Royal Statistical Society: Series A*, 172, 405-425.

## See Also

[joinpoint.relaxProp](#)

joinpoint.cond

*Fitting a join point conditional relative survival model***Description**

Fitting a joinpoint conditional relative survival model

**Usage**

```
joinpoint.cond(data, subset, start.interval, end.interval=NULL,
year="Year", interval="Interval",
number.event="Died", number.alive="Alive_at_Start",
               number.loss="Lost_to_Followup",
expected.rate="Expected_Survival_Interval",
model.form=NULL, maxnum.jp=0, proj.year.num=5,
op=list(), delLastIntvl=FALSE, add.data.cols="_ALL_")
```

**Arguments**

|                |                                                                                                                                                                    |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data           | Data frame containing all variables in the model.                                                                                                                  |
| subset         | A logical vector of length nrow(data), a character string or NULL to include a particular subset of data in the analysis. See <b>Details</b> and <b>Examples</b> . |
| start.interval | A positive integer giving the number of intervals to condition on.                                                                                                 |
| end.interval   | A positive integer > start.interval giving the end number of intervals.                                                                                            |
| year           | Column name of data giving the year or year code. This column must be numeric. The default is 'Year'.                                                              |
| interval       | Column name of data giving the time interval elapsed from the starting time to the event time. This column must be numeric. The default is 'Interval'.             |
| number.event   | Column name of data giving the number of events or deaths. This column must be numeric. The default is 'Died'.                                                     |
| number.alive   | Column name of data giving the number of subjects alive. This column must be numeric. The default is 'Alive_at_Start'.                                             |
| number.loss    | Column name of data giving the number of subjects lost to followup. This column must be numeric. The default is 'Lost_to_Followup'.                                |
| expected.rate  | Column name of data giving the interval survival. This column must be numeric. The default is 'Expected_Survival_Interval'.                                        |
| model.form     | an object of class "formula": a symbolic description of covariates. Example: ~-1+age+as.factor(stage)                                                              |
| maxnum.jp      | The maximum number of join points allowed. The default is zero, which is equivalent to a proportional hazard relative survival model.                              |
| proj.year.num  | The number of projection years for use in the prediction step. Default value is 5 years, with a valid range of 0 to 30 years.                                      |
| op             | List of more options. Details —                                                                                                                                    |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               | <ul style="list-style-type: none"> <li>• <b>numbetwn</b>: integer value, number of skipped obs between joinpoints exclusive (not count for the joinpoints). Default is 2.</li> <li>• <b>numfromstart</b>: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 3.</li> <li>• <b>numtoend</b>: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 4.</li> </ul> |
| delLastIntvl  | an logical value indicating whether or not deleting records of last intervals of all years. The default is FALSE.                                                                                                                                                                                                                                                                                                                                                                                          |
| add.data.cols | Character vector of column names in data to add onto the returned data frames of results. Use "_ALL_" to add all columns and use NULL to not add any columns. The default is "_ALL_".                                                                                                                                                                                                                                                                                                                      |

## Details

The data to be included in the analysis must contain unique year, interval pairs. If not, then an error will be thrown. The subset option can be used to ensure that there are unique pairs of year and interval.

This function will set up the data based on the value of start by removing all rows with interval less than or equal to start and then call the [joinpoint](#) function.

## Value

An object of class "joinpoint" will be returned with attributes:

|               |                                                                                                      |
|---------------|------------------------------------------------------------------------------------------------------|
| coefficients  | a named vector of coefficients and standard errors                                                   |
| jp            | the estimates of the join points                                                                     |
| converged     | convergence status                                                                                   |
| predicted     | the fitted relative survival rates                                                                   |
| fullpredicted | the full output matrix, with all year/interval combinations and projections                          |
| xbeta         | the linear predictor                                                                                 |
| ll            | log likelihood                                                                                       |
| aic           | AIC                                                                                                  |
| bic           | BIC                                                                                                  |
| FitList       | a list that contains fitting results for the number of joinpoints = 0,1,...,numJPoints respectively. |

## References

Yu, B., Huang, L., Tiwari, R. C., Feuer, E. J. and Johnson, K. A. (2009), Modeling population-based cancer survival trends by using join point models for grouped survival data. Journal of the Royal Statistical Society: Series A, 172, 405-425.

