# Package 'banter'

February 12, 2023

**Type** Package

**Title** BioAcoustic eveNT classifiER

**Description** Create a hierarchical acoustic event species classifier out of
multiple call type detectors as described in
Rankin et al (2017) <doi:10.1111/mms.12381>.

**Version** 0.9.6

**Depends** R (>= 4.1.0), magrittr

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methods, parallel, randomForest (>= 4.6), rfPermute (>= 2.5.1),
rlang, stats, swfscMisc (>= 1.5), tibble (>= 3.1.2), tidyr (>=
1.1.1)

**Suggests** testthat

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**Encoding** UTF-8

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**Author** Eric Archer [aut, cre],
Taiki Sakai [aut]

**Maintainer** Eric Archer <eric.archer@noaa.gov>

**Repository** CRAN

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## R topics documented:

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banter-package            *BioAcoustic EveNT ClassifiER*

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### Description

banter

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

---

addBanterDetector            *Add a BANTER Detector Model*

---

### Description

Add a detector model to a BANTER classifier.

### Usage

```
addBanterDetector(
  x,
  data,
  name,
  ntree,
  sampsize = 1,
  importance = FALSE,
  num.cores = 1
)

removeBanterDetector(x, name)
```

## Arguments

| | |
|---|---|
| x | a `banter_model` object. |
| data | detector data.frame or named list of detector data.frames. If a data.frame, then name must be provided. |
| name | detector name. |
| ntree | number of trees. |
| sampsize | number or fraction of samples to use in each tree. If < 1, then it will be used to select this fraction of the smallest sample size. |
| importance | retain importance scores in model? Defaults to `FALSE` and will be ignored if `num.cores > 1`. |
| num.cores | number of cores to use for Random Forest model. Set to `NULL` to use the maximum number detected on your system - 1. |

## Value

a `banter_model` object with the detector model added or removed.

## Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S., Archer, F., Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add the 'bp' (burst pulse) detector model
bant.mdl <- addBanterDetector(
  x = bant.mdl,
  data = train.data$detectors$bp,
  name = "bp",
  ntree = 50, sampsize = 1, num.cores = 1
)
bant.mdl

# remove the 'bp' detector model
bant.mdl <- removeBanterDetector(bant.mdl, "bp")
bant.mdl
```

---

banterGuide　　　　*BANTER Guide*

---

### Description

Open a browser window displaying "BANTER: A User's Guide to Acoustic Classification".

### Usage

```
banterGuide()
```

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

---

getBanterModel　　　　*Extract Random Forest Model*

---

### Description

Extract BANTER event or detector Random Forest model.

### Usage

```
getBanterModel(x, model = "event")
```

### Arguments

| | |
|---|---|
| x | a [banter_model](#) object. |
| model | name of model to extract. Default is "event" to extract the event-level model. Can also be the name of a detector. |

### Value

a [randomForest](#) model object.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

# extract the event randomForest model
event.rf <- getBanterModel(bant.mdl)
event.rf

# extract the burst pulse (bp) detector model
bp.rf <- getBanterModel(bant.mdl, "bp")
bp.rf
```

---

getBanterModelData          *Extract Random Forest Model Data*

---

## Description

Extract BANTER event data used for the Random Forest model.

## Usage

```
getBanterModelData(x)
```

## Arguments

x                    a `banter_model` object.

## Value

the event data frame used to build the input model x.

## Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

### Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

event.df <- getBanterModelData(bant.mdl)
head(event.df)
```

---

getDetectorNames *Detector Names*

---

### Description

Return names of detectors loaded in BANTER model.

### Usage

```
getDetectorNames(x)
```

### Arguments

x               a banter_model object.

### Value

a vector of names.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
getDetectorNames(bant.mdl)
```

---

getSampSize                    *Sample Size*

---

## Description

Return sample sizes used for a BANTER model.

## Usage

```
getSampSize(x, model = "event")
```

## Arguments

| | |
|---|---|
| x | a [banter_model](banter_model) object. |
| model | name of model to extract. Default is "event" to return values for the event-level model. Can also be name of a detector. |

## Value

a vector of sample sizes.

## Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

### Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 2, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

# sample size for the event model
getSampSize(bant.mdl)

# sample size for the burst pulse (bp) detector model
getSampSize(bant.mdl, "bp")
```

---

initBanterModel               *Initialize BANTER model*

---

### Description

Initialize a BANTER model with event data.

### Usage

```
initBanterModel(x)
```

### Arguments

x                   a data.frame of events. Every row is a unique event. Must have columns named
                    event.id and species. All other columns will be used as predictor variables
                    for the BANTER event classifier model.

### Value

a [banter_model](banter_model) object without any detector models.

### Note

Values in the column species are passed through the [make.names](make.names) function on creation to ensure
they don't include invalid characters.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

### Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
bant.mdl
```

---

modelPctCorrect               *Model Percent Correct*

---

### Description

Extract percent correctly classified by species for detector and event models.

### Usage

```
modelPctCorrect(x)
```

### Arguments

x                   a `banter_model` object.

### Value

a data.frame with the percent correctly classified for each model in `x`.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)
modelPctCorrect(bant.mdl)
```

---

numCalls                          *Number and Proportion of Calls*

---

## Description

Return the number and proportion of calls in BANTER detector models.

## Usage

```
numCalls(x, by = c("species", "event"))

propCalls(x, by = c("species", "event"))
```

## Arguments

x               a [banter_model](#) object.

by              return summary by "species" or "event".

## Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

# number of calls by species and event
numCalls(bant.mdl, "species")
numCalls(bant.mdl, "event")

# proportion of calls by species and event
propCalls(bant.mdl, "species")
propCalls(bant.mdl, "event")
```

---

numEvents                       *Number of Events*

---

### Description

Return the number of events in a BANTER model by species.

### Usage

```
numEvents(x, model = "event")
```

### Arguments

| | |
|---|---|
| x | a [banter_model](#) object. |
| model | name of model to extract. Default is "event" to summarize the event-level model. Can also be name of a detector. |

### Value

a data.frame giving the number of events available for each species.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

# number of events in event model
numEvents(bant.mdl)

# number of events in burst pulse (bp) detector model
numEvents(bant.mdl, "bp")
```

---

plotDetectorTrace            *Plot BANTER Detector Traces*

---

## Description

Plot traces of OOB error rates for detector Random Forest models.

## Usage

```
plotDetectorTrace(x, detector = NULL)
```

## Arguments

| | |
|---|---|
| x | a [banter_model](#) object. |
| detector | names of models to plot. If set to NULL, traces for all models will be shown. |

## Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## See Also

[plotTrace](#)

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)

plotDetectorTrace(bant.mdl)
```

---

predict                          *Predict BANTER events*

---

## Description

Predict species of events for novel data from a BANTER model.

## Usage

```
predict(object, ...)

## S3 method for class 'banter_model'
predict(object, new.data, ...)

## S4 method for signature 'banter_model'
predict(object, new.data, ...)
```

## Arguments

| | |
|---|---|
| object | a [banter_model](#) object. |
| ... | unused. |
| new.data | a list of event and detector data that has the same predictors as in the banter_model. It must contain elements called events and detectors. The events element must be a data.frame that has a column called event.id and the same predictor columns as the event data used to initialize the banter model (see [initBanterModel](#)). The detectors element must be a named list with the same detectors used to build the model (see [addBanterDetector](#)). |

**Value**

A list with the following elements:

**events**  the data frame used in the event model for predictions.

**predict.df**  data.frame of predicted species and assignment probabilities for each event.

**detector.freq**  data.frame giving the number of events available for each detector.

**validation.matrix**  if `species` is a column in `new.data`, a table giving the classification rate for each event

**Note**

At least one detector in the model must be present in `new.data`. Any detectors in the training model that are absent will have all species proportions and the the detector propoortion set to 0. If a column called `species` is in `new.data`, columns for the original species designation and if that matches predicted (`correct`) will be added to the `predict.df` data.frame of the output.

