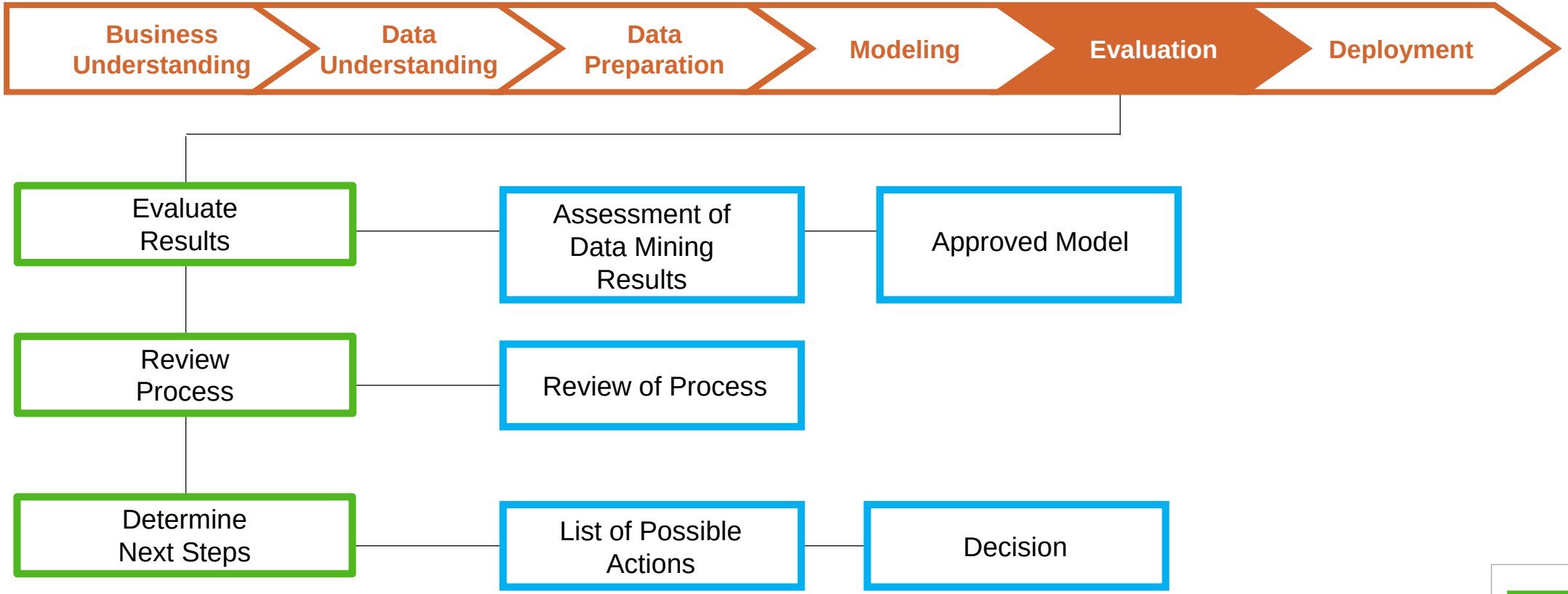
# Week 5 Unit 1: **Evaluation Phase – Overview**

SAP

openSAP
open.sap.com

# Evaluation Phase – Overview

## CRISP-DM – Phase 5: Evaluation

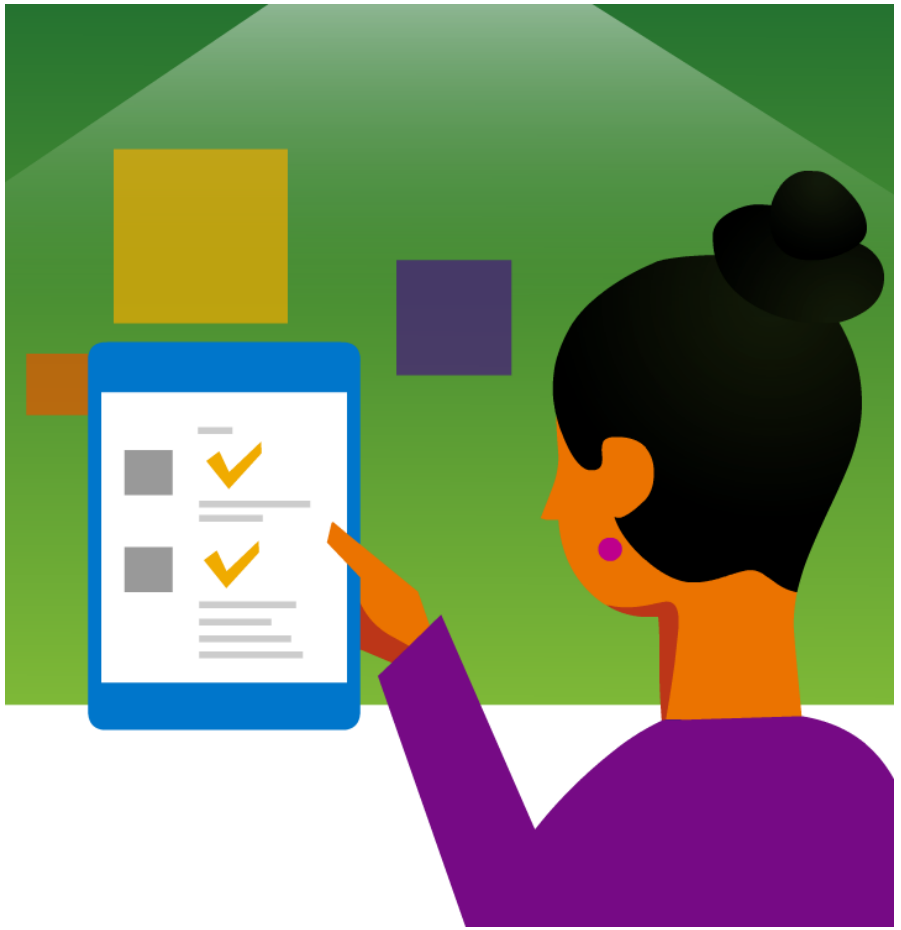



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Evaluation Phase – Overview

## Phase 5.1: Evaluate Results

- **Task**
  - Assess the degree to which the model meets the business objectives.
  - Test the model(s) on test applications if time and budget constraints permit.
- **Output – Assessment of Data Mining Results with respect to business success criteria**
- **Output – Approved Model**



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Evaluation Phase – Overview

## Phase 5.2: Review Process

- **Task**
  - Conduct a more thorough review of the data mining engagement to determine if there is any important factor or task that has somehow been overlooked.
  - Identify any quality assurance issues.
- **Output – Review of Process**
  - Summarize the process review and highlight activities that have been missed and/or should be repeated.

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Evaluation Phase – Overview

## Phase 5.3: Determine Next Steps

- **Task**
  - Assess how to proceed with the project.
- **Output – List of Possible Actions**
  - List the potential further actions along with the reasons for and against each option.
- **Output – Decision**
  - Describe the decision on how to proceed.

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Thank you

**Contact information:**

**open@sap.com**

openSAP
open.sap.com

# © 2016 SAP SE or an SAP affiliate company. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP SE or an SAP affiliate company.

SAP and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP SE (or an SAP affiliate company) in Germany and other countries. Please see http://global12.sap.com/corporate-en/legal/copyright/index.epx for additional trademark information and notices.

Some software products marketed by SAP SE and its distributors contain proprietary software components of other software vendors.

National product specifications may vary.

These materials are provided by SAP SE or an SAP affiliate company for informational purposes only, without representation or warranty of any kind, and SAP SE or its affiliated companies shall not be liable for errors or omissions with respect to the materials. The only warranties for SAP SE or SAP affiliate company products and services are those that are set forth in the express warranty statements accompanying such products and services, if any. Nothing herein should be construed as constituting an additional warranty.

In particular, SAP SE or its affiliated companies have no obligation to pursue any course of business outlined in this document or any related presentation, or to develop or release any functionality mentioned therein. This document, or any related presentation, and SAP SE's or its affiliated companies' strategy and possible future developments, products, and/or platform directions and functionality are all subject to change and may be changed by SAP SE or its affiliated companies at any time for any reason without notice. The information in this document is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. All forward-looking statements are subject to various risks and uncertainties that could cause actual results to differ materially from expectations. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates, and they should not be relied upon in making purchasing decisions.

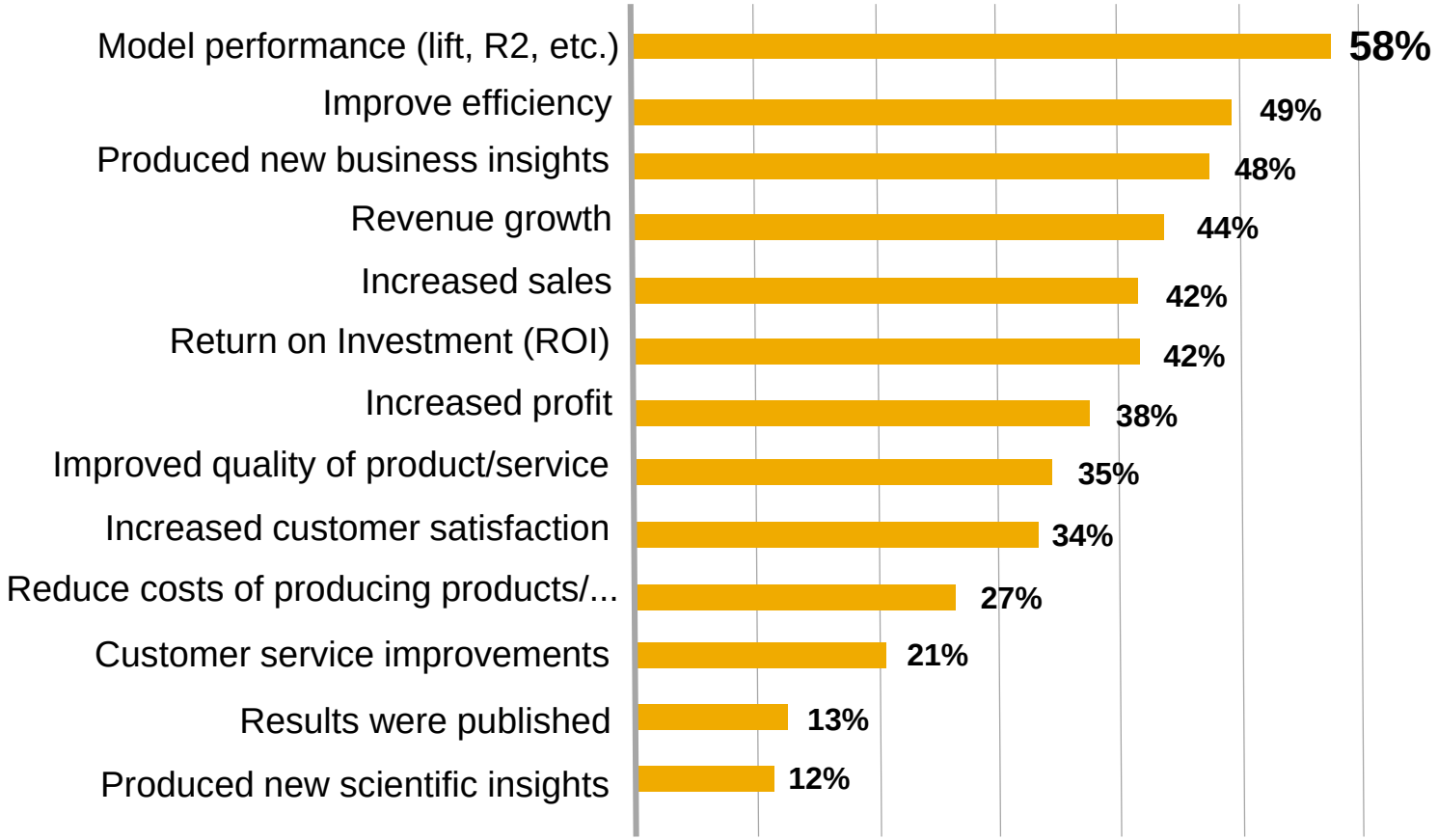
# Week 5 Unit 2: **Model Performance Metrics**