## See Also

[joinpoint](#), [joinpoint.conditional](#)

## Examples

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

# Subset of observations to use
subset <- "Age_groups == '00-49' & Breast_stage == 'Localized'"

# Fit the conditional survival join point model with starting
# interval 5
fit <- joinpoint.cond(breast.example, subset, 5,
                     year="Year_of_diagnosis_1975",
                     model.form=NULL, maxnum.jp=0)
```

---

joinpoint.conditional *Fitting a join point conditional relative survival model from the unconditional model*

---

## Description

Fitting a joinpoint conditional relative survival model from the unconditional model

## Usage

```
joinpoint.conditional(fit.uncond, start.intervals, end.intervals, njp=NULL)
```

## Arguments

|                 |                                                                                                                                                                                                                                                                                                  |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fit.uncond      | Object returned from <a href="#">joinpoint</a> .                                                                                                                                                                                                                                                 |
| start.intervals | Vector of integers giving the intervals to condition on.                                                                                                                                                                                                                                         |
| end.intervals   | Vector of integers giving the end number of intervals. This vector must have the same length and order as start.intervals with end.intervals[i] > start.intervals[i].                                                                                                                            |
| njp             | NULL or the number of joinpoints corresponding to one of the fitted models in fit.uncond. If njp = k, then the conditional probabilities will be based on the model with k joinpoints. If NULL, then the model corresponding to the best fit returned by <a href="#">joinpoint</a> will be used. |

## Details

This function computes the conditional survival

$$P(T > t_{j+k} | T > t_j) = \frac{P(T > t_{j+k})}{P(T > t_j)}, \quad k = 1, \dots, m$$

## Value

A data frame similar to the fullpredicted data frame returned from [joinpoint](#) except that it will only contain rows corresponding to the start.intervals and end.intervals that were specified. The data frame will also contain the additional column "Start.interval", and will be grouped by the start.intervals.

## References

Yu, B., Huang, L., Tiwari, R. C., Feuer, E. J. and Johnson, K. A. (2009), Modeling population-based cancer survival trends by using join point models for grouped survival data. *Journal of the Royal Statistical Society: Series A*, 172, 405-425.

## See Also

[joinpoint](#), [joinpoint.seerdata](#)

## Examples

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

# Subset of observations to use
subset <- "Age_groups == '00-49' & Breast_stage == 'Localized'"

# Fit the unconditional survival join point model
fit <- joinpoint(breast.example, subset,
                 year="Year_of_diagnosis_1975",
                 model.form=NULL, maxnum.jp=0)

# Compute conditional survival  $S(10 \mid 5) = P(T>10 \mid T>5)$ 
ret <- joinpoint.conditional(fit, 5, 10)
```

---

|                     |                                                |
|---------------------|------------------------------------------------|
| joinpoint.relaxProp | <i>Relaxing the proportionality assumption</i> |
|---------------------|------------------------------------------------|

---

## Description

Fitting a joinpoint survival model by relaxing the proportionality assumption

## Usage

```
joinpoint.relaxProp(data, subset, max.cutpoint=5,
                    year="Year", interval="Interval", number.event="Died",
                    number.alive="Alive_at_Start", number.loss="Lost_to_Followup",
                    expected.rate="Expected_Survival_Interval",
                    observed.rate="Observed_Survival_Interval",
                    model.form=NULL, maxnum.jp=0,
                    proj.year.num=5, op=list(), delLastIntvl=FALSE, add.data.cols=NULL)
```

