Package: fedmatch (via r-universe)

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Title Fast, Flexible, and User-Friendly Record Linkage Methods

Version 2.1.0

Description Provides a flexible set of tools for matching two un-linked data sets. 'fedmatch' allows for three ways to match data: exact matches, fuzzy matches, and multi-variable matches. It also allows an easy combination of these three matches via the tier matching function.

Depends R (>= 3.5.3)

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`articles` *articles*

Description

Data.frame with common articles

Usage

```
articles
```

Format

An object of class `data.table` (inherits from `data.frame`) with 23 rows and 2 columns.

See Also

clean_strings

build_clean_settings *Building settings for string cleaning*

Description

build_clean_settings is a convenient way to make the proper list for the clean_settings argument of tier_match.

Usage

```
build_clean_settings(
  sp_char_words = fedmatch::sp_char_words,
  common_words = NULL,
  remove_char = NULL,
  remove_words = FALSE,
  stem = FALSE
)
```

Arguments

sp_char_words	character vector. Data.frame where first column is special characters and second column is full words. The default is
common_words	data.frame. Data.frame where first column is abbreviations and second column is full words.
remove_char	character vector. string of specific characters (for example, "letters") to be removed
remove_words	logical. If TRUE, removes all abbreviations and replacement words in common_words
stem	logical. If TRUE, words are stemmed

Value

list with settings to pass to clean_strings

build_corpus *Calculate word corpus for weighted jaccard matching*

Description

Calculate word corpus for weighted jaccard matching

Usage

```
build_corpus(namelist1, namelist2)
```

Arguments

namelist1	character vector of names from dataset 1
namelist2	character vector of names from dataset 2

Value

a data.table with columns for frequency, inverse frequency, and log inverse frequency for each word in the two strings.

---

build_fuzzy_settings *Build settings for fuzzy matching*

Description

build_fuzzy_settings is a convenient way to build the list for the fuzzy settings argument in merge_plus

Usage

```
build_fuzzy_settings(
  method = "jw",
  p = 0.1,
  maxDist = 0.05,
  matchNA = FALSE,
  nthread = getOption("sd_num_thread")
)
```

Arguments

method	character vector of length 1. Either one of the methods listed in stringdist::amatch, or our custom method 'wgt_jaccard.' See the vignettes for more details.
p	numeric vector of length 1. See stringdist::amatch()
maxDist	numeric vector of length 1. See stringdist::amatch()
matchNA	whether or not to match on NAs, see stringdist::amatch()
nthread	number of threads to use in the underlying C code.

Value

a list containing options for the 'fuzzy_settings' argument of merge_plus.

build_multivar_settings *Build settings for multivar matching*

Description

build_multivar_settings is a convenient way to build the list for the multivar settings argument in merge_plus

Usage

```
build_multivar_settings(
  logit = NULL,
  missing = FALSE,
  wgts = NULL,
  compare_type = "diff",
  blocks = NULL,
  blocks.x = NULL,
  blocks.y = NULL,
  top = 1,
  threshold = NULL,
  nthread = 1
)
```

Arguments

logit	a glm or lm model as a result from a logit regression on a verified dataset. See details.
missing	boolean T/F, whether or not to treat missing (NA) observations as its own binary column for each column in by. See details.
wgts	rather than a lm model, you can supply weights to calculate matchscore. Can be weights from calculate_weights.
compare_type	a vector with the same length as "by" that describes how to compare the variables. Options are "in", "indicator", "substr", "difference", "ratio", "stringdist", and "wgt_jaccard_dist". See the Multivar Matching Vignette for details.
blocks	variable present in both data sets to "block" on before computing scores. Matchscores will only be computed for observations that share a block. See details.
blocks.x	name of blocking variables in x. cannot supply both blocks and blocks.x
blocks.y	name of blocking variables in y. cannot supply both blocks and blocks.y
top	integer. Number of matches to return for each observation.
threshold	numeric. Minimum score for a match to be included in the result.
nthread	integer. Number of cores to use when computing all combinations. See parallel::makecluster()

Value

a list containing options for the 'multivar_settings' argument of merge_plus.

build_score_settings *Build settings for scoring*

Description

build_score_settings is a convenient way to make the proper list for the score_settings argument of merge_plus Each vector in build_score_settings should be the same length, and each position (first, second, third, etc.) corresponds to one variable to score on.