SAP

openSAP
open.sap.com

# Model Performance Metrics

## Introduction



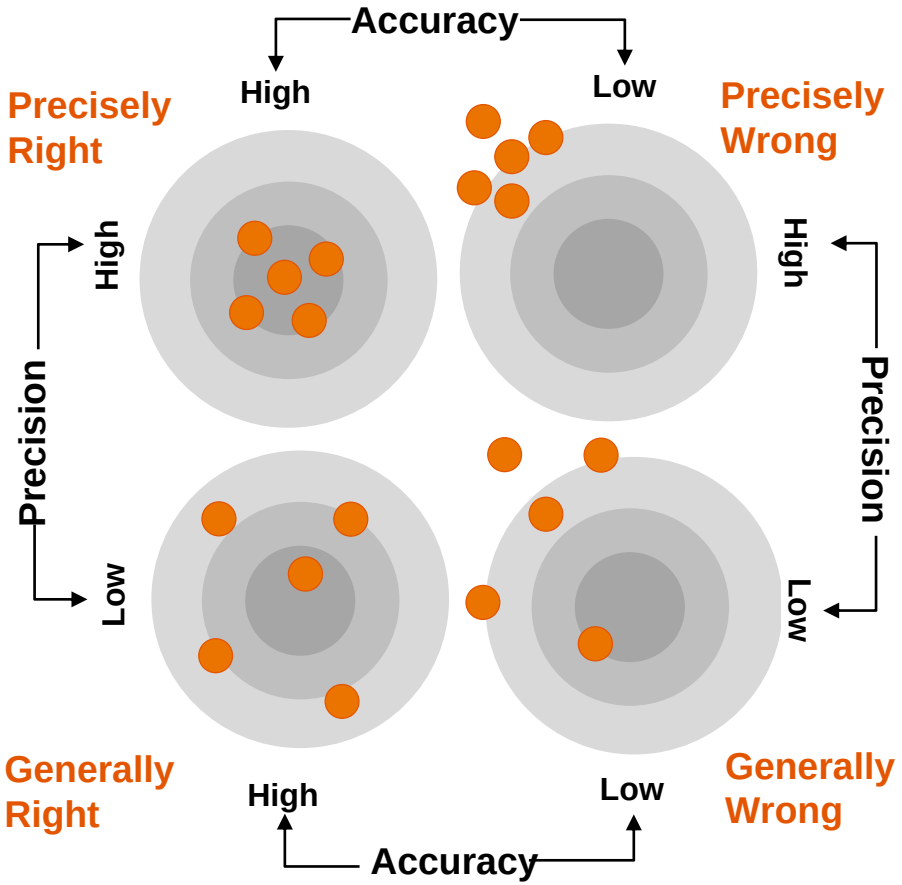

*From Rexer Analytics 3rd Annual Data Miner Survey by Karl Rexer, PhD, Heather N. Allen, PhD and Paul Gearan*

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for classification models

- The following performance metrics are often used to assess classification model success:
  - Confusion matrices summarize Type I and Type II errors
  - Lift, gains, ROC, and area under the curve (AUC)
  - SAP has developed predictive power (KI) and prediction confidence (KR) metrics




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Confusion matrix

| | | Predicted Class | | Total |
|---|---|---|---|---|
| | | 1 | 0 | |
| Actual Class | 1 | TP | FN | P |
| | 0 | FP | TN | N |

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

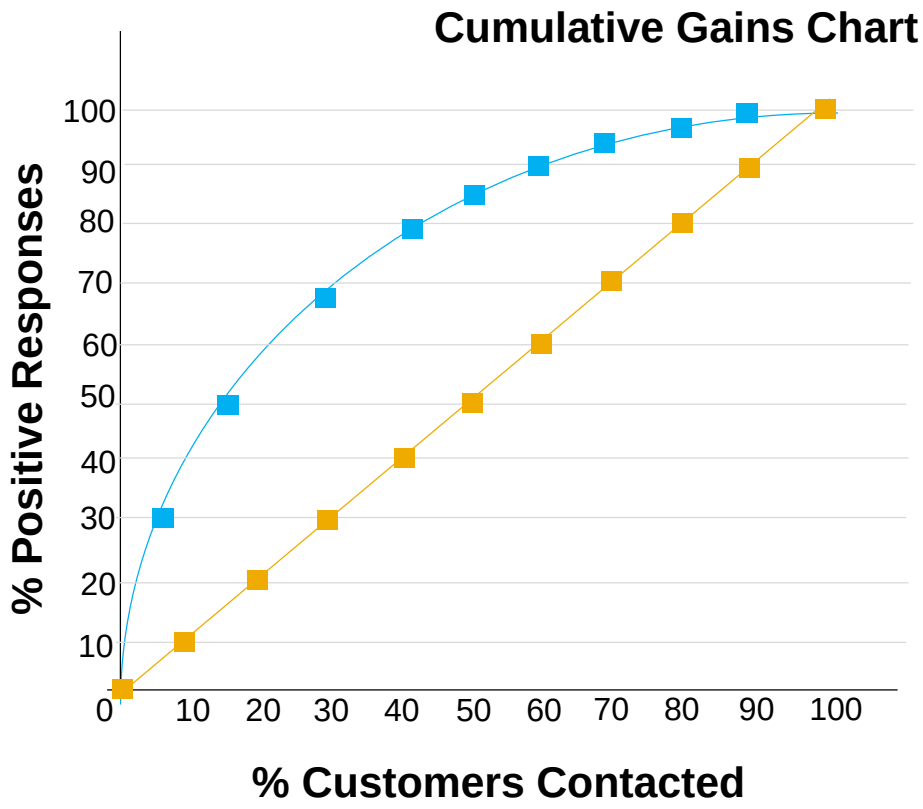
## Confusion matrix: costs and benefits

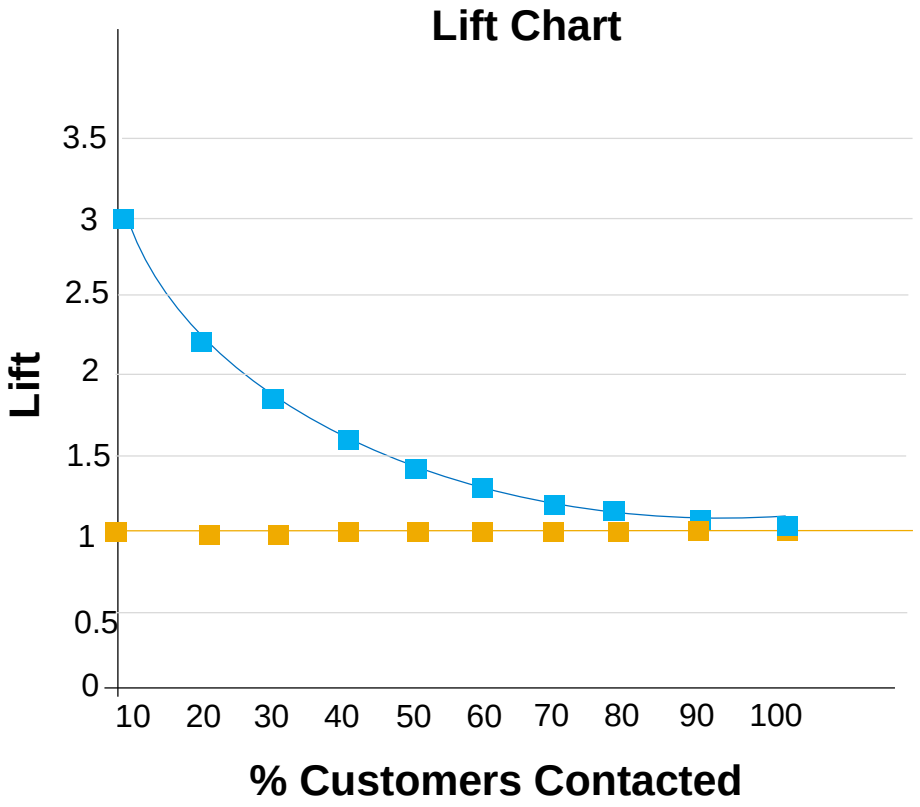
| Actual \ Predicted | Yes | No | |
|---|---|---|---|
| Yes | + Benefit Value | – Benefit Value | Actual Total Positive |
| No | Cost | N/A | Actual Total Negative |
| | Total Predicted Positive | Total Predicted Negative | |

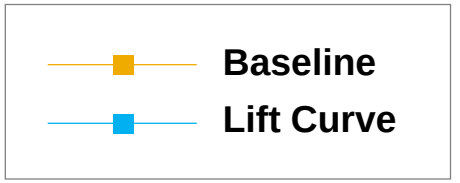
© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Lift and gains charts