## Arguments

|        |                                                                                                                                                                                               |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data   | Data frame containing all variables in the model.                                                                                                                                             |
| subset | A logical vector of length <code>nrow(data)</code> , a character string or <code>NULL</code> to include a particular subset of data in the analysis. See <b>Details</b> and <b>Examples</b> . |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| max.cutpoint  | A positive integer or NULL giving the number of cutpoints to consider. If NULL, then it will be set to the number of intervals minus one. The default is 5.                                                                                                                                                                                                                                                                                                                                                                                |
| year          | Column name of data giving the year or year code. This column must be numeric. The default is 'Year'.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| interval      | Column name of data giving the time interval elapsed from the starting time to the event time. This column must be numeric. The default is 'Interval'.                                                                                                                                                                                                                                                                                                                                                                                     |
| number.event  | Column name of data giving the number of events or deaths. This column must be numeric. The default is 'Died'.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| number.alive  | Column name of data giving the number of subjects alive. This column must be numeric. The default is 'Alive_at_Start'.                                                                                                                                                                                                                                                                                                                                                                                                                     |
| number.loss   | Column name of data giving the number of subjects lost to followup. This column must be numeric. The default is 'Lost_to_Followup'.                                                                                                                                                                                                                                                                                                                                                                                                        |
| expected.rate | Column name of data giving the expected interval survival. This column must be numeric. The default is 'Expected_Survival_Interval'.                                                                                                                                                                                                                                                                                                                                                                                                       |
| observed.rate | Column name of data giving the observed interval survival. This column must be numeric. The default is 'Observed_Survival_Interval'.                                                                                                                                                                                                                                                                                                                                                                                                       |
| model.form    | an object of class "formula": a symbolic description of covariates. Example: <code>~1+age+as.factor(stage)</code>                                                                                                                                                                                                                                                                                                                                                                                                                          |
| maxnum.jp     | The maximum number of join points allowed. The default is zero, which is equivalent to a proportional hazard relative survival model.                                                                                                                                                                                                                                                                                                                                                                                                      |
| proj.year.num | The number of projection years for use in the prediction step. Default value is 5 years, with a valid range of 0 to 30 years.                                                                                                                                                                                                                                                                                                                                                                                                              |
| op            | List of more options. Details — <ul style="list-style-type: none"> <li>• <b>numbetwn</b>: integer value, number of skipped obs between joinpoints exclusive (not count for the joinpoints). Default is 2.</li> <li>• <b>numfromstart</b>: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 3.</li> <li>• <b>numtoend</b>: integer value, number of skipped obs from the first obs to joinpoints exclusive (not count for the joinpoint). Default is 4.</li> </ul> |
| dellastIntvl  | an logical value indicating whether or not deleting records of last intervals of all years. The default is FALSE.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| add.data.cols | Character vector of column names in data to add onto the returned data frames of results. Use "_ALL_" to add all columns and use NULL to not add any columns. The default is NULL.                                                                                                                                                                                                                                                                                                                                                         |

## Details

This function finds the optimal clustering of intervals (1, ..., I), where I is the number of intervals, such that there are at most two ordered clusters of the form (1, ..., j) and (j+1, ..., I). For each ordered cluster, a model is fit and the BIC is computed. The algorithm is as follows:

1. Fit the (unconditional) joinpoint survival model on intervals (1, ..., I) and compute the BIC and call it BIC-0.
2. For each cutpoint j, j = 1, ..., max.cutpoint, fit the (unconditional) joinpoint survival model on





---

|                    |                                          |
|--------------------|------------------------------------------|
| joinpoint.seerdata | <i>Read in and format SEER*Stat data</i> |
|--------------------|------------------------------------------|

---

## Description

A function that reads in and format SEER\*Stat data in a single step. Either numeric values or value labels can be imported.

## Usage

```
joinpoint.seerdata(seerfilename,newvarnames,UseVarLabelsInData=FALSE)
```

## Arguments

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| seerfilename       | The file name of the seer files. Here one needs two files: the seer directory file with name extention 'dic' and the seer data file with the same name of the directory file but different name extention, i.e. 'txt'.                                                                                                                                                                                           |
| newvarnames        | A list of key words used for referencing the variable in the seer directory file and data file.                                                                                                                                                                                                                                                                                                                  |
| UseVarLabelsInData | A logic value or character variables giving variable names. If true or the variable names, then variable labels read from the dic file will replace associated numeric values in the data.frame object, which stores data from the associated data file, for all vars in dic or those (names of which are given by UseVarLabelsInData). If false, then data read from the associated data file won't be changed. |

## Value

A data frame containing the SEER\*Stat data read in.

