

Package: accept (via r-universe)

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Title The Acute COPD Exacerbation Prediction Tool (ACCEPT)

Version 1.2.1

Description Allows clinicians to predict the rate and severity of future acute exacerbation in Chronic Obstructive Pulmonary Disease (COPD) patients, based on the clinical prediction models published in Adibi et al. (2020) [doi:10.1016/S2213-2600\(19\)30397-2](https://doi.org/10.1016/S2213-2600(19)30397-2) and Safari et al. (2022) [doi:10.1016/j.eclinm.2022.101574](https://doi.org/10.1016/j.eclinm.2022.101574).

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accept	<i>A flexible version of ACCEPT 2.0 model, which imputes predictors using MICE approach.</i>
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Description

A flexible version of ACCEPT 2.0 model, which imputes predictors using MICE approach.

Usage

```
accept(  
  newdata,  
  format = "tibble",  
  version = "accept3",  
  prediction_interval = FALSE,  
  return_predictors = FALSE,  
  country = NULL,  
  obs_modsev_risk = NULL,  
  ...  
)
```

Arguments

newdata	new patient data with missing values to be imputed before prediction with the same format as accept samplePatients.
format	default is "tibble". Can also be set to "json".

version	indicates which version of ACCEPT needs to be called. Options include "accept1", "accept2", "accept3" (default).
prediction_interval	default is FALSE. If set to TRUE, returns prediction intervals of the predictions.
return_predictors	default is FALSE. IF set to TRUE, returns the predictors along with prediction results.
country	Required for accept3 version. Three-letter ISO country code (e.g., "CAN", "USA", "GBR"). Supported countries: ARG, AUS, BRA, CAN, COL, DEU, DNK, ESP, FRA, GBR, ITA, JPN, KOR, MEX, NLD, NOR, SWE, USA. For the UK, two care-setting-specific versions are available: "GBR-primary" (primary care, ACCEPT 3.0-CPRD) and "GBR-specialty" (specialty care). Bare "GBR" defaults to specialty care with a warning. For unsupported countries, provide obs_modsev_risk parameter or add it as a column in the data.
obs_modsev_risk	Observed moderate-to-severe exacerbation risk for unsupported countries. Can be provided as a parameter or as a column in newdata.
...	for other versions of accept.

Value

patientData with prediction.

Examples

```
results <- accept(newdata = samplePatients, country = "CAN")
results_us <- accept(newdata = samplePatients, country = "USA")
# For unsupported country with obs_modsev_risk parameter
results_custom <- accept(newdata = samplePatients, country = "XXX", obs_modsev_risk = 0.2)
```

accept1	<i>Predicts COPD exacerbation rate by severity level based on Acute COPD Exacerbation Tool (ACCEPT)</i>
---------	---

Description

Predicts COPD exacerbation rate by severity level based on Acute COPD Exacerbation Tool (ACCEPT)

Usage

```
accept1(
  patientData,
  random_sampling_N = 100,
  lastYrExacCol = "LastYrExacCount",
  lastYrSevExacCol = "LastYrSevExacCount",
  ...
)
```

Arguments

patientData patient data matrix. Can have one or many patients in it
 random_sampling_N number of random sampling. Default is 100.
 lastYrExacCol the column specifying last year all exacerbation count
 lastYrSevExacCol the column specifying last year severe exacerbation count
 ... for backward compatibility

Value

patientData with prediction

Examples

```
results <- accept1(samplePatients)
```

accept2	<i>Predicts COPD exacerbation rate by severity level based on the updated accept2 model, which improves accuracy in patients without an exacerbation history.</i>
---------	---

Description

Predicts COPD exacerbation rate by severity level based on the updated accept2 model, which improves accuracy in patients without an exacerbation history.