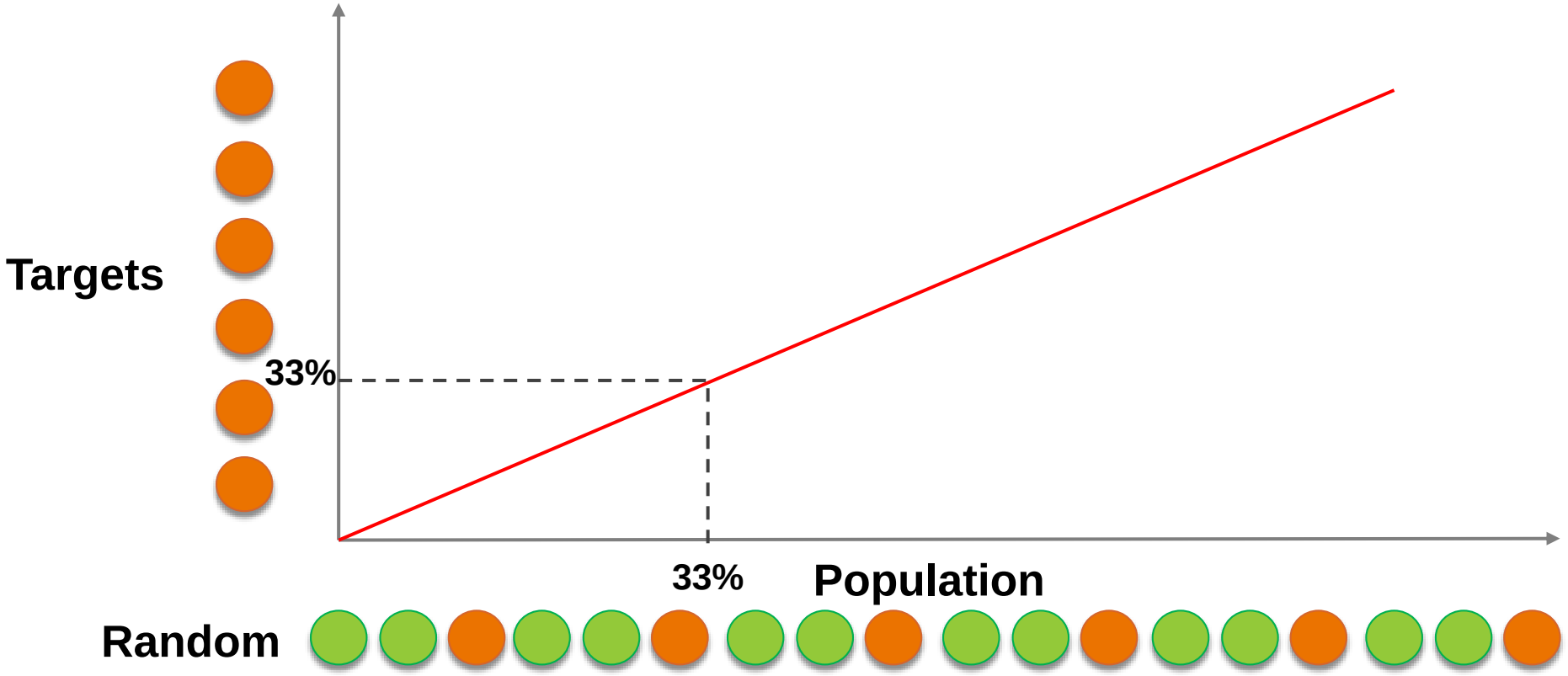




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

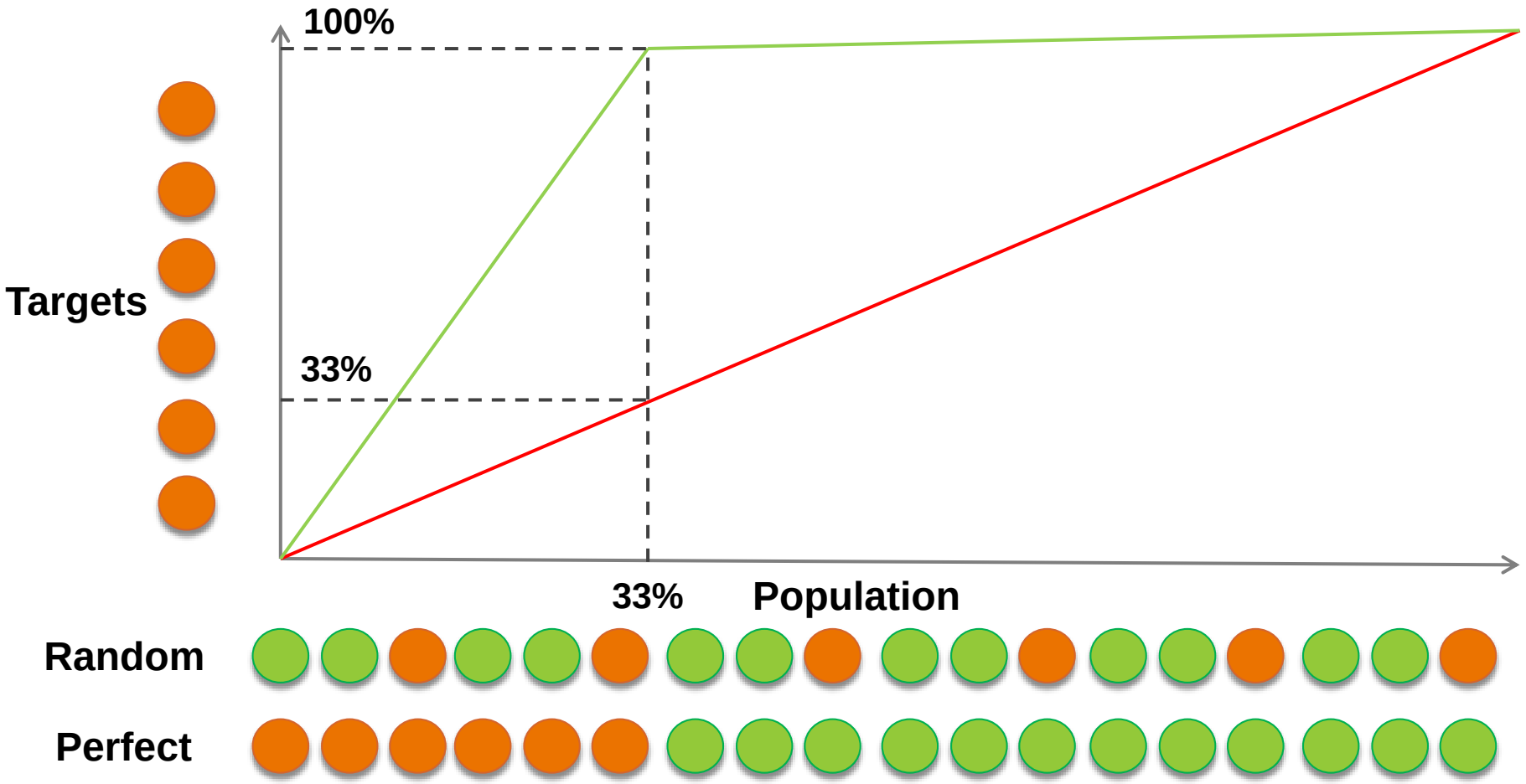
## Gains (detected) chart – Random model




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

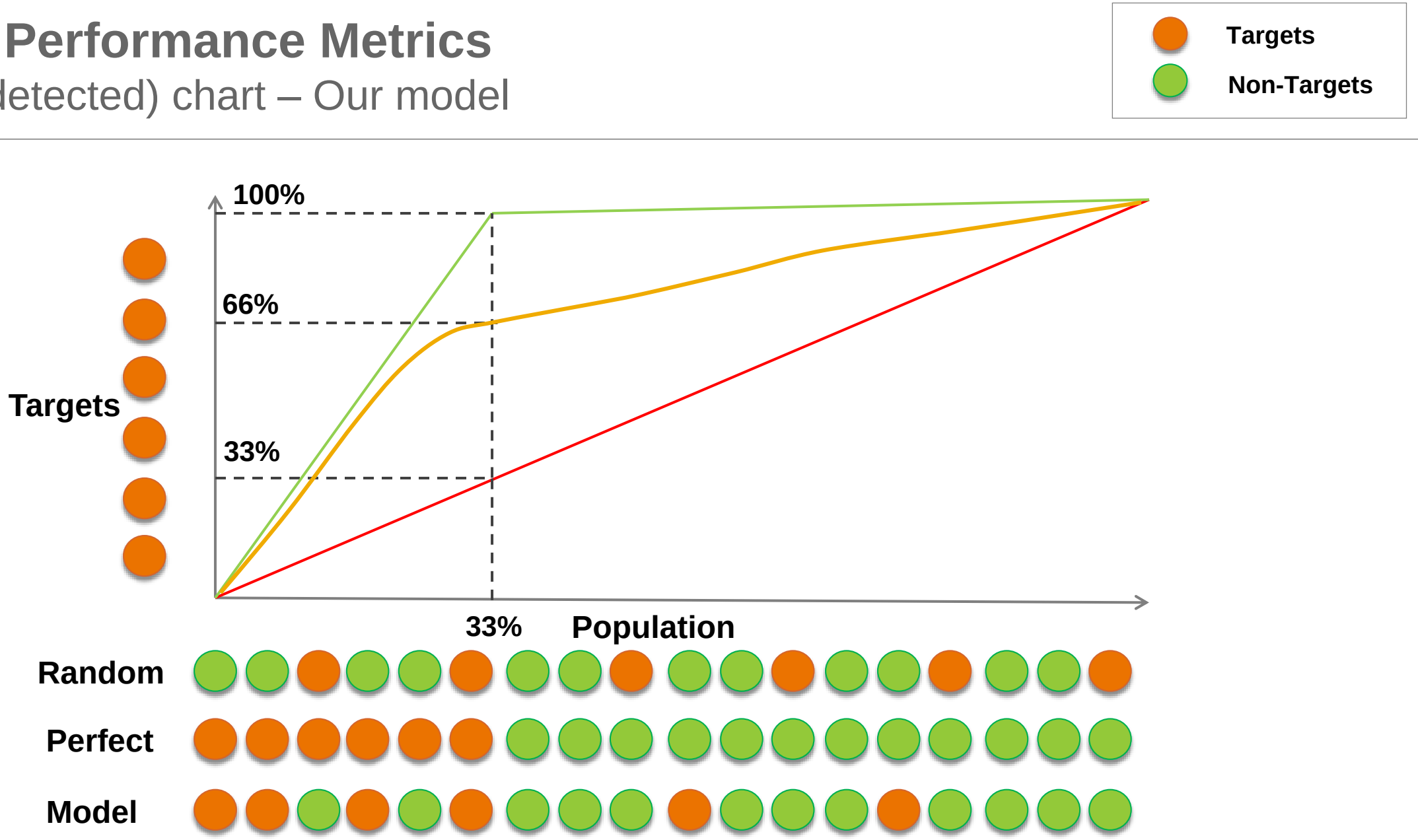
## Gains (detected) chart – Perfect model