## Examples

```
# For this example we will be referencing the SEER*Stat session that was used to
# create the breast.example data included with the package.
# If the "breast.example.txt" is the output data file from SEER*Stat, then joinpoint.seerdata
# can be used to input the data quickly, while taking into account the relevant information
# in the accompanying dictionary file.
# Input data is stored in breast.example
# breast.data = joinpoint.seerdata(seerfilename="breast.example",
#                               newvarnames=c("Age_groups", "Breast_Stage", "Year_of_diagnosis_1975"),
#                               UseVarLabelsInData=FALSE)
# breast.data = joinpoint.seerdata(seerfilename="breast.example",
#                               newvarnames=c("Breast_Stage", "Year_of_diagnosis_1975"),
#                               UseVarLabelsInData=c("Breast_Stage", "Year_of_diagnosis_1975"))
# The breast.data object can immediately be used as input to the joinpoint modeling function.
```

---

jp.plot.cond.year      *Plot of conditional survival versus year at diagnosis*

---

## Description

Plot of conditional survival versus year at diagnosis

## Usage

```
jp.plot.cond.year(fit.cond, start.interval=NULL, end.interval=NULL,
                  year.col="Year", interval.col="Interval",
                  relSurvInt.col="Relative_Survival_Interval", addToYear=0,
                  ylim=NULL)
```

## Arguments

|                |                                                                                                                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------|
| fit.cond       | Object returned from <a href="#">joinpoint.conditional</a> .                                                            |
| start.interval | NULL or the starting interval. If NULL, then the smallest starting interval will be chosen.                             |
| end.interval   | NULL or the ending interval. If NULL, then the largest interval will be chosen.                                         |
| year.col       | The name of the year at diagnosis column in fit.cond. The default is "Year".                                            |
| interval.col   | The name of the interval column in fit.cond. The default is "Interval".                                                 |
| relSurvInt.col | The name of the relative survival interval column in fit.cond. The default is "Relative_Survival_Interval".             |
| addToYear      | Integer to add to the year at diagnosis column to give the correct years at diagnosis for displaying. The default is 0. |
| ylim           | NULL or the y-axis limits of the plot. If NULL, then the limits will be determined from the data.                       |

## Details

The lines on the plot use the pred\_cum column in fit.cond, while the points are from the relSurvInt.col column.

## Value

NULL

## See Also

[joinpoint](#), [joinpoint.conditional](#)

## Examples

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

# Subset of observations to use
subset <- "Age_groups == '00-49' & Breast_stage == 'Localized'"

# Fit the unconditional survival join point model
fit <- joinpoint(breast.example, subset,
  year="Year_of_diagnosis_1975",
  model.form=NULL, maxnum.jp=0)

# Compute conditional survival  $S(10 \mid 5) = P(T > 10 \mid T > 5)$ 
ret <- joinpoint.conditional(fit, 5, 10)

jp.plot.cond.year(ret, year.col="Year_of_diagnosis_1975")
```

---

jp.plot.death

*Plot of the annual probability of dying*

---

## Description

Plot of the annual probability of dying

## Usage

```
jp.plot.death(fit.uncond, fit.cond, start.interval=NULL, end.interval=NULL,
  year.col="Year", interval.col="Interval",
  relSurvInt.col="Relative_Survival_Interval", addToYear=0,
  ylim=NULL)
```

## Arguments

|                |                                                                                                                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------|
| fit.uncond     | Object returned from <a href="#">joinpoint</a> .                                                                        |
| fit.cond       | Object returned from <a href="#">joinpoint.conditional</a> .                                                            |
| start.interval | NULL or the starting interval. If NULL, then the smallest starting interval will be chosen.                             |
| end.interval   | NULL or the ending interval. If NULL, then the largest interval will be chosen.                                         |
| year.col       | The name of the year at diagnosis column in fit.cond. The default is "Year".                                            |
| interval.col   | The name of the interval column in fit.cond. The default is "Interval".                                                 |
| relSurvInt.col | The name of the relative survival interval column in fit.cond. The default is "Relative_Survival_Interval".             |
| addToYear      | Integer to add to the year at diagnosis column to give the correct years at diagnosis for displaying. The default is 0. |
| ylim           | NULL or the y-axis limits of the plot. If NULL, then the limits will be determined from the data.                       |

**Details**

The lines on the plot use the `pred_int` column in `fit.cond`, while the points are from the `relSurvInt.col` column.

**Value**

NULL

**See Also**

[joinpoint](#), [joinpoint.conditional](#)

**Examples**

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

# Subset of observations to use
subset <- "Age_groups == '00-49' & Breast_stage == 'Localized'"

# Fit the unconditional survival join point model
fit <- joinpoint(breast.example, subset,
                 year="Year_of_diagnosis_1975",
                 model.form=NULL, maxnum.jp=0)

# Compute conditional survival  $S(10 \mid 5) = P(T > 10 \mid T > 5)$ 
ret <- joinpoint.conditional(fit, 5, 10)

jp.plot.death(fit, ret, year.col="Year_of_diagnosis_1975")
```