Usage

```
accept2(  
  patientData,  
  random_sampling_N = 100,  
  lastYrExacCol = "LastYrExacCount",  
  lastYrSevExacCol = "LastYrSevExacCount",  
  KeepSGRQ = TRUE,  
  KeepMeds = TRUE,  
  ...  
)
```

Arguments

patientData patient data matrix. Can have one or many patients in it
 random_sampling_N number of random sampling. Default is 100.
 lastYrExacCol the column specifying last year all exacerbation count

lastYrSevExacCol	the column specifying last year severe exacerbation count
KeepSGRQ	default is TRUE. If set to false, the reduced model without SGRQ will be used.
KeepMeds	default is TRUE. If set to false, the reduced model without medication predictors will be used.
...	for backward compatibility

Value

patientData with prediction

Examples

```
results <- accept2(samplePatients)
```

accept3	<i>Predicts country-specific COPD exacerbation risk based on ACCEPT 3.0 model with external recalibration</i>
---------	---

Description

This function provides country-specific exacerbation risk predictions by applying recalibration adjustments to the ACCEPT 2.0 model. It accounts for differences in healthcare systems, diagnostic practices, and baseline risk across 18 countries.

Usage

```
accept3(  
  country,  
  ID,  
  age,  
  male,  
  BMI,  
  smoker,  
  mMRC = NA,  
  CVD,  
  ICS,  
  LABA,  
  LAMA,  
  LastYrExacCount,  
  LastYrSevExacCount,  
  FEV1,  
  SGRQ = NA,  
  oxygen,  
  obs_modsev_risk  
)
```

Arguments

country	Three-letter ISO country code (e.g., "CAN", "USA", "GBR"). Supported countries: ARG, AUS, BRA, CAN, COL, DEU, DNK, ESP, FRA, GBR, ITA, JPN, KOR, MEX, NLD, NOR, SWE, USA. For unsupported countries, observed moderate-to-severe risk is used for recalibration.
ID	A unique character string identifying the patient
age	Patient's age (40-90 years)
male	Whether the patient is male (TRUE/FALSE)
BMI	Body mass index (10-60)
smoker	Whether the patient is currently a smoker (TRUE/FALSE)
mMRC	Modified Medical Research Council dyspnea scale (0-4)
CVD	Whether the patient has cardiovascular disease (TRUE/FALSE)
ICS	Whether the patient is on inhaled corticosteroids (TRUE/FALSE)
LABA	Whether the patient is on long acting beta agonist (TRUE/FALSE)
LAMA	Whether the patient is on long acting muscarinic antagonist (TRUE/FALSE)
LastYrExacCount	Total number of exacerbations in the previous year
LastYrSevExacCount	Number of severe exacerbations in the previous year
FEV1	Forced expiratory volume in 1 second in percent predicted (10-120)
SGRQ	St. George's Respiratory Questionnaire score (0-100). Either this or mMRC should be provided.
oxygen	Whether the patient has had supplemental oxygen therapy within the past year (TRUE/FALSE)
obs_modsev_risk	Observed moderate-to-severe exacerbation risk in the local population. Only used for countries not in the supported list. If NA, country-specific intercept is used.

Details

ACCEPT 3.0 builds upon ACCEPT 2.0 by adding country-specific recalibration to improve prediction accuracy across diverse healthcare settings. The model uses empirically-derived country-specific intercepts for 18 countries. For other countries, users can provide observed local risk data for recalibration.

The recalibration applies transformation slopes of 0.9162 for moderate-to-severe exacerbations and 0.9626 for severe exacerbations.

Value

Returns a list containing:

- ID: Patient identifier

- `predicted_exac_probability`: Recalibrated probability of moderate-to-severe exacerbation
- `predicted_severe_exac_probability`: Recalibrated probability of severe exacerbation

When called through `accept()` with `version="accept3"`, returns a tibble that also includes:

- `predicted_exac_rate`: Recalibrated rate of moderate-to-severe exacerbation (calculated as $-\log(1-p)$)
- `predicted_severe_exac_rate`: Recalibrated rate of severe exacerbation (calculated as $-\log(1-p)$)

See Also

[accept](#), [accept2](#), [accept1](#)

Examples

```
# Single patient prediction for Canada
result <- accept3(
  country = "CAN", ID = "P001", age = 65, male = TRUE, BMI = 25,
  smoker = FALSE, mMRC = 2, CVD = TRUE, ICS = TRUE, LABA = TRUE, LAMA = TRUE,
  LastYrExacCount = 1, LastYrSevExacCount = 0, FEV1 = 45, oxygen = FALSE,
  obs_modsev_risk = NA
)

# For unsupported country with local risk data
result <- accept3(
  country = "CHN", ID = "P002", age = 70, male = FALSE, BMI = 22,
  smoker = TRUE, mMRC = 3, CVD = FALSE, ICS = TRUE, LABA = TRUE, LAMA = FALSE,
  LastYrExacCount = 2, LastYrSevExacCount = 1, FEV1 = 35, oxygen = TRUE,
  obs_modsev_risk = 0.35
)
```