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

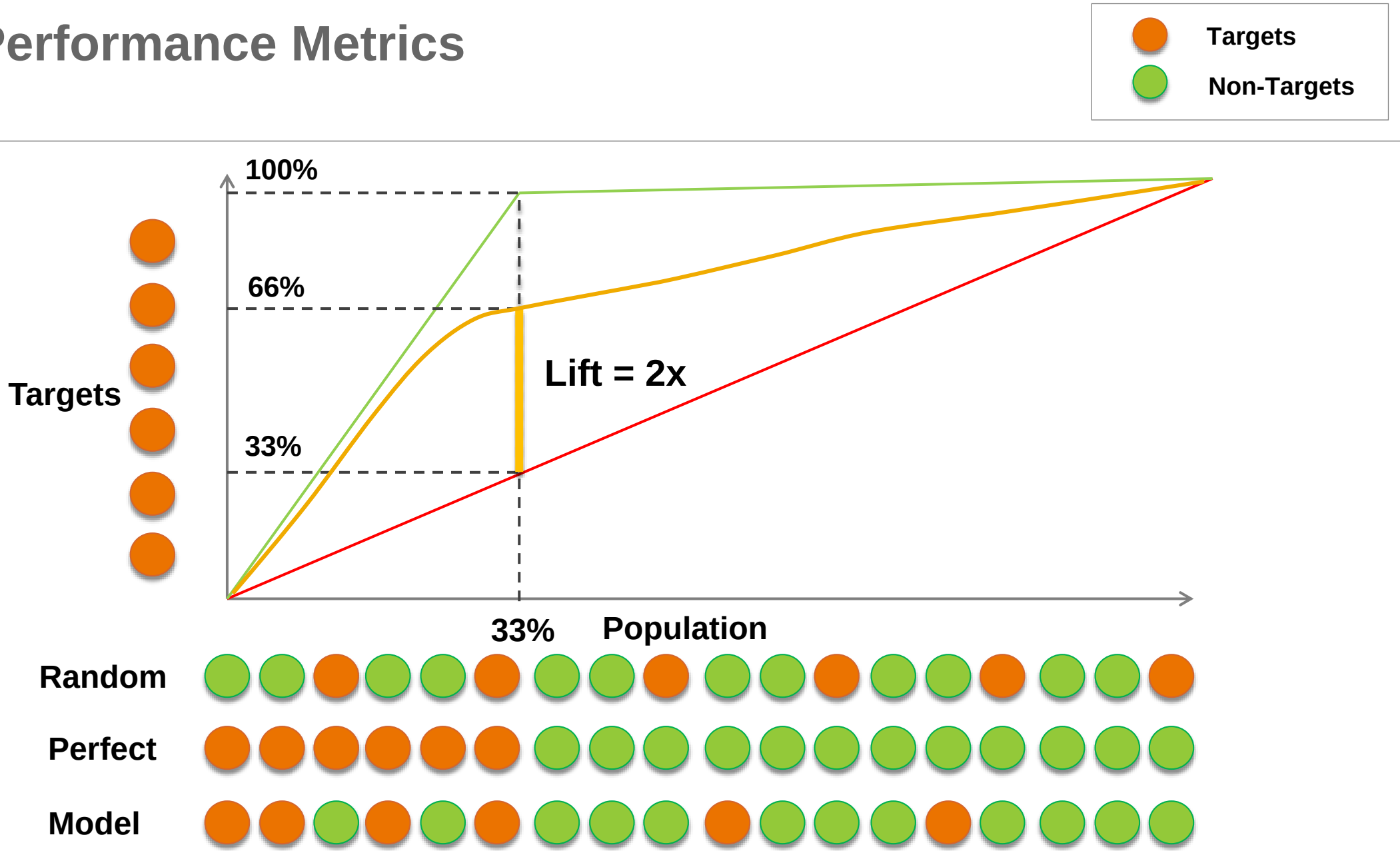
## Gains (detected) chart – Our model




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

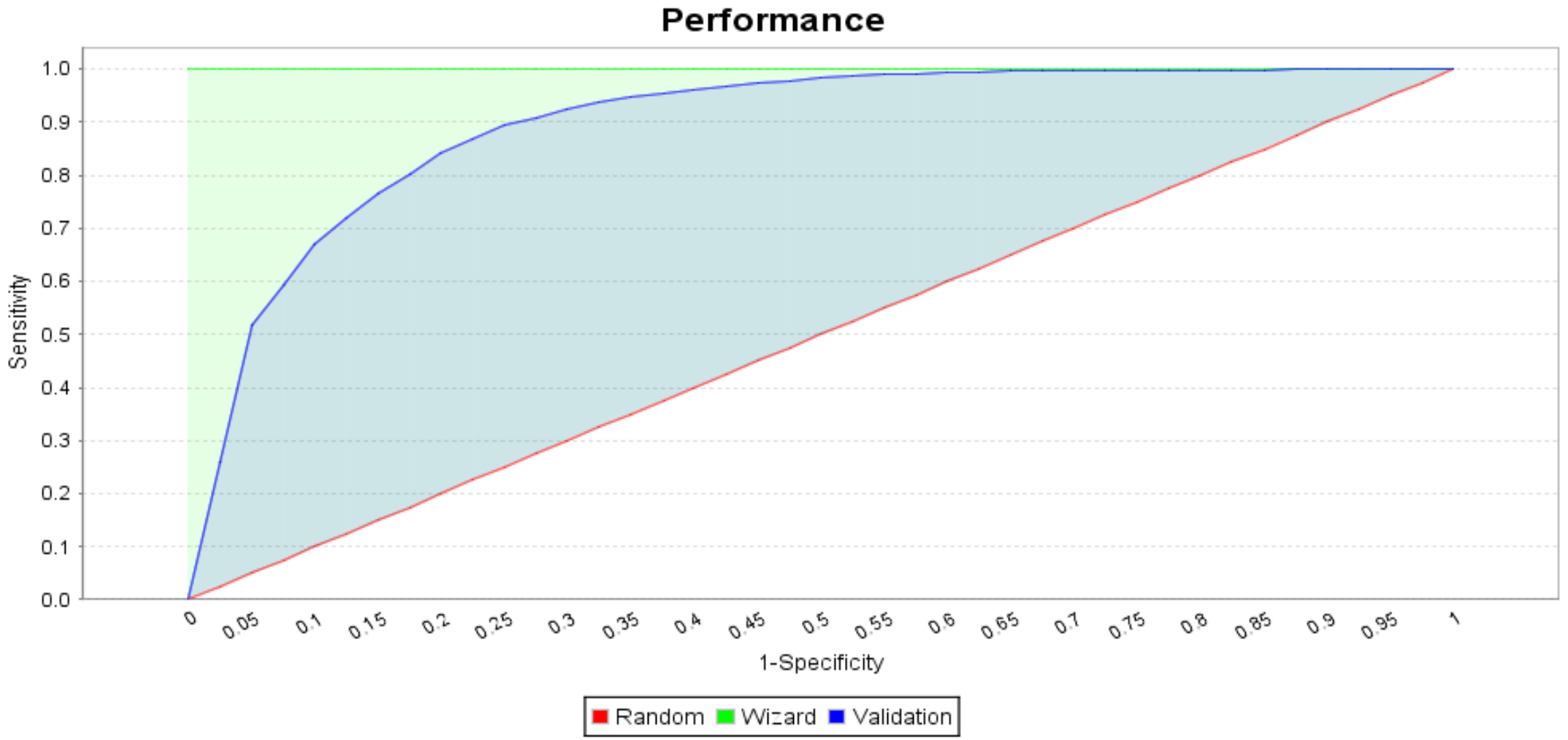
## Lift chart




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## ROC curve



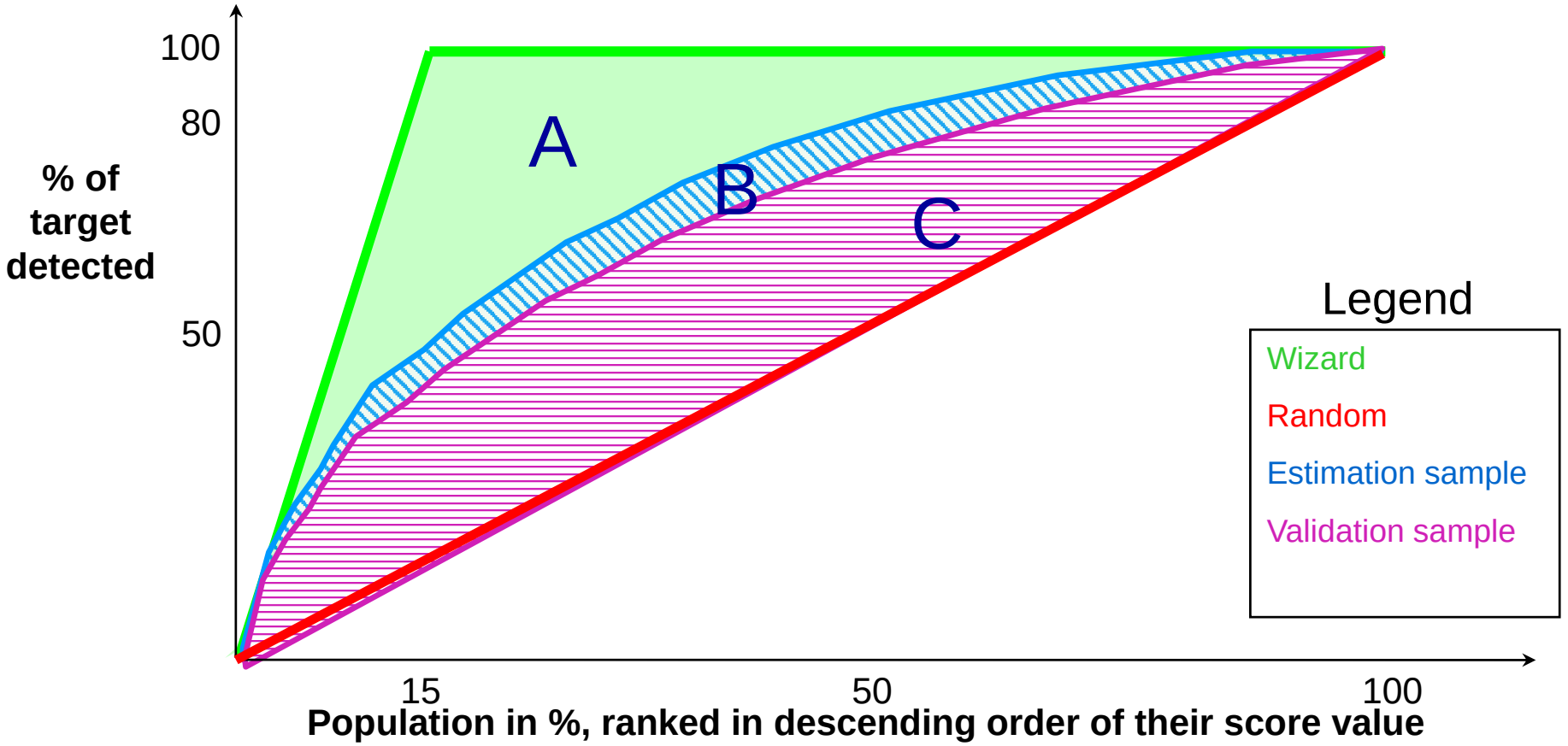

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## SAP metrics – Predictive power (KI) and prediction confidence (KR)

**Predictive Power $(Ki)_{Validation} \approx C/(A+B+C)$**
**Predictive Power $(Ki)_{Estimation} \approx (B+C)/(A+B+C)$**

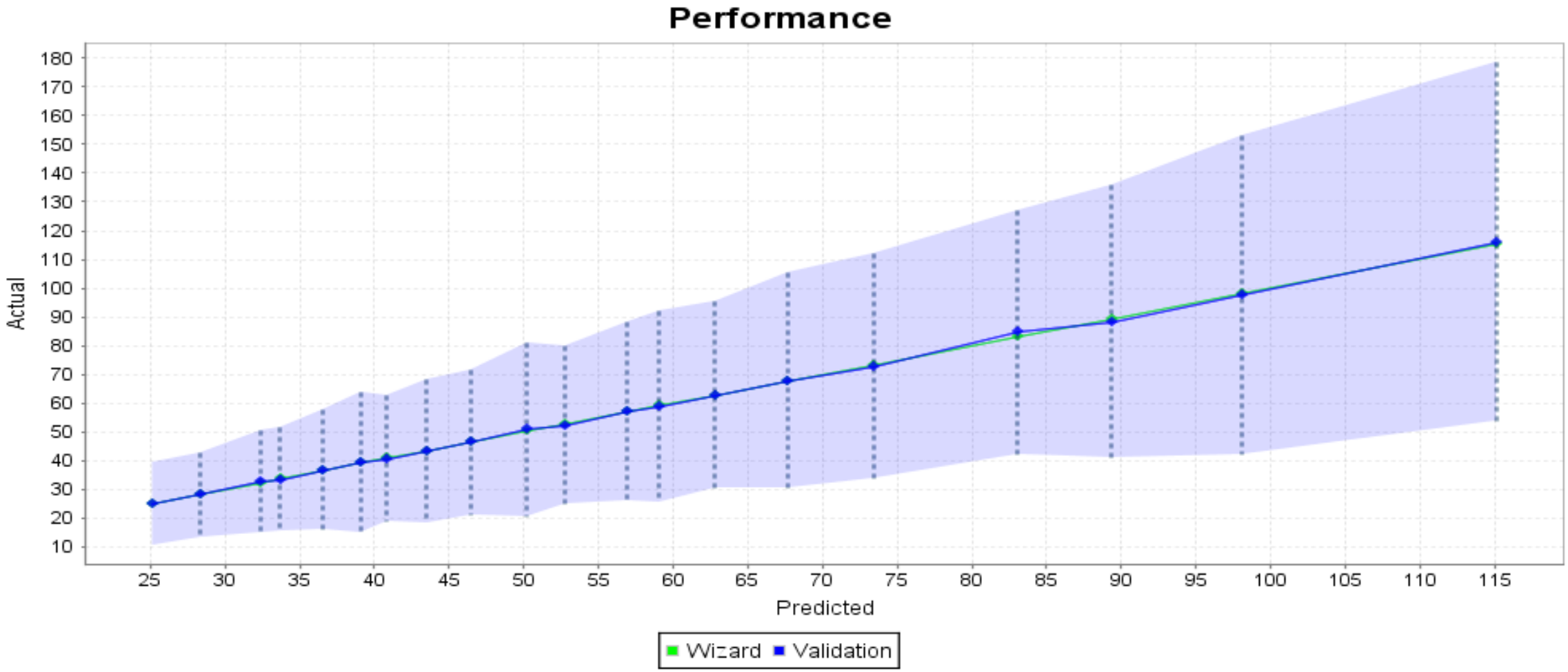
**Prediction Confidence (Kr) ≈ 1- B/(A+B+C)**