**Author(s)**

Eric Archer <eric.archer@noaa.gov>

**References**

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

**Examples**

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 2, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)

# predict test data
data(test.data)
test.pred <- predict(bant.mdl, test.data)
test.pred
```

---

runBanterModel                 *Run BANTER Model*

---

### Description

Build full event classifier model

### Usage

```
runBanterModel(x, ntree, sampsize = 1)
```

### Arguments

| | |
|---|---|
| x | a `banter_model` object. |
| ntree | number of trees. |
| sampsize | number or fraction of samples to use in each tree. |

### Value

a `banter_model` object with the complete BANTER model.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S., Archer, F., Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

### Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)
summary(bant.mdl)
```

---

subsampleDetections          *Subsample Detections*

---

### Description

Extract a random subsample of detections for each event and detector.

### Usage

```
subsampleDetections(data, n)
```

### Arguments

| | |
|---|---|
| data | a detector data.frame or list of detector data.frames. |
| n | a value giving the number (n >= 1) or fraction (n between 0 and 1) of detections per event per detector to select. Detections are randomly selected without replacement. If n is greater than the number of detections in an event, all detections for that event will be retained. |

### Value

a detector data.frame or list of detector data.frames with no more than n detections per event per detector.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

### References

Rankin, S., Archer, F., Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

### Examples

```
data(train.data)

# initial number of detections per event per detector
sapply(train.data$detectors, function(x) table(x$event.id))

# select half of all detectors
detect.half <- subsampleDetections(train.data$detectors, 0.5)
sapply(detect.half, function(x) table(x$event.id))

# select 20 detections
detect.20 <- subsampleDetections(train.data$detectors, 20)
sapply(detect.20, function(x) table(x$event.id))
```

```
# select 10 detections fro 'ec' detector
ec.10 <- subsampleDetections(train.data$detectors$ec, 10)
table(ec.10$event.id)
```

---

summary                         *BANTER Classifier Model Summary*

---

### Description

Display summaries for event and detector models

### Usage

```
summary(object, ...)

## S3 method for class 'banter_model'
summary(object, model = "event", n = 0.5, bins = 20, ...)

## S4 method for signature 'banter_model'
summary(object, model = "event", n = 0.5, bins = 20, ...)
```

### Arguments

| | |
|---|---|
| object | a [banter_model](#) object. |
| ... | ignored. |
| model | name of model to summarize. Default is "event" to summarize the event-level model. Can also be name of a detector. |
| n | number of final iterations to summarize OOB error rate for. If between 0 and 1 is taken as a proportion of chain. |
| bins | number of bins in inbag histogram. |

### Value

In the plot that is created, the upper panel shows the trace of the Random Forest model OOB rate across sequential trees in the forest. The lower plot shows a frequency histogram of the number of times each sample was inbag (used as training data in a tree in the forest). The vertical red lines indicate the expected inbag rate for samples of each species.

### Author(s)

Eric Archer <eric.archer@noaa.gov>

## References

Rankin, S. , Archer, F. , Keating, J. L., Oswald, J. N., Oswald, M. , Curtis, A. and Barlow, J. (2017), Acoustic classification of dolphins in the California Current using whistles, echolocation clicks, and burst pulses. Marine Mammal Science 33:520-540. doi:10.1111/mms.12381

## Examples

```
data(train.data)
# initialize BANTER model with event data
bant.mdl <- initBanterModel(train.data$events)
# add all detector models
bant.mdl <- addBanterDetector(
  bant.mdl, train.data$detectors,
  ntree = 50, sampsize = 1, num.cores = 1
)
# run BANTER event model
bant.mdl <- runBanterModel(bant.mdl, ntree = 1000, sampsize = 1)
summary(bant.mdl)
```

---

| test.data | *Testing events and detectors* |
|---|---|

---

## Description

A list of events and call data from detectors for testing BANTER model

## Usage

```
data(test.data)
```

## Format

list

---

| train.data | *Training events and detectors* |
|---|---|

---

## Description

A list of events and call data from detectors for training BANTER model

## Usage

```
data(train.data)
```

## Format

list

# Index