---

jp.plot.surv

*Plot of conditional survival versus interval*

---

**Description**

Plot of conditional survival versus interval

**Usage**

```
jp.plot.surv(fit.uncond, fit.cond, start.interval=NULL, end.interval=NULL,
             year.col="Year", interval.col="Interval",
             relSurvInt.col="Relative_Survival_Interval", addToYear=0,
             ylim=NULL, yearsToPlot=NULL, legend.pos="bottom")
```

**Arguments**

|                             |                                                                                                                             |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <code>fit.uncond</code>     | Object returned from <a href="#">joinpoint</a> .                                                                            |
| <code>fit.cond</code>       | Object returned from <a href="#">joinpoint.conditional</a> .                                                                |
| <code>start.interval</code> | NULL or the starting interval. If NULL, then the smallest starting interval will be chosen.                                 |
| <code>end.interval</code>   | NULL or the ending interval. If NULL, then the largest interval will be chosen.                                             |
| <code>year.col</code>       | The name of the year at diagnosis column in <code>fit.cond</code> . The default is "Year".                                  |
| <code>interval.col</code>   | The name of the interval column in <code>fit.cond</code> . The default is "Interval".                                       |
| <code>relSurvInt.col</code> | The name of the relative survival interval column in <code>fit.cond</code> . The default is "Relative_Survival_Interval".   |
| <code>addToYear</code>      | Integer to add to the year at diagnosis column to give the correct years at diagnosis for displaying. The default is 0.     |
| <code>ylim</code>           | NULL or the y-axis limits of the plot. If NULL, then the limits will be determined from the data.                           |
| <code>yearsToPlot</code>    | NULL or the years at diagnosis to display in the plot. If NULL, then no more than five years will be selected for the plot. |
| <code>legend.pos</code>     | Character string to give the legend position in the plot. The default is "bottom".                                          |

**Details**

The lines on the plot use the `pred_cum` column in `fit.cond`, while the points are from the `relSurvInt.col` column.

**Value**

NULL

**See Also**

[joinpoint](#), [joinpoint.conditional](#)

**Examples**

```
#Load the provided SEER 18 breast cancer example data.
data("breast.example", package="JPSurv")

# Subset of observations to use
subset <- "Age_groups == '00-49' & Breast_stage == 'Localized'"

# Fit the unconditional survival join point model
fit <- joinpoint(breast.example, subset,
  year="Year_of_diagnosis_1975",
  model.form=NULL, maxnum.jp=0)

# Compute conditional survival  $S(10 | 5) = P(T > 10 | T > 5)$ 
ret <- joinpoint.conditional(fit, 5, 10)

jp.plot.surv(fit, ret, year.col="Year_of_diagnosis_1975")
```

---

Plot.dying.year.annotate

*Figure - Percent Change in the Annual Probability of Dying of Cancer by Diagnosis Year*

---

## Description

A function that returns a plot (or a list including the Relative Change in Hazard trend measures and the plot) for percent change in the annual probability of dying of cancer by diagnosis year using ggplot. The annotation feature is available for  $nJP \leq 3$  and the number of multiple intervals selected  $\leq 3$ .