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models

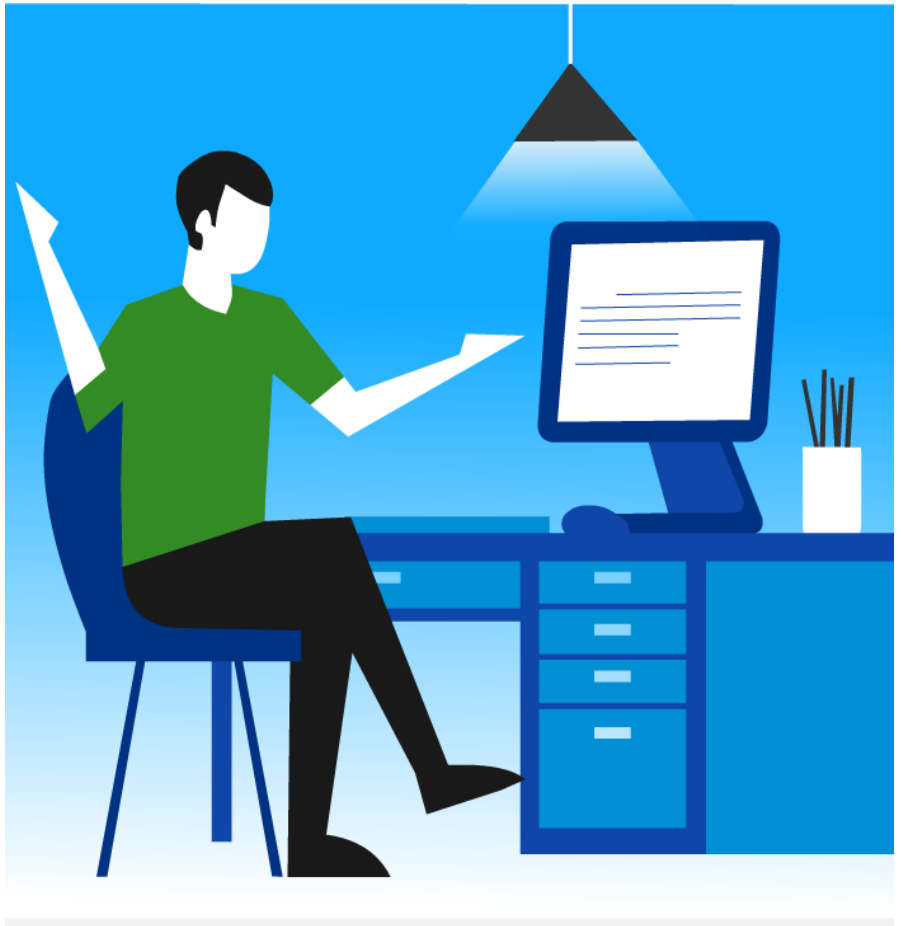



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Summary

- The choice of performance metric should be the one that most closely matches the business objectives defined at the beginning of the project during the Business Understanding phase.
- The metric used for model selection is of critical importance, because the model selected based on one metric may not be a good model for a different metric.



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Thank you

**Contact information:**

**open@sap.com**

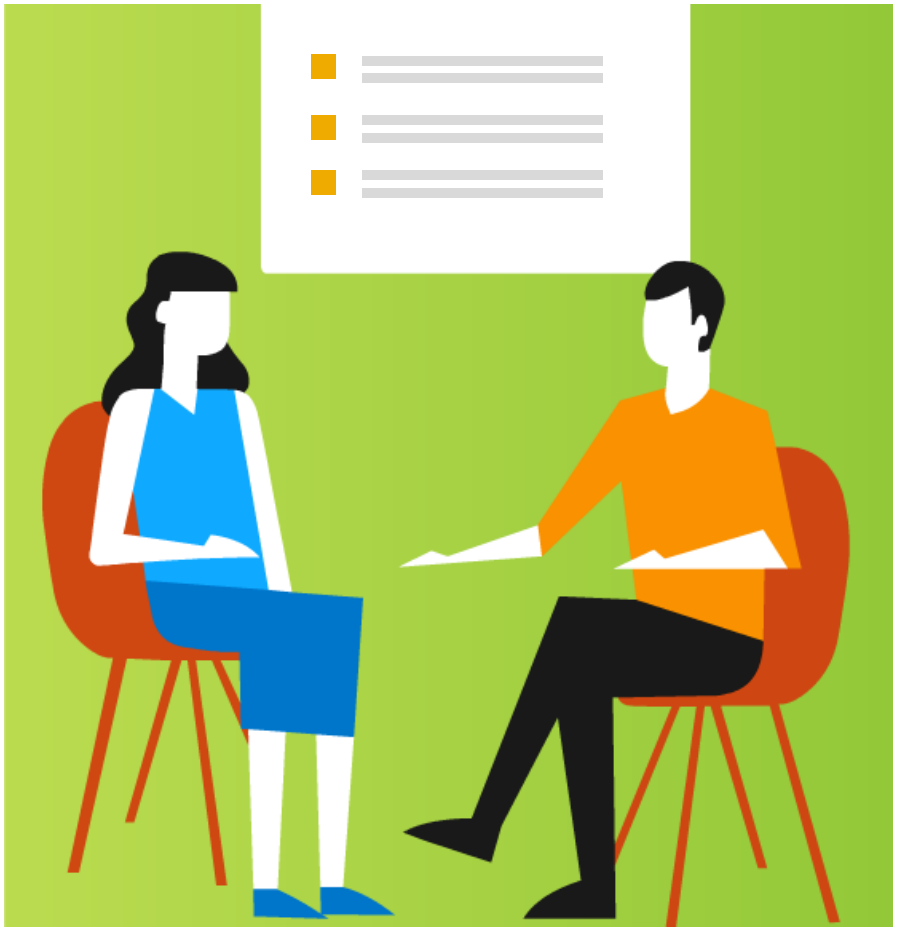
openSAP
open.sap.com

# Model Performance Metrics

## Appendix

## Additional Material

- Confusion Matrix
  - Commonly used metrics
- Gains and Lift Chart Examples
  - Decision tree
  - Logistic regression
- ROC Curve
  - Sensitivity and specificity
- Success Criteria for Regression Models
  - Notation
  - Mean absolute error (L1)
  - Mean square error (L2)
  - Maximum error (Linf)
  - Coefficient of determination (R2)



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Confusion matrix – Commonly used metrics

| | | |
|---|---|---|
| **True Positive Rate, Hit Rate, Recall, Sensitivity** | TP/P | The proportion of positive instances that are correctly classified as positive |
| **False Positive Rate, False Alarm Rate** | FP/N | The proportion of negative instances that are erroneously classified as positive |
| **False Negative Rate** | FN/P | The proportion of positive instances that are erroneously classified as negative = 1 - True Positive Rate |
| **True Negative Rate** | TN/N | The proporion of negative instances that are correctly classified as negative |

| | | |
|---|---|---|
| **Precision, Positive Predicted Value** | TP/(TP + FP) | Proportion of instances classified as positive that are really positive |
| **F1 Score, Harmonic Mean** | (2 x Precision x Recall) / (Precision + Recall) | A measure combining Precision and Recal |
| **Accuracy, Predictive Accuracy** | (TP + TN) / (P + N) | The proportion of instances that are correctly classified |
| **Error Rate** | (FP + FN) / (P + N) | The proporion of instances that are incorrectly classified |

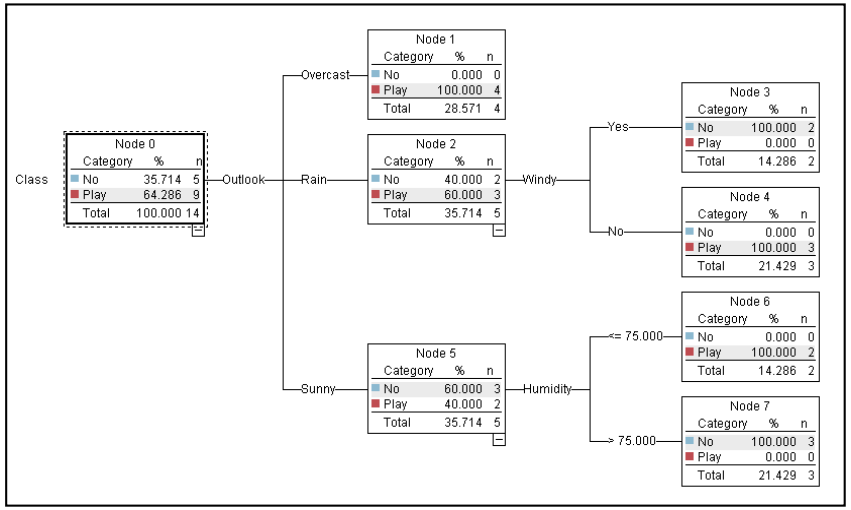
© 2016 SAP SE or an SAP affiliate company. All rights reserved.

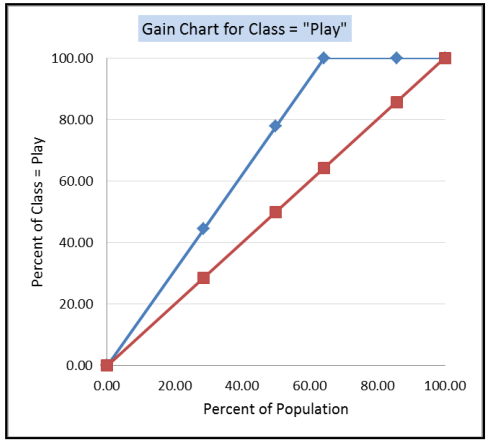
# Model Performance Metrics

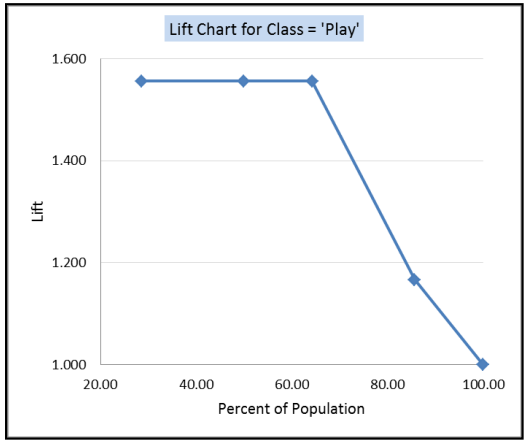
## Gains chart and lift chart – Classification tree example

| Scenario | Outlook | nperature | Humidity | Windy | Class | Predicted |
|---|---|---|---|---|---|---|
| 1 | Sunny | 75 | 70 | Yes | Play | Play |
| 2 | Sunny | 80 | 90 | Yes | No | No |
| 3 | Sunny | 85 | 85 | No | No | No |
| 4 | Sunny | 72 | 95 | No | No | No |
| 5 | Sunny | 69 | 70 | No | Play | Play |
| 6 | Overcast | 72 | 90 | Yes | Play | Play |
| 7 | Overcast | 83 | 78 | No | Play | Play |
| 8 | Overcast | 64 | 65 | Yes | Play | Play |
| 9 | Overcast | 81 | 75 | No | Play | Play |
| 10 | Rain | 71 | 80 | Yes | No | No |
| 11 | Rain | 65 | 70 | Yes | No | No |
| 12 | Rain | 75 | 80 | No | Play | Play |
| 13 | Rain | 68 | 80 | No | Play | Play |
| 14 | Rain | 70 | 96 | No | Play | Play |

| Tree Node | Class % of Bin | Play | No | Total | Cumulative Class | Cumulative Total | Cumulative % Total | Cumulative % Class | Base Line | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.00 | 0.00 | 0 | | | Lift |
| 1 | 100.00 | 4 | 0 | 4 | 4 | 4 | 28.57 | 44.44 | 28.57 | | 28.57 | 1.556 |
| 4 | 100.00 | 3 | 0 | 3 | 7 | 7 | 50.00 | 77.78 | 50.00 | | 50.00 | 1.556 |
| 6 | 100.00 | 2 | 0 | 2 | 9 | 9 | 64.29 | 100.00 | 64.29 | | 64.29 | 1.556 |
| 7 | 0.00 | 0 | 3 | 3 | 9 | 12 | 85.71 | 100.00 | 85.71 | | 85.71 | 1.167 |
| 3 | 0.00 | 0 | 2 | 2 | 9 | 14 | 100.00 | 100.00 | 100.00 | | 100.00 | 1.000 |
| Total | | 9 | 5 | 14 | | | | | | | | |