<code>accept3_cprd</code>	<i>Predicts COPD exacerbation risk for UK primary-care patients using ACCEPT 3.0-CPRD</i>
---------------------------	---

Description

ACCEPT 3.0-CPRD is a UK primary-care recalibration of ACCEPT 2.0 derived from the CPRD (Clinical Practice Research Datalink) primary-care dataset. It applies two Cox-model recalibration parameters: an optimism-corrected baseline hazard (H_0) and slope (β), separately for moderate-to-severe and severe exacerbations.

When optional predictors (LABA, oxygen, ICS, LAMA, statin/CVD, BMI, smoker) are missing, a CPRD-specific sequential triangular regression imputation model fills them in before prediction.

Usage

```
accept3_cprd(patientData, return_predictors = FALSE, quiet = TRUE)
```

Arguments

patientData	A tibble of patients in the same format as samplePatients. Mandatory columns: ID, age, male, FEV1, LastYrExacCount, LastYrSevExacCount, and either mMRC or SGRQ. Optional columns: LABA, oxygen, ICS, LAMA, statin, BMI, smoker.
return_predictors	Logical. If TRUE, the input predictors are returned alongside predictions. Default FALSE.
quiet	Logical. If TRUE (default), suppresses imputation messages. Set to FALSE to report which predictors were imputed.

Details

Recalibration formula For each outcome the recalibrated 1-year risk is:

$$\hat{p}_{UK} = 1 - \exp\left(-H_0 \cdot \exp(\beta \cdot \log(-\log(1 - \hat{p}_2)))\right)$$

where $\hat{p}_2$ is the ACCEPT 2.0 predicted probability, and H_0 and β are the optimism-corrected parameters from the CPRD Cox model (Table in manuscript):

- Moderate-to-severe: $H_0 = 0.676$, $\beta = 0.986$
- Severe: $H_0 = 0.482$, $\beta = 1.124$

Optional-predictor imputation Missing optional predictors are imputed sequentially (triangular matrix): LABA -> oxygen -> ICS -> LAMA -> statin -> BMI -> smoker. Each model uses mandatory predictors (age, male, mMRC, FEV1, LastYrSevExacCount, LastYrExacCount) plus any previously imputed optional predictors. Binary variables are imputed with logistic regression (probability rounded to 0/1); BMI with linear regression.

Value

A tibble with columns:

- predicted_exac_probability - recalibrated moderate-to-severe risk
- predicted_exac_rate - corresponding rate (-log(1-p))
- predicted_severe_exac_probability - recalibrated severe risk
- predicted_severe_exac_rate - corresponding rate

If return_predictors = TRUE, input columns are prepended.

See Also

[accept](#), [accept2](#), [accept3](#)

Examples

```
results <- accept3_cprd(samplePatients)
```

 handler_predict.accept_model

Model handler functions for API endpoint

Description

Useful for supporting accept_model class in vetiver

Usage

```
## S3 method for class 'accept_model'
handler_predict(vetiver_model, ...)
```

Arguments

vetiver_model A deployable [vetiver_model()] object
 ... any other inputs

Value

A 'handler_startup' function should return invisibly, while a 'handler_predict' function should return a function with the signature 'function(req)'. The request body ('req\$body') consists of the new data at prediction time; this function should return predictions either as a tibble or as a list coercable to a tibble via [tibble::as_tibble()].

 plotExacerbations *Creates bar graph comparing no treatment with azithromycin treatment*

Description

Creates bar graph comparing no treatment with azithromycin treatment

Usage

```
plotExacerbations(
  patientResults,
  type = "rate",
  interval = "PI",
  colors = c("#007bff", "rgb(204,204,204)")
)
```

Arguments

patientResults patient results vector, produced by accept.
 type string: either "probability" or "rate"
 interval string: either "CI" or "PI" PI = Predicted Interval CI = Confidence Interval
 colors vector: a vector of colors to be used in the graph must be length 2 can use
 hexadecimal, rgb, or R color codes