## Usage

```
Plot.dying.year.annotate(plotdata, fit, nJP, yearvar,
                        obsintvar = "Relative_Survival_Interval",
                        predintvar = "Predicted_ProbDeath_Int",
                        interval = "Interval",
                        annotation = 0, topanno = 1, trend = 0,
                        title = NULL)
```

## Arguments

|            |                                                                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotdata   | The graph data returned by function download.data with downloadtype="graph".                                                                                                           |
| fit        | The joinpoint object containing the model output.                                                                                                                                      |
| nJP        | The number of joinpoints in the model.                                                                                                                                                 |
| yearvar    | The variable name for year of diagnosis used in argument 'year' of the function joinpoint.                                                                                             |
| obsintvar  | The variable name for observed interval survival. The default is "Relative_Survival_Interval" for relative survival data. For cause-specific data, it needs to be changed accordingly. |
| predintvar | The variable name for predicted interval survival. The default is "Predicted_ProbDeath_Int".                                                                                           |
| interval   | The variable name for year since diagnosis. The default is 'Interval'.                                                                                                                 |
| annotation | The indicator for the annotation feature. The default is 0 (no annotation on the plot). Two plots with and without annotations will be returned in a list when annotation=1.           |
| topanno    | The indicator for showing the top curve annotation. The default is 1 (annotation for the top curve).                                                                                   |
| trend      | The indicator for returning the Relative Change in Hazard trend measures . The default is 0 (no trend tables returned).                                                                |
| title      | The title used for the plot. If title=NULL, the default title "Annual Probability of Dying of Cancer by Diagnosis Year" will be used.                                                  |

**Value**

The returned object is a list and depends on the values for trend and annotation. The list will contain some or all of the names `plot_anno`, `plot_no_anno`, and `trends`, where `plot_anno` is an object of class `ggplot` for a plot with annotations, `plot_no_anno` is an object of class `ggplot` for a plot without annotations, and `trends` is a list of data frames for the change in hazard trend measures with columns `start.year`, `end.year`, `estimate`, `std.error`, `lowCI`, `upCI`, and `interval`.

**Author(s)**

Fanni Zhang <zhangf@imsweb.com>

**See Also**

[download.data](#), [Plot.surv.year.annotate](#), [Plot.surv.int.multiyears](#), [aapc](#).

**Examples**

```
data("breast.example", package="JPSurv")
data("fit1", package="JPSurv")

yearvar<-"Year_of_diagnosis_1975"
obsintvar<-"Relative_Survival_Interval"
predintvar<-"Predicted_ProbDeath_Int"
interval<-"Interval"
nJP<-3
data.graph<-download.data(breast.example,fit1,nJP,yearvar,"graph",
                          subsetStr1,interval,int.select=c(1,3,5))
out.anno<-Plot.dying.year.annotate(data.graph,fit1,nJP,yearvar,obsintvar,
                                   predintvar,interval,annotation=1,topanno=1,trend=1)
out<-Plot.dying.year.annotate(data.graph,fit1,nJP,yearvar,obsintvar,
                              predintvar,interval,annotation=0,topanno=0,trend=1)
trend.rch<-out.anno$trends
plot.rch.anno<-out.anno$plot_anno
plot.rch<-out$plot_no_anno
```

---

Plot.surv.int.multiyears

*Figure - Cumulative Survival by Interval*

---

**Description**

A function that returns a plot for Cumulative Survival by Interval supporting multiple selected years.

**Usage**

```
Plot.surv.int.multiyears(plotdata, fit, nJP, yearvar,
                        obscumvar = "Relative_Survival_Cum",
                        predcumvar = "Predicted_Survival_Cum",
                        interval = "Interval", year.select = NULL)
```



**Arguments**

|             |                                                                                                                                                                                                                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotdata    | Either of the following data set would work. 1) the graph data returned by function <code>download.data</code> with <code>downloadtype="graph"</code> and all intervals needed for <code>int.col</code> . 2) the full data returned by function <code>download.data</code> with <code>downloadtype="full"</code> . |
| fit         | The joinpoint object containing the model output.                                                                                                                                                                                                                                                                  |
| nJP         | The number of joinpoints in the model.                                                                                                                                                                                                                                                                             |
| yearvar     | The variable name for year of diagnosis used in argument 'year' of the function <code>joinpoint</code> .                                                                                                                                                                                                           |
| obscumvar   | The variable name for observed relative cumulative survival. The default is "Relative_Survival_Cum" for relative survival data. For cause-specific data, it needs to be changed accordingly.                                                                                                                       |
| predcumvar  | The variable name for predicted cumulative survival. The default is "Predicted_Survival_Cum".                                                                                                                                                                                                                      |
| interval    | The variable name for year since diagnosis. The default is 'Interval'.                                                                                                                                                                                                                                             |
| year.select | The year values selected for the plot. The default is NULL.                                                                                                                                                                                                                                                        |

**Value**

An object of class `ggplot` containing the plot.