Usage

```
build_score_settings(
  score_var_x = NULL,
  score_var_y = NULL,
  score_var_both = NULL,
  wgts = NULL,
  score_type
)
```

Arguments

score_var_x	character vector. the variables from the 'x' dataset to score on
score_var_y	character vector. the variables from the 'y' dataset to score on
score_var_both	the variables from both datasets (shared names) to score on, before any prefixes are applied.
wgts	numeric vector. The weights for the linear sum of scores
score_type	Charcter vector. Options are "in", "indicator", "substr", "difference", "ratio", "stringdist". See the Multivar Matching Vignette for details.

Value

a list containing options for the 'score_settings' argument of merge_plus.

build_tier *Build settings for a tier*

Description

build_tier_settings is a convenient way to make the proper list for the tier_list argument of tier_match Each vector in build_score_settings should be the same length, and each position (first, second, third, etc.) corresponds to one variable to score on.

Usage

```
build_tier(
  by.x = NULL,
  by.y = NULL,
  check_merge = NULL,
  match_type = NULL,
  fuzzy_settings = build_fuzzy_settings(),
  score_settings = NULL,
  filter = NULL,
  filter.args = NULL,
  evaluate = NULL,
  evaluate.args = NULL,
  clean_settings = build_clean_settings(),
  clean = NULL,
  sequential_words = NULL,
  allow.cartesian = FALSE,
  multivar_settings = build_multivar_settings()
)
```

Arguments

by.x	character string. Variable to merge on in data1. See merge
by.y	character string. Variable to merge on in data2. See merge
check_merge	logical. Checks that your unique_keys are indeed unique.
match_type	string. If 'exact', match is exact, if 'fuzzy', match is fuzzy. If 'multivar,' match is multivar-based. See multivar_match,
fuzzy_settings	additional arguments for amatch, to be used if match_type = 'fuzzy'. Suggested defaults provided. (see amatch, method='jw')
score_settings	list. Score settings for post-hoc matchscores.
filter	function or numeric. Filters a merged data1-data2 dataset. If a function, should take in a data.frame (data1 and data2 merged by name1 and name2) and spit out a trimmed version of the data.frame (fewer rows). Think of this function as applying other conditions to matches, other than a match by name. The first argument of filter should be the data.frame. If numeric, will drop all observations with a matchscore lower than or equal to filter.
filter.args	list. Arguments passed to filter, if a function
evaluate	Function to evaluate merge_plus output.
evaluate.args	list. Arguments passed to evaluate
clean_settings	list. Settings for string cleaning. See clean_strings and build_clean_settings.
clean	Boolean, T/F, whether or not to clean strings prior to the match.
sequential_words	data.table of words in the same format of the common_words argument in clean_strings. Each of these will be replaced from the by columns.
allow.cartesian	whether or not to allow many-many matches, see data.table::merge()

multivar_settings
: list of settings to go to the multivar match if match_type == 'multivar'. See multivar-match.

Value

a list containing 1 tier for the 'tier_list' argument of tier_match.

---

calculate_weights *Calculate weights for computing matchscore*

Description

Calculate weights for comparison variables based on m and u probabilities estimated from a verified dataset.

Usage

```
calculate_weights(
  data,
  variables,
  compare_type = "stringdist",
  suffixes = c("_1", "_2"),
  non_negative = FALSE
)
```

Arguments

data	data.frame. Verified data. Should have all of the variables you want to calculate weights for from both datasets, named the same with data-specific suffixes.
variables	character vector of the variable names of the variables you want to calculate weights for.
compare_type	character vector. One of 'stringdist' (for string variables) 'ratio','difference' (for numerics) 'indicator' (0-1 dummy indicating if the two are the same),'in' (0-1 dummy indicating if data1 is IN data2), and 'substr' (numeric indicating how many digits are the same.)
suffixes	character vector. Suffixes of of the variables that indicate what data they are from. Default is same as the default for base R merge, c('.x','.y')
non_negative	logical. Do you want to allow negative weights?