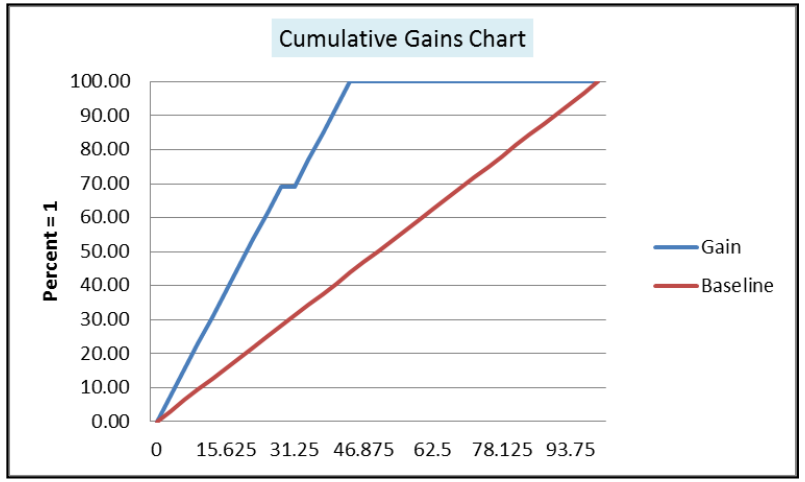



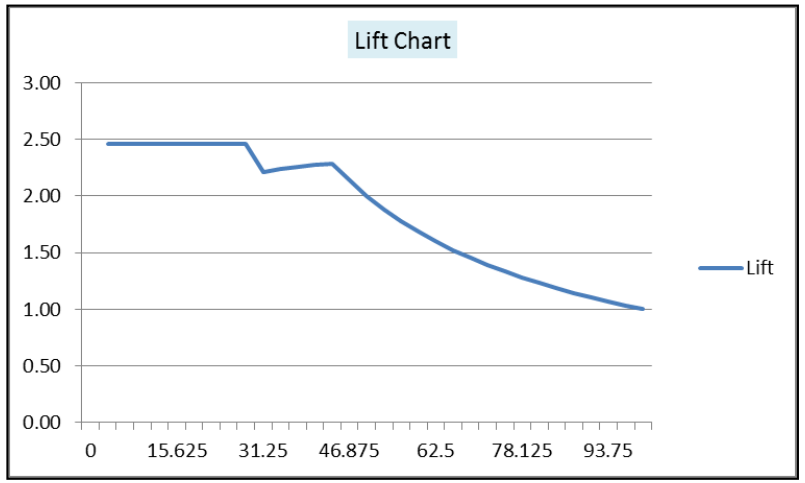

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Gains chart and lift chart – Logistic regression example

| Record ID | Fitted | Fitted Sorted | Actual | Cumulative Actual | Gain | Baseline | Lift |
|---|---|---|---|---|---|---|---|
| | | | | | 0.00 | 0 | |
| 0 | 0.8423 | 1.0000 | 1 | 1 | 7.69 | 3.125 | 2.46 |
| 1 | 0.4048 | 0.9995 | 1 | 2 | 15.38 | 6.25 | 2.46 |
| 2 | 0.9702 | 0.9983 | 1 | 3 | 23.08 | 9.375 | 2.46 |
| 3 | 0.0417 | 0.9964 | 1 | 4 | 30.77 | 12.5 | 2.46 |
| 4 | 0.0694 | 0.9924 | 1 | 5 | 38.46 | 15.625 | 2.46 |
| 5 | 0.0050 | 0.9702 | 1 | 6 | 46.15 | 18.75 | 2.46 |
| 6 | 0.2480 | 0.9700 | 1 | 7 | 53.85 | 21.875 | 2.46 |
| 7 | 0.0093 | 0.9437 | 1 | 8 | 61.54 | 25 | 2.46 |
| 8 | 0.0410 | 0.9434 | 1 | 9 | 69.23 | 28.125 | 2.46 |
| 9 | 0.0112 | 0.9211 | 0 | 9 | 69.23 | 31.25 | 2.22 |
| 10 | 0.0112 | 0.8960 | 1 | 10 | 76.92 | 34.375 | 2.24 |
| 11 | 0.0005 | 0.8423 | 1 | 11 | 84.62 | 37.5 | 2.26 |
| 12 | 0.0085 | 0.5857 | 1 | 12 | 92.31 | 40.625 | 2.27 |
| 13 | 0.0057 | 0.4048 | 1 | 13 | 100.00 | 43.75 | 2.29 |
| 14 | 0.0000 | 0.2480 | 0 | 13 | 100.00 | 46.875 | 2.13 |
| 15 | 0.0000 | 0.0694 | 0 | 13 | 100.00 | 50 | 2.00 |
| 16 | 0.0000 | 0.0417 | 0 | 13 | 100.00 | 53.125 | 1.88 |
| 17 | 0.9700 | 0.0410 | 0 | 13 | 100.00 | 56.25 | 1.78 |
| 18 | 0.9995 | 0.0359 | 0 | 13 | 100.00 | 59.375 | 1.68 |
| 19 | 0.9983 | 0.0304 | 0 | 13 | 100.00 | 62.5 | 1.60 |
| 20 | 0.9211 | 0.0155 | 0 | 13 | 100.00 | 65.625 | 1.52 |
| 21 | 0.0155 | 0.0112 | 0 | 13 | 100.00 | 68.75 | 1.45 |
| 22 | 0.0304 | 0.0112 | 0 | 13 | 100.00 | 71.875 | 1.39 |
| 23 | 0.0359 | 0.0093 | 0 | 13 | 100.00 | 75 | 1.33 |
| 24 | 0.0028 | 0.0085 | 0 | 13 | 100.00 | 78.125 | 1.28 |
| 25 | 0.9964 | 0.0057 | 0 | 13 | 100.00 | 81.25 | 1.23 |
| 26 | 0.9924 | 0.0050 | 0 | 13 | 100.00 | 84.375 | 1.19 |
| 27 | 1.0000 | 0.0028 | 0 | 13 | 100.00 | 87.5 | 1.14 |
| 28 | 0.9434 | 0.0005 | 0 | 13 | 100.00 | 90.625 | 1.10 |
| 29 | 0.9437 | 0.0000 | 0 | 13 | 100.00 | 93.75 | 1.07 |
| 30 | 0.8960 | 0.0000 | 0 | 13 | 100.00 | 96.875 | 1.03 |
| 31 | 0.5857 | 0.0000 | 0 | 13 | 100.00 | 100 | 1.00 |




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## ROC curve, sensitivity, and specificity


Churners are depicted in red

Non-churners are black

| | | Customers in the Top 30% | Customers not in the Top 30% | Total |
|---|---|---|---|---|
| Actual | Churner | **5** | **6** | **11** |
| | Non-Churner | **4** | **16** | **20** |
| Total | | **9** | **22** | **31** |

$$\text{Sensitivity (30\%)} = \frac{Number\ of\ churners\ in\ top\ 30\%}{Total\ number\ of\ churners} = \frac{5}{11} = 45\% = Detected\ (30\%)$$

$$\text{Specificity (30\%)} = \frac{\text{Number of non} - \text{churners not in top 30\%}}{\text{Total number of non} - \text{churners}} = \frac{16}{20} = 80\%$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## ROC curve, sensitivity, and specificity


2 Extreme cases :

| TOP 0% | | Customers in the Top 0% | Customers not in the Top 0% | Total |
|---|---|---|---|---|
| Actual | Churner | 0 | 11 | 11 |
| | Not Churner | 0 | 20 | 20 |
| Total | | 0 | 31 | 31 |

Sensitivity(0%) = 0
1-Specificity(0%) = 0

| TOP 100% | | Customers in the Top 100% | Customers not in the Top 100% | Total |
|---|---|---|---|---|
| Actual | Churner | 11 | 0 | 11 |
| | Not Churner | 20 | 0 | 20 |
| Total | | 31 | 0 | 31 |

Sensitivity(100%) = 1
1-Specificity(0%) = 1

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models

If we use the following notation:

- Target (response value): $y_i$
- Predictor (predictor response value): $\hat{y}_i$
- Residual: $r_t = y_t - \hat{y}_1$
- Error: $u_i = |y_i - \hat{y}_1| = |r_i|$
- Weight of the tested observation: $w_i$
- Total weight of the population:

$$W = \sum_{i=1}^{n} w_i$$

- Target average:

$$\bar{y} = \frac{1}{W} \sum_{i=1}^{N} w_i y_i$$

- Predictor average:

$$\bar{y} = \frac{1}{W} \sum_{i=1}^{N} w_i \hat{y}_i$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models – Mean absolute error (L1)

- Definition: mean of the absolute values of the differences between predictions and actual results (city block distance or Manhattan distance)

- Formula:

$$L1 = \frac{1}{W} \sum_{i=1}^{N} w_i \, u_i$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models – Mean square error (L2)

- Definition: square root of the mean of the quadratic errors (Euclidian distance or root mean squared error – RMSE)

- Formula:

$$MSE = \frac{SSE_w}{W} = \frac{1}{W}\sum_{i=1}^{N} w_i u_i^2$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models – Maximum error (Linf)

- Definition: maximum absolute difference between predicted and actual values (upper bound) (Chebyshev distance)

- Formula:

$$L\infty = \max_i u_i$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Performance Metrics

## Success criteria for regression models – Coefficient of determination (R2)

- Definition: ratio between the variability (sum of squares) of the prediction and the variability (sum of squares) of the data.

- Formula:

$$SSR = \sum_{i=1}^{N} W_i(\hat{y}_u - \bar{y})^2$$

$$SST = \sum_{i=1}^{N} w_i(y_i - \bar{y})^2$$

$$R2 = \frac{SSR}{SST}$$

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# © 2016 SAP SE or an SAP affiliate company. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP SE or an SAP affiliate company.

SAP and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP SE (or an SAP affiliate company) in Germany and other countries. Please see http://global12.sap.com/corporate-en/legal/copyright/index.epx for additional trademark information and notices.

Some software products marketed by SAP SE and its distributors contain proprietary software components of other software vendors.

National product specifications may vary.

