

# Package ‘EMP’

May 8, 2025

**Type** Package

**Title** Expected Maximum Profit Classification Performance Measure

**Version** 2.0.6

**Date** 2025-05-07

**Maintainer** Cristian Bravo <cbravoro@uwo.ca>

**Depends** R (>= 3.0.0), ROCR

**Description** Functions for estimating EMP (Expected Maximum Profit Measure) in Credit Risk Scoring and Customer Churn Prediction, according to Verbraken et al (2013, 2014) <[DOI:10.1109/TKDE.2012.50](https://doi.org/10.1109/TKDE.2012.50)>, <[DOI:10.1016/j.ejor.2014.04.001](https://doi.org/10.1016/j.ejor.2014.04.001)>.

**License** GPL (>= 3)

**NeedsCompilation** no

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**Repository** CRAN

**Date/Publication** 2025-05-08 20:00:06 UTC

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EMP-package

*Expected Maximum Profit Classification Performance Measure*

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## Description

The EMP measure is an alternative to AUC that includes the expected profit of a given model, when compared to a baseline (no model used). Presented in Verbraken et al. (2014) as a preferred measure for credit risk scoring in any profit-driven environment and in Verbraken et al. (2013) as a measure for customer churn prediction. For credit scoring, this implementation assumes an LGD distribution with two point masses, and a constant ROI. For churn prediction, this implementation assumes a beta distribution and a constant CLV.

## Details

Package: EMP  
Type: Package  
Version: 2.0.6  
Date: 2025-05-07  
License: GPL (>=3)

The package exports only two functions, `empCreditScoring` and `empChurn`.

## Author(s)

Authors: Cristian Bravo, Seppe vanden Broucke and Thomas Verbraken. Maintainer: Cristian Bravo <cbravoro@uwo.ca>.

## References

Verbraken, T., Wouter, V. and Baesens, B. (2013). A Novel Profit Maximizing Metric for Measuring Classification Performance of Customer Churn Prediction Models. *Knowledge and Data Engineering, IEEE Transactions on.* 25 (5): 961-973. Available Online: [doi:10.1109/TKDE.2012.50](https://doi.org/10.1109/TKDE.2012.50) Verbraken, T., Bravo, C., Weber, R. and Baesens, B. (2014). Development and application of consumer credit scoring models using profit-based classification measures. *European Journal of Operational Research.* 238 (2): 505 - 513. Available Online: [doi:10.1016/j.ejor.2014.04.001](https://doi.org/10.1016/j.ejor.2014.04.001)

## Examples

```
# Construct artificial probability scores and true class labels
score.ex <- runif(1000, 0, 1)
class.ex <- unlist(lapply(score.ex, function(x){rbinom(1,1,x)}))

# Calculate EMP measures for credit risk scoring
empCreditScoring(score.ex, class.ex)

# Calculate EMP measures for customer churn prediction
empChurn(score.ex, class.ex)
```

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 empChurn

*empChurn*


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### Description

Estimates the EMP for customer churn prediction, considering constant CLV and a given cost of contact  $f$  and retention offer  $d$ .

### Usage

```
empChurn(scores, classes, alpha = 6,
beta = 14, clv = 200, d = 10, f = 1)
```

### Arguments

scores	A vector of predicted probabilities.
classes	A vector of true binary class labels.
alpha	Alpha parameter of unimodel beta distribution.
beta	Beta parameter of unimodel beta distribution.
clv	Constant CLV per retained customer.
d	Constant cost of retention offer.
f	Constant cost of contact.

### Value

An EMP object with four components.

MP	The Maximum Profit of the ROC curve at MPfrac cutoff.
MPfrac	The percentage of cases that should be excluded, that is, the percentual cutoff at MP profit.
EMP	The Expected Maximum Profit of the ROC curve at EMPfrac cutoff.
EMPfrac	The percentage of cases that should be excluded, that is, the percentual cutoff at EMP profit.

### Author(s)

Cristian Bravo, Seppe vanden Broucke and Thomas Verbraken.

### References

Verbraken, T., Wouter, V. and Baesens, B. (2013). A Novel Profit Maximizing Metric for Measuring Classification Performance of Customer Churn Prediction Models. *Knowledge and Data Engineering, IEEE Transactions on*. 25 (5): 961-973. Available Online: [doi:10.1109/TKDE.2012.50](https://doi.org/10.1109/TKDE.2012.50)

Verbraken, T., Bravo, C., Weber, R. and Baesens, B. (2014). Development and application of consumer credit scoring models using profit-based classification measures. *European Journal of Operational Research*. 238 (2): 505 - 513. Available Online: [doi:10.1016/j.ejor.2014.04.001](https://doi.org/10.1016/j.ejor.2014.04.001)

**See Also**

See Also [empChurn](#), [prediction](#).

**Examples**

```
# Construct artificial probability scores and true class labels
score.ex <- runif(1000, 0, 1)
class.ex <- unlist(lapply(score.ex, function(x){rbinom(1,1,x)}))

# Calculate EMP measures for customer churn prediction
empChurn(score.ex, class.ex)

# Calculate EMP measures for customer churn prediction with
# lower clv and higher costs
empChurn(score.ex, class.ex, clv = 100, d = 30, f = 5)
```

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empCreditScoring      *empCreditScoring*

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**Description**

Estimates the EMP for credit risk scoring, considering constant ROI and a bimodal LGD function with point masses  $p_0$  and  $p_1$  for no loss and total loss, respectively.

**Usage**

```
empCreditScoring(scores, classes, p0=0.55, p1=0.1, ROI=0.2644)
```

**Arguments**

scores	A vector of predicted probabilities.
classes	A vector of true binary class labels.
p0	Percentage of cases on the first point mass of the LGD distribution (complete recovery).
p1	Percentage of cases on the second point mass of the LGD distribution (complete loss).
ROI	Constant ROI per granted loan. A percentage.

**Value**

An EMP object with two components.

EMP	The Expected Maximum Profit of the ROC curve at EMPfrac cutoff.
EMPfrac	The percentage of cases that should be excluded, that is, the percentual cutoff at EMP profit.

**Author(s)**

Cristian Bravo, Seppe vanden Broucke and Thomas Verbraken.

**References**

Verbraken, T., Wouter, V. and Baesens, B. (2013). A Novel Profit Maximizing Metric for Measuring Classification Performance of Customer Churn Prediction Models. *Knowledge and Data Engineering, IEEE Transactions on.* 25 (5): 961-973. Available Online: [doi:10.1109/TKDE.2012.50](https://doi.org/10.1109/TKDE.2012.50) Verbraken, T., Bravo, C., Weber, R. and Baesens, B. (2014). Development and application of consumer credit scoring models using profit-based classification measures. *European Journal of Operational Research.* 238 (2): 505 - 513. Available Online: [doi:10.1016/j.ejor.2014.04.001](https://doi.org/10.1016/j.ejor.2014.04.001)

**See Also**

See Also [empChurn](#), [prediction](#).

**Examples**

```
# Construct artificial probability scores and true class labels
score.ex <- runif(1000, 0, 1)
class.ex <- unlist(lapply(score.ex, function(x){rbinom(1,1,x)}))

# Calculate EMP measures for credit risk scoring
empCreditScoring(score.ex, class.ex)

# Calculate EMP measures for credit risk scoring with point masses
# in 0.1 and 0.9, and 0.1 ROI
empCreditScoring(score.ex, class.ex, 0.1, 0.1, 0.1)
```

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