Details

This function uses the classic Record Linkage methodology first developed by Felligi and Sunter. See Record Linkage. m is the probability of a given link between observations is a true match, while

u is the probability of an unlinked pair of observations being a true match. `calculate_weights` computes a preliminary weight for each variable by computing

$$w = \log_2(\frac{m}{u}),$$

then making these weights sum to 1. Thus, the weights that have higher m and lower u probabilities will get higher weights, which makes sense given the definitions. These weights can then be easily passed into the `score_settings` argument of `merge_plus` or `tier_match`, or into the `wgts` argument of `multivar_match`.

Value

list with m probabilities, u probabilities, w weights, and settings, the list argument required as an input for score_settings in merge_plus using the calculate weights.

`clean_strings` *String cleaning for easier matching*

Description

`clean_strings` takes a string vector and cleans it according to user-given options.

Usage

```
clean_strings(
  string,
  sp_char_words = fedmatch::sp_char_words,
  common_words = NULL,
  remove_char = NULL,
  remove_words = FALSE,
  stem = FALSE
)
```

Arguments

`string`	character or character vector of strings
`sp_char_words`	character vector. Data.frame where first column is special characters and second column is full words. The default is
`common_words`	data.frame. Data.frame where first column is abbreviations and second column is full words.
`remove_char`	character vector. string of specific characters (for example, "letters") to be removed
`remove_words`	logical. If TRUE, removes all abbreviations and replacement words in common_words
`stem`	logical. If TRUE, words are stemmed

Details

This function takes a variety of options, each of which changes the behavior. Without the default settings, `clean_strings` will do the following: make the string lowercase; replace special characters &, $, \ names ("and", "dollar", "percent", "at"); convert tabs to spaces and removes extra spaces. This default cleaning puts the strings in a standard format to allow for easier matching.

The other options allow for the removal or replacement of other words or characters.

Value

cleaned strings

`corp_data1` *corp_data1*

Description

Some made up data on the top 10 US companies in the Fortune 500. Mock-matched to corp_data2 in examples/match_template.R

Usage

```
corp_data1
```

Format

An object of class `data.table` (inherits from `data.frame`) with 10 rows and 6 columns.

`corp_data2` *corp_data2*

Description

Some made up data on the top 10 US companies in the Fortune 500. Mock-matched to corp_data1 in examples/match_template.R

Usage

```
corp_data2
```

Format

An object of class `data.table` (inherits from `data.frame`) with 10 rows and 6 columns.

corporate_words *corporate_words*

Description

Data.frame with common corporate abbreviations in column 1 and corresponding long names in column 2. Useful for cleaning company names for matching.

Usage

```
corporate_words
```

Format

An object of class `data.table` (inherits from `data.frame`) with 54 rows and 2 columns.

See Also

clean_strings

fund_words *fund_words*

Description

Data.frame with abbreviations common in the names of financial (i.e. mutual) funds in column 1 and corresponding long names in column 2. Useful for cleaning fund names for matching.

Usage

```
fund_words
```

Format

An object of class `data.frame` with 63 rows and 2 columns.

See Also

clean_strings

`fuzzy_match` *Use string distances to match on names*

Description

Use the `stringdist` package to perform a fuzzy match on two datasets.

Usage

```
fuzzy_match(
  data1,
  data2,
  by = NULL,
  by.x = NULL,
  by.y = NULL,
  suffixes,
  unique_key_1,
  unique_key_2,
 fuzzy_settings = list(method = "jw", p = 0.1, maxDist = 0.05, matchNA = FALSE, nthread
    = getOption("sd_num_thread"))
)
```

Arguments

`data1`	data.frame. First to-merge dataset.
`data2`	data.frame. Second to-merge dataset.
`by`	character string. Variables to merge on (common across data 1 and data 2). See `merge`
`by.x`	character string. Variable to merge on in data1. See `merge`
`by.y`	character string. Variable to merge on in data2. See `merge`
`suffixes`	character vector with length==2. Suffix to add to like named variables after the merge. See `merge`
`unique_key_1`	character vector. Primary key of data1 that uniquely identifies each row (can be multiple fields)
`unique_key_2`	character vector. Primary key of data2 that uniquely identifies each row (can be multiple fields)
`fuzzy_settings`	list of arguments to pass to to the fuzzy matching function. See `amatch`.