These materials are provided by SAP SE or an SAP affiliate company for informational purposes only, without representation or warranty of any kind, and SAP SE or its affiliated companies shall not be liable for errors or omissions with respect to the materials. The only warranties for SAP SE or SAP affiliate company products and services are those that are set forth in the express warranty statements accompanying such products and services, if any. Nothing herein should be construed as constituting an additional warranty.

In particular, SAP SE or its affiliated companies have no obligation to pursue any course of business outlined in this document or any related presentation, or to develop or release any functionality mentioned therein. This document, or any related presentation, and SAP SE's or its affiliated companies' strategy and possible future developments, products, and/or platform directions and functionality are all subject to change and may be changed by SAP SE or its affiliated companies at any time for any reason without notice. The information in this document is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. All forward-looking statements are subject to various risks and uncertainties that could cause actual results to differ materially from expectations. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates, and they should not be relied upon in making purchasing decisions.

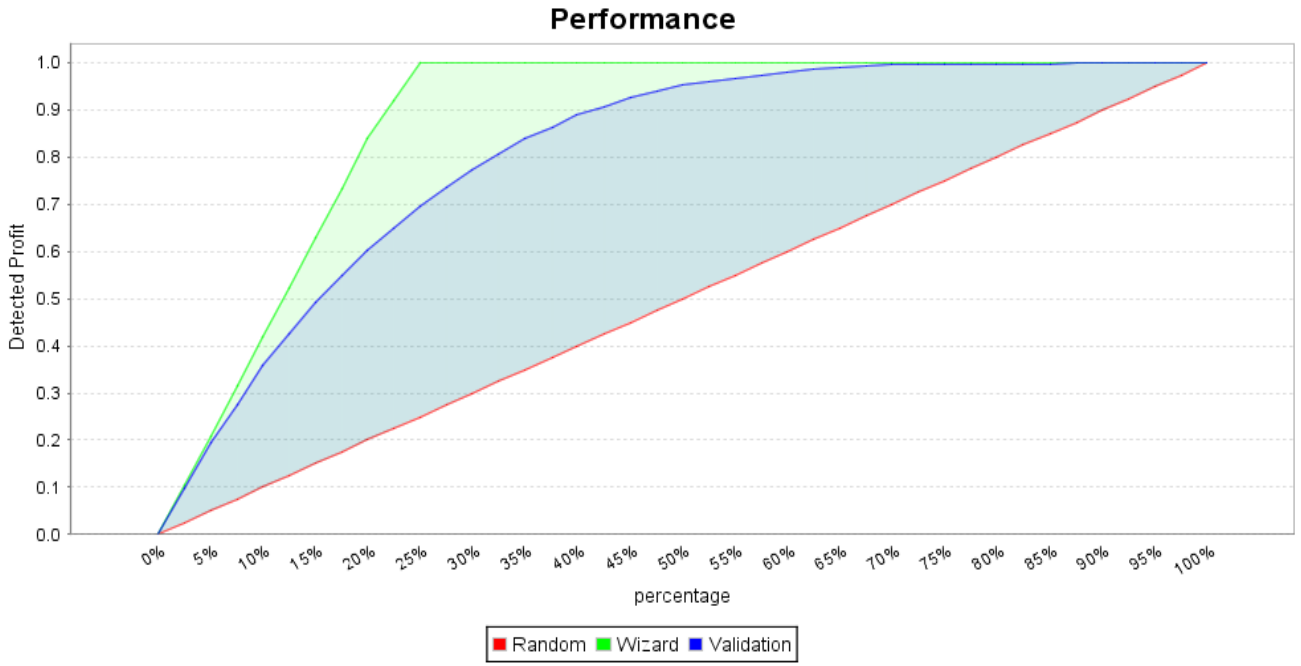
# Week 5 Unit 3: **Model Testing**

openSAP
open.sap.com

# Model Testing

## Introduction – Gains charts, lift charts, and decile tables

To test the strength of classification models, many data scientists use lift charts and decile tables, which measure the performance of the model against random guessing, or what the results would be if you didn't use any model.




| percentage | Random | Wizard | Validation | Estimation |
|---|---|---|---|---|
| **0%** | 0.00 | 0.00 | 0.00 | 0.00 |
| **5%** | 0.05 | 0.21 | 0.20 | 0.20 |
| **10%** | 0.10 | 0.42 | 0.36 | 0.36 |
| **15%** | 0.15 | 0.63 | 0.49 | 0.50 |
| **20%** | 0.20 | 0.84 | 0.60 | 0.61 |
| **25%** | 0.25 | 1.00 | 0.70 | 0.70 |
| **30%** | 0.30 | 1.00 | 0.77 | 0.77 |
| **35%** | 0.35 | 1.00 | 0.84 | 0.84 |
| **40%** | 0.40 | 1.00 | 0.89 | 0.89 |
| **45%** | 0.45 | 1.00 | 0.93 | 0.93 |
| **50%** | 0.50 | 1.00 | 0.95 | 0.95 |
| **55%** | 0.55 | 1.00 | 0.97 | 0.97 |
| **60%** | 0.60 | 1.00 | 0.98 | 0.98 |
| **65%** | 0.65 | 1.00 | 0.99 | 0.99 |
| **70%** | 0.70 | 1.00 | 1.00 | 0.99 |
| **75%** | 0.75 | 1.00 | 1.00 | 1.00 |
| **80%** | 0.80 | 1.00 | 1.00 | 1.00 |
| **85%** | 0.85 | 1.00 | 1.00 | 1.00 |
| **90%** | 0.90 | 1.00 | 1.00 | 1.00 |
| **95%** | 0.95 | 1.00 | 1.00 | 1.00 |
| **100%** | 1.00 | 1.00 | 1.00 | 1.00 |

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Testing

## Direct mailing example

- Last year, a company sent out a mail campaign, without using a predictive model, to 10,000 customers.
- It cost the company $1 for each item mailed.
- The response rate was 20% (there were 2,000 positive responses).

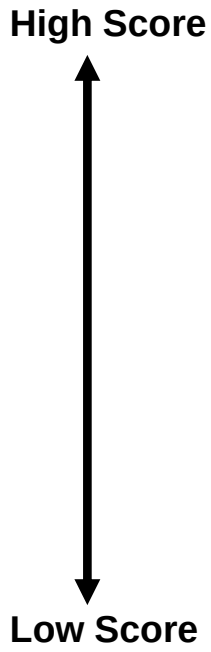
| *Total Customers Contacted* | *Positive Responses* | *Cost ($)* |
|---|---|---|
| 10000 | 2000 | 10000 |

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Testing

## Direct mailing example

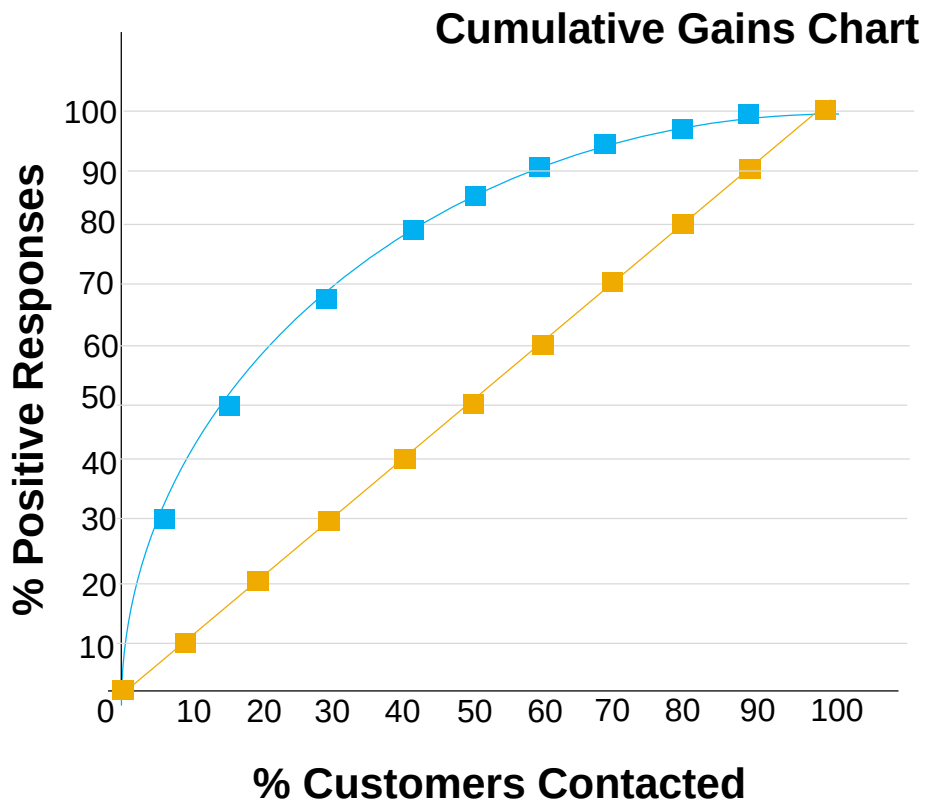
| Decile | Total Customers Contacted | Positive Responses per decile | Cumulative Positive Responses | Cost ($) to contact |
|---|---|---|---|---|
| 1 | 1000 | 600 | 600 | 1000 |
| 2 | 2000 | 400 | 1000 | 2000 |
| 3 | 3000 | 300 | 1300 | 3000 |
| 4 | 4000 | 280 | 1580 | 4000 |
| 5 | 5000 | 120 | 1700 | 5000 |
| 6 | 6000 | 100 | 1800 | 6000 |
| 7 | 7000 | 80 | 1880 | 7000 |
| 8 | 8000 | 60 | 1940 | 8000 |
| 9 | 9000 | 40 | 1980 | 9000 |
| 10 | 10000 | 20 | 2000 | 10000 |




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Testing

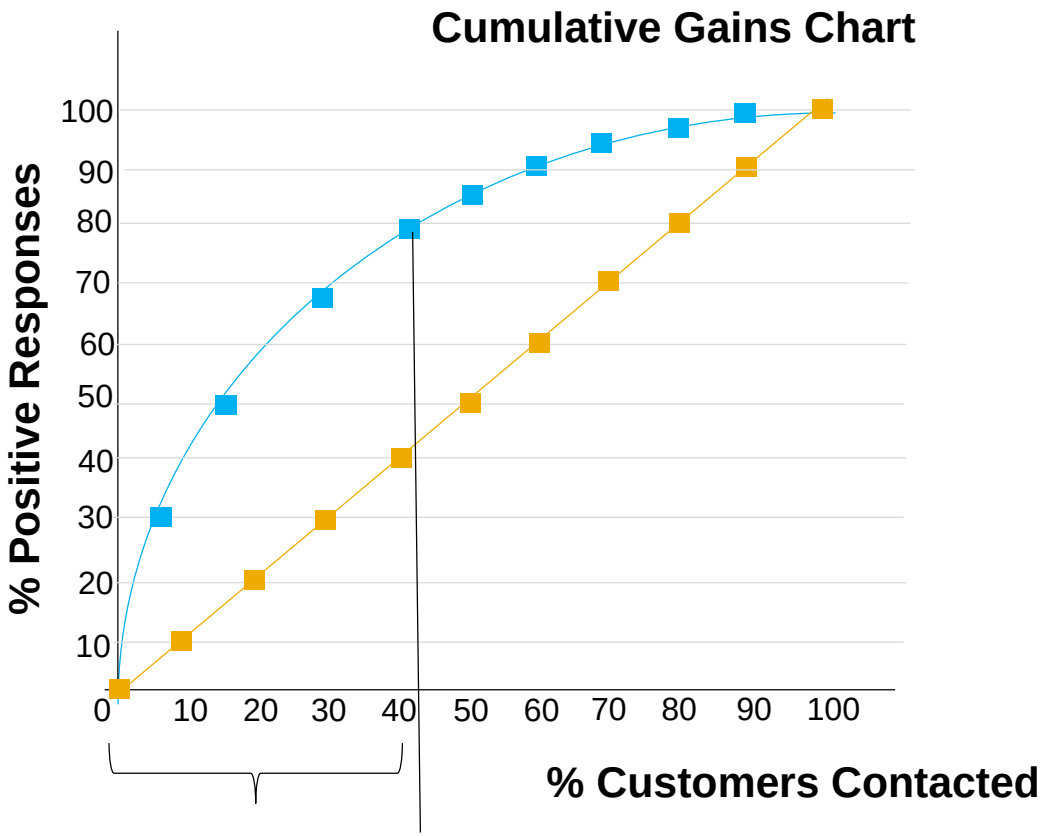
## Direct mailing example – Cumulative gains chart