Value

a bar graph

Examples

```
## Not run:
results <- accept1(samplePatients[1,])
plotExacerbations(results)

## End(Not run)
```

plotHeatMap	<i>Creates heatmap of number of exacerbations</i>
-------------	---

Description

Creates heatmap of number of exacerbations

Usage

```
plotHeatMap(patientResults, n = 10, shortened = TRUE)
```

Arguments

patientResults patient results vector, produced by accept.
 n how many exacerbations to consider
 shortened boolean

Value

a heatmap

Examples

```
## Not run:
results <- accept1(samplePatients[1,])
plotHeatMap(results)

## End(Not run)
```

predict.accept_model *Model predictions*

Description

Model predictions

Usage

```
## S3 method for class 'accept_model'
predict(object, ...)
```

Arguments

object a model object
 ... new data for which the prediction is needed

Value

prediction results from ACCEPT model

predictCountProb *Predicts probability of observing n exacerbations in the next year*

Description

Predicts probability of observing n exacerbations in the next year

Usage

```
predictCountProb(patientResults, n = 10, shortened = TRUE)
```

Arguments

patientResults patient results vector, produced by accept.
 n how many exacerbations
 shortened boolean: Shortened results groups into 0, 1, 2, and 3 or more exacerbations

Value

a matrix of probabilities with the number of exacerbations as rows and number of severe exacerbations as columns

Examples

```
results <- accept2(samplePatients[1,])
predictCountProb (results)
```

samplePatients

Sample Patient Characteristics Inputs

Description

A dataset containing sample patient characteristics to run the prediction model variables are as follows:

Format

A data frame with 2 rows and 19 variables

Details

- ID. A unique character string identifying a patients
- male. whether the patient is male
- age. the age of the patient (40–90)
- smoker. whether the patient is currently a smoker
- oxygen. whether the patient has had supplemental oxygen therapy within the past year (0,1)
- FEV1. forced expiratory volume in 1 second in percent predicted
- BMI. body mass index (10–60)
- SGRQ. St. George’s Respiratory Questionnaire score (0–100)
- statin. whether the patient is taking statins due to cardiovascular conditions
- LAMA. whether the patient is on long acting muscarinic antagonist
- LABA. whether the patient is on long acting beta agonist
- ICS. whether the patient is on inhaled corticosteroids
- LastYrExacCount. total number of exacerbations in the previous year
- LastYrSevExacCount. number of severe exacerbations in the previous year

set_openai_api_key

Set OpenAI API key

Description

NLP functionalities require a paid OpenAI API key to communicate with Open AI models.

Usage

```
set_openai_api_key(key, overwrite = FALSE, temporary = FALSE)
```

Arguments

key	an OpenAI API key. For more information on keys see the OpenAI API blog
overwrite	Option to overwrite any existing OpenAI keys already stored locally.
temporary	Option to not store the API key for use across sessions.

Examples

```
## Not run:
set_openai_api_key("YOUR_OPENAI_API_KEY")

# This will set the key permanently until overwritten again
set_openai_api_key("YOUR_OPENAI_API_KEY")

## End(Not run)
```

```
show_openai_api_key    View saved openAI API key
```

Description

View saved API key'

Usage

```
show_openai_api_key()
```

Examples

```
show_openai_api_key()
```

```
vetiver_create_description.accept_model
    Create a vetiver model object description
```

Description

Create a vetiver model object description

Usage

```
## S3 method for class 'accept_model'
vetiver_create_description(model)
```

Arguments

model	model name
-------	------------

Value

the description of the model

```
vetiver_create_meta.accept_model
```

Metadata constructors for 'vetiver_model()' object

Description

Useful for supporting accept_model class in vetiver

Usage

```
## S3 method for class 'accept_model'
vetiver_create_meta(model, metadata)
```

Arguments

model	a trained model object
metadata	list containing additional metadata to store with the pin

Value

The vetiver_create_meta function returns a 'vetiver_meta()' list.

```
vetiver_ptype.accept_model
```

Create a vetiver input data prototype

Description

Create a vetiver input data prototype

Usage

```
## S3 method for class 'accept_model'
vetiver_ptype(model, ...)
```

Arguments

model	a vetiver model object
...	any other inputs

Value

A 'vetiver_ptype' method returns a zero-row dataframe, and 'vetiver_create_ptype()' returns either such a zero-row dataframe, 'NULL', or the dataframe passed to 'save_prototype'.

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