Details

`stringdist amatch` computes string distances between every pair of strings in two vectors, then picks the closest string pair for each observation in the dataset. This is used by `fuzzy_match` to perform a string distance-based match between two datasets. This process can take quite a long time, for quicker matches try adjusting the `nthread` argument in `fuzzy_settings`. The default fuzzy_settings are sensible starting points for company name matching, but adjusting these can greatly change how the match performs.

Value

a data.table, the resultant merged data set, including all columns from both data sets.

`match_evaluate` *evaluate a matched dataset*

Description

`match_evaluate` takes in matches and outputs summary statistics for those matches, including the number of matches in each tier and the percent matched from each dataset.

Usage

```
match_evaluate(
  matches,
  data1,
  data2,
  unique_key_1,
  unique_key_2,
  suffixes = c("_1", "_1"),
  tier = "tier",
  tier_order = NULL,
  quality_vars = NULL
)
```

Arguments

`matches`	data.frame. Merged dataset.
`data1`	data.frame. First to-merge dataset.
`data2`	data.frame. Second to-merge dataset.
`unique_key_1`	character vector. Primary key of data1 that uniquely identifies each row (can be multiple fields)
`unique_key_2`	character vector. Primary key of data2 that uniquely identifies each row (can be multiple fields)
`suffixes`	character vector. Mnemonics associated data1 and data2.
`tier`	character vector. Default=NULL. The variable that defines a tier.
`tier_order`	character vector. Default= "tier". Variable that defines the order of tiers, if needed.
`quality_vars`	character vector. Variables you want to use to calculate the quality of each tier. Calculates mean.

Details

The most straightforward way to use `match_evaluate` is to pass it to the `evaluate` argument of `tier_match` or `merge_plus`. This will have `merge_plus` return a data.table with the evaluation information, alongside the matches themselves.

I

`match_evaluate` returns the number of matches in each tier, the number of unique matches in each tier, and the percent matched for each dataset. If no tiers are supplied, the entire dataset will be used as one "tier." The argument `quality_vars` allows for the calculation of averages of any columns in the dataset, by tier. The most straightforward case would be a matchscore, which can again all be done in `merge_plus` with the scoring argument. This lets you see the average matchscore by tier.

Value

data.table. Table describing each tier according to aggregate_by variables and quality_vars variables.

See Also

merge_plus

`merge_plus` *Merge two datasets either by exact, fuzzy, or multivar-based matching*

Description

`merge_plus` is a wrapper for a standard merge, a fuzzy string match, and a a "multivar" match based on several columns of the data. Parameters allow for control for fine-tuning of the match. This is primarily used as the workhorse for the `tier_match` function.

Usage

```
merge_plus(
  data1,
  data2,
  by = NULL,
  by.x = NULL,
  by.y = NULL,
  suffixes = c("_1", "_2"),
  check_merge = TRUE,
  unique_key_1,
  unique_key_2,
  match_type = "exact",
  fuzzy_settings = build_fuzzy_settings(),
  score_settings = NULL,
  filter = NULL,
  filter.args = list(),
```

```
  evaluate = match_evaluate,
  evaluate.args = list(),
  allow.cartesian = FALSE,
  multivar_settings = build_multivar_settings()
)
```

Arguments

data1	data.frame. First to-merge dataset (ordering matters - see Fuzzy Matching vignette.)
data2	data.frame. Second to-merge dataset.
by	character string. Variables to merge on (common across data 1 and data 2). See merge
by.x	length-1 character vector. Variable to merge on in data1. See merge
by.y	length-1 character vector. Variable to merge on in data2. See merge
suffixes	character vector with length==2. Suffix to add to like named variables after the merge. See merge
check_merge	logical. Checks that your unique_keys are indeed unique.
unique_key_1	character vector. Primary key of data1 that uniquely identifies each row (can be multiple fields)
unique_key_2	character vector. Primary key of data2 that uniquely identifies each row (can be multiple fields)
match_type	string. If 'exact', match is exact, if 'fuzzy', match is fuzzy. If 'multivar,' match is multivar-based. See multivar_match,
fuzzy_settings	additional arguments for amatch, to be used if match_type = 'fuzzy'. Suggested defaults provided. See build_fuzzy_settings.
score_settings	list. Score settings for post-hoc matchscores. See build_score_settings
filter	function or numeric. Filters a merged data1-data2 dataset. If a function, should take in a data.frame (data1 and data2 merged by name1 and name2) and spit out a trimmed version of the data.frame (fewer rows). Think of this function as applying other conditions to matches, other than a match by name. The first argument of filter should be the data.frame. If numeric, will drop all observations with a matchscore lower than or equal to filter.
filter.args	list. Arguments passed to filter, if a function
evaluate	Function to evaluate merge_plus output.
evaluate.args	list. Arguments passed to evaluate
allow.cartesian	whether or not to allow many-many matches, see data.table::merge()
multivar_settings	list of settings to go to the multivar match if match_type == 'multivar'. See multivar-match and build_multivar_settings.