**Author(s)**

Fanni Zhang <zhangf@imsweb.com>

**See Also**

[download.data](#), [Plot.dying.year.annotate](#), [Plot.surv.year.annotate](#).

**Examples**

```
data("breast.example", package="JPSurv")
data("fit3", package="JPSurv")

yearvar<-"Year_of_diagnosis_1975"
obscumvar<-"Relative_Survival_Cum"
predcumvar<-"Predicted_Survival_Cum"
interval<-"Interval"
nJP<-2
data.full<-download.data(breast.example,fit3,nJP,yearvar,"full",
                        subsetStr3,interval="Interval")
plot<-Plot.surv.int.mutiyears(data.full,fit3,nJP,yearvar,obscumvar,
                             predcumvar,interval,year.select=c(1985,1990))
```

---

Plot.surv.year.annotate

*Figure - Average Change in Cumulative Survival by Diagnosis Year*

---

## Description

A function that returns a plot (or a list including the Absolute Change in Survival trend measures and the plot) for average change in cumulative survival by diagnosis year using ggplot. The annotation feature is available for nJP $\leq$ 3 and the number of multiple intervals selected  $\leq$ 3.

## Usage

```
Plot.surv.year.annotate(plotdata, fit, nJP, yearvar,
                        obscumvar = "Relative_Survival_Cum",
                        predcumvar = "Predicted_Survival_Cum",
                        interval = "Interval", annotation = 0,
                        trend = 0, title = NULL)
```

## Arguments

|            |                                                                                                                                                                                                   |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| plotdata   | The graph data returned by function download.data with downloadtype="graph".                                                                                                                      |
| fit        | The joinpoint object containing the model output.                                                                                                                                                 |
| nJP        | The number of joinpoints in the model.                                                                                                                                                            |
| yearvar    | The variable name for year of diagnosis used in argument 'year' of the function joinpoint.                                                                                                        |
| obscumvar  | The variable name for observed relative cumulative survival. The default is "Relative_Survival_Cum" for relative survival data. For cause-specific data, it needs to be changed accordingly.      |
| predcumvar | The variable name for predicted cumulative survival. The default is "Predicted_Survival_Cum".                                                                                                     |
| interval   | The variable name for year since diagnosis. The default is 'Interval'.                                                                                                                            |
| annotation | The indicator for the annotation feature. The default is 0 (no annotation on the plot). Two plots with and without annotations will be returned in a list when annotation=1.                      |
| trend      | The indicator for returning the Absolute Change in Survival trend measure tables. The default is 0 (no trend tables returned).                                                                    |
| title      | The title used for the plot. If title=NULL, the default title "Relative Survival by Diagnosis Year" or "Cause-Specific Survival by Diagnosis Year" will be used according to the input data type. |

## Value

The returned object is a list and depends on the values for trend and annotation. The list will contain some or all of the names plot\_anno, plot\_no\_anno, and trends, where plot\_anno is an object of class ggplot for a plot with annotations, plot\_no\_anno is an object of class ggplot for a plot without annotations, and trends is a list of data frames for the change in hazard trend measures with columns start.year, end.year, estimate, std.error, lowCI, upCI, and interval.

**Author(s)**

Fanni Zhang <zhangf@imsweb.com>

**See Also**

[download.data](#), [Plot.dying.year.annotate](#), [Plot.surv.int.multiyears](#), [aapc.multiints](#).

**Examples**

```
data("breast.example", package="JPSurv")
data("fit3", package="JPSurv")

yearvar<-"Year_of_diagnosis_1975"
obscumvar<-"Relative_Survival_Cum"
predcumvar<-"Predicted_Survival_Cum"
interval<-"Interval"
nJP<-2
data.graph<-download.data(breast.example,fit3,nJP,yearvar,"graph",
                          subsetStr3,interval,int.select=c(1,5))

out<-Plot.surv.year.annotate(data.graph,fit3,nJP,yearvar,obscumvar,
                             predcumvar,interval,annotation=0,trend=0)
```

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