Value

list with matches, filtered matches (if applicable), data1 and data2 minus matches, and match evaluation

See Also

match_evaluate

`multivar_match` *Matching by computing multivar_scores based on several variables*

Description

`multivar_match` computes a multivar_score between each pair of observations between datasets x and y using several variables, then executes a merge by picking the highest multivar_score pair for each observation in x.

Usage

```
multivar_match(
  data1,
  data2,
  by = NULL,
  by.x = NULL,
  by.y = NULL,
  unique_key_1,
  unique_key_2,
  logit = NULL,
  missing = FALSE,
  wgts = NULL,
  compare_type = "diff",
  blocks = NULL,
  blocks.x = NULL,
  blocks.y = NULL,
  nthread = 1,
  top = 1,
  threshold = NULL,
  suffixes = c("_1", "_2")
)
```

Arguments

`data1`	data.frame. First to-merge dataset.
`data2`	data.frame. Second to-merge dataset.
`by`	character string. Variables to merge on (common across data 1 and data 2). See `merge`
`by.x`	character string. Variable to merge on in data1. See `merge`
`by.y`	character string. Variable to merge on in data2. See `merge`
`unique_key_1`	character vector. Primary key of data1 that uniquely identifies each row (can be multiple fields)

unique_key_2	character vector. Primary key of data2 that uniquely identifies each row (can be multiple fields)
logit	a glm or lm model as a result from a logit regression on a verified dataset. See details.
missing	boolean T/F, whether or not to treat missing (NA) observations as its own binary column for each column in by. See details.
wgts	rather than a lm model, you can supply weights to calculate multivar_score. Can be weights from `calculate_weights`.
compare_type	a vector with the same length as "by" that describes how to compare the variables. Options are "in", "indicator", "substr", "difference", "ratio", "stringdist", and "wgt_jaccard_dist". See the Multivar Matching Vignette for details.
blocks	variable present in both data sets to "block" on before computing scores. multivar_scores will only be computed for observations that share a block. See details.
blocks.x	name of blocking variables in x. cannot supply both blocks and blocks.x
blocks.y	name of blocking variables in y. cannot supply both blocks and blocks.y
nthread	integer. Number of cores to use when computing all combinations. See `parallel::makecluster()`
top	integer. Number of matches to return for each observation.
threshold	numeric. Minimum score for a match to be included in the result.
suffixes	see `merge`

Details

The best way to understand this function is to see the vignette 'Multivar_matching'.

There are two ways of performing this match: either with or without a pre-trained logit. To use a logit, you must have a verified set of matches. The names of the variables in this set must match the names of the variables in the data you pass into `multivar_match`. Without a pre-trained logit, you must have a set of weights for each variable that you want in the comparison. These can either be made up ahead of time, or you can use a verified set of matches and `calculate_weights`.

Value

a data.table, the resultant match, including columns from both data sets.

`sp_char_words` *sp_char_words*

Description

Common special characters and their replacements for string cleaning

Usage

```
sp_char_words
```

Format

An object of class `data.table` (inherits from `data.frame`) with 4 rows and 2 columns.

`State_FIPS` *State_FIPS*

Description

Data.table with state FIPS codes and abbreviations.

Usage

```
State_FIPS
```

Format

An object of class `data.table` (inherits from `data.frame`) with 55 rows and 3 columns.

`tier_match` *Perform an iterative match by tier*

Description

Constructs a tier_match by running `merge_plus` with different parameters sequentially on the same data. Allows for sequential removal of observations after each tier.

Usage

```
tier_match(
  data1,
  data2,
  by = NULL,
  by.x = NULL,
  by.y = NULL,
  suffixes = c("_1", "_2"),
  check_merge = TRUE,
  unique_key_1,
  unique_key_2,
  tiers = list(),
  takeout = "both",
  match_type = "exact",
  clean = FALSE,
  clean_settings = build_clean_settings(),
  score_settings = NULL,
  filter = NULL,
```

```
  filter.args = list(),
  evaluate = match_evaluate,
  evaluate.args = list(),
  allow.cartesian = TRUE,
  fuzzy_settings = build_fuzzy_settings(),
  multivar_settings = build_multivar_settings(),
  verbose = FALSE
)
```

Arguments

data1	data.frame. First to-merge dataset.
data2	data.frame. Second to-merge dataset.
by	character string. Variables to merge on (common across data 1 and data 2). See merge
by.x	character string. Variable to merge on in data1. See merge
by.y	character string. Variable to merge on in data2. See merge
suffixes	see merge
check_merge	logical. Checks that your unique_keys are indeed unique, and prevents merge from running if merge would result in data.frames larger than 5 million rows
unique_key_1	character vector. Primary key of data1 that uniquely identifies each row (can be multiple fields)
unique_key_2	character vector. Primary key of data2 that uniquely identifies each row (can be multiple fields)
tiers	list(). tier is a list of lists, where each list holds the parameters for creating that tier. All arguments to tier_match listed after this argument can either be supplied directly to tier_match, or indirectly via tiers.
takeout	character vector, either 'data1', 'data2', 'both', or 'neither'. Removes observations after each tier from the selected dataset.
match_type	string. If 'exact', match is exact, if 'fuzzy', match is fuzzy.
clean	Boolean, T/F, whether or not to clean strings prior to the match.
clean_settings	list. Settings for string cleaning. See clean_strings and build_clean_settings.
score_settings	list. Settings for post-hoc matchscoring. See build_score_settings.
filter	function or numeric. Filters a merged data1-data2 dataset. If a function, should take in a data.frame (data1 and data2 merged by name1 and name2) and spit out a trimmed version of the data.frame (fewer rows). Think of this function as applying other conditions to matches, other than a match by name. The first argument of filter should be the data.frame. If numeric, will drop all observations with a matchscore lower than or equal to filter.
filter.args	list. Arguments passed to filter, if a function
evaluate	Function to evaluate merge_plus output. see evaluate_match.
evaluate.args	list. Arguments passed to function specified by evaluate

allow.cartesian
: whether or not to allow many-many matches, see data.table::merge()

fuzzy_settings
: additional arguments for amatch, to be used if match_type = 'fuzzy'. Suggested defaults provided. (see amatch, method='jw')

multivar_settings
: list of settings to go to the multivar match if match_type == 'multivar'. See multivar-match.

verbose
: boolean, whether or not to print tier names and time to match each tier as the matching happens.

Details

See the tier match vignette to get a clear understanding of the tier_match syntax.

Value

list with matches, data1 and data2 minus matches, and match evaluation

See Also

merge_plus clean_strings

---

wgt_jaccard_distance *Computing Weighted Jaccard Distance*

Description

#' wgt_jaccard_distance computes the Weighted Jaccard Distance between two strings. It is vectorized, and accepts only two equal-length string vectors.

Usage

```
wgt_jaccard_distance(string_1, string_2, corpus, nthreads = 1)
```

Arguments

string_1
: character vector

string_2
: character vector

corpus
: corpus data.table, constructed with fedmatch::build_corpus

nthreads
: number of threads to use in the underlying C++ code

Details

See the vignette fuzzy_matching for details on how the Weighted Jaccard similarity is computed.

Value

numeric vector with the Weighted Jaccard distances for each element of string_1 and string_2.

word_frequency *Compute frequency of words in a corpus*

Description

word_frequency counts the frequency of words in a set of strings. Also does minimal cleaning (removes punctuation and extra spaces). Useful for determining what words are common and may need to be replaced or removed with clean_strings.

Usage

```
word_frequency(string)
```

Arguments

string	character vector

Value

data.table with word frequency

World_Bank_Codes *World_Bank_Codes*

Description

World Bank 3-Character Country Codes for 213 countries

Usage

```
World_Bank_Codes
```

Format

An object of class data.table (inherits from data.frame) with 213 rows and 2 columns.

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