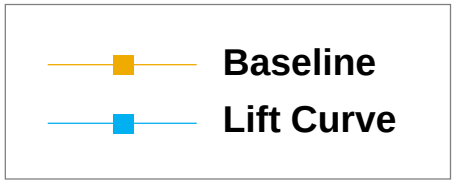

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Testing

## Direct mailing example – Cumulative gains chart




Top 40% of customers **with the highest model scores**



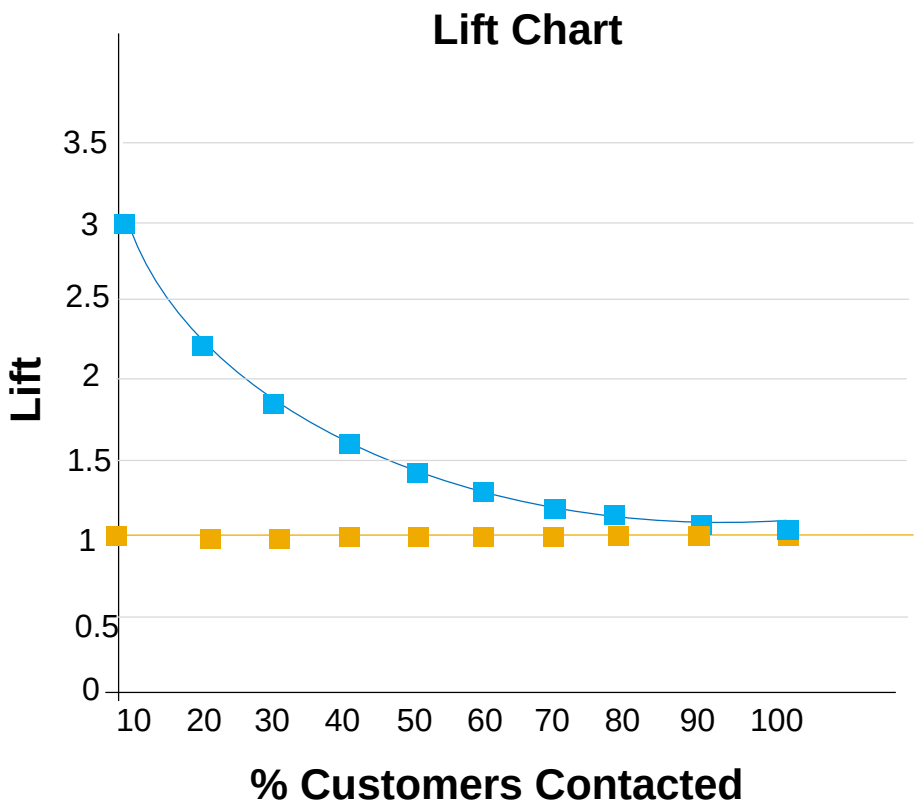

| Decile | Total Customers Contacted | Positive Responses per decile | Cumulative Positive Responses | Cost ($) to contact |
|---|---|---|---|---|
| 1 | 1000 | 600 | 600 | 1000 |
| 2 | 2000 | 400 | 1000 | 2000 |
| 3 | 3000 | 300 | 1300 | 3000 |
| 4 | 4000 | 280 | 1580 | 4000 |
| 5 | 5000 | 120 | 1700 | 5000 |
| 6 | 6000 | 100 | 1800 | 6000 |
| 7 | 7000 | 80 | 1880 | 7000 |
| 8 | 8000 | 60 | 1940 | 8000 |
| 9 | 9000 | 40 | 1980 | 9000 |
| 10 | 10000 | 20 | 2000 | 10000 |

**Decile Table**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Model Testing

## Direct mailing example – Lift chart




© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Thank you

**Contact information:**

**open@sap.com**

openSAP
open.sap.com

# © 2016 SAP SE or an SAP affiliate company. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP SE or an SAP affiliate company.

SAP and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP SE (or an SAP affiliate company) in Germany and other countries. Please see http://global12.sap.com/corporate-en/legal/copyright/index.epx for additional trademark information and notices.

Some software products marketed by SAP SE and its distributors contain proprietary software components of other software vendors.

National product specifications may vary.

These materials are provided by SAP SE or an SAP affiliate company for informational purposes only, without representation or warranty of any kind, and SAP SE or its affiliated companies shall not be liable for errors or omissions with respect to the materials. The only warranties for SAP SE or SAP affiliate company products and services are those that are set forth in the express warranty statements accompanying such products and services, if any. Nothing herein should be construed as constituting an additional warranty.

In particular, SAP SE or its affiliated companies have no obligation to pursue any course of business outlined in this document or any related presentation, or to develop or release any functionality mentioned therein. This document, or any related presentation, and SAP SE's or its affiliated companies' strategy and possible future developments, products, and/or platform directions and functionality are all subject to change and may be changed by SAP SE or its affiliated companies at any time for any reason without notice. The information in this document is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. All forward-looking statements are subject to various risks and uncertainties that could cause actual results to differ materially from expectations. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates, and they should not be relied upon in making purchasing decisions.

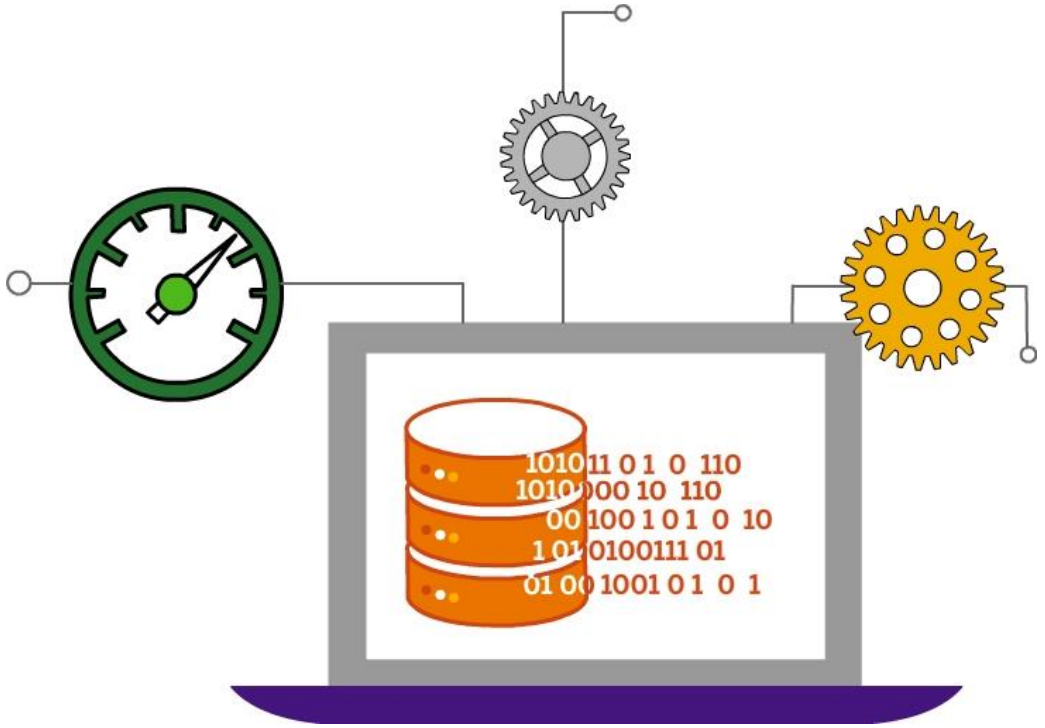
# Week 5 Unit 4: **Improving Model Performance**

SAP

openSAP
open.sap.com

# Improving Model Performance

## Add more data

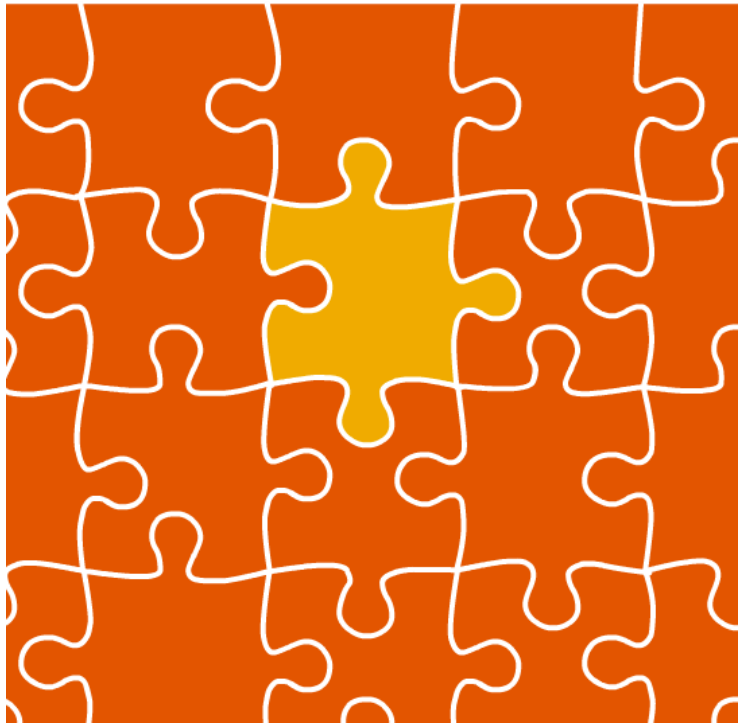


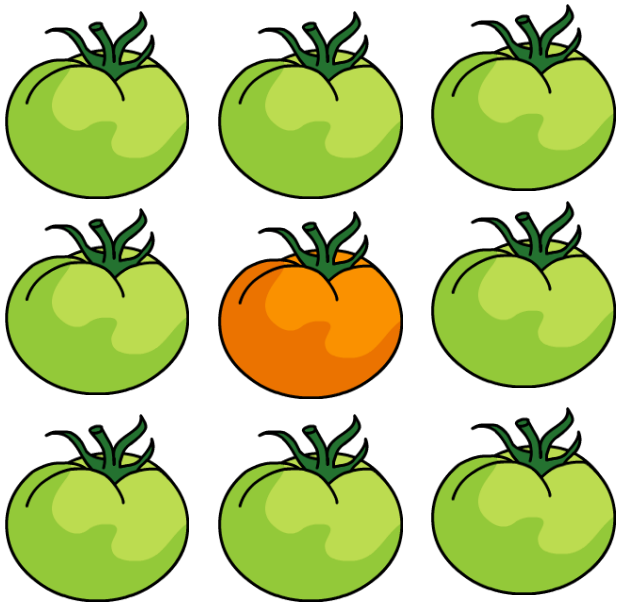
**more data = more accurate models**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Improve data quality – Missing values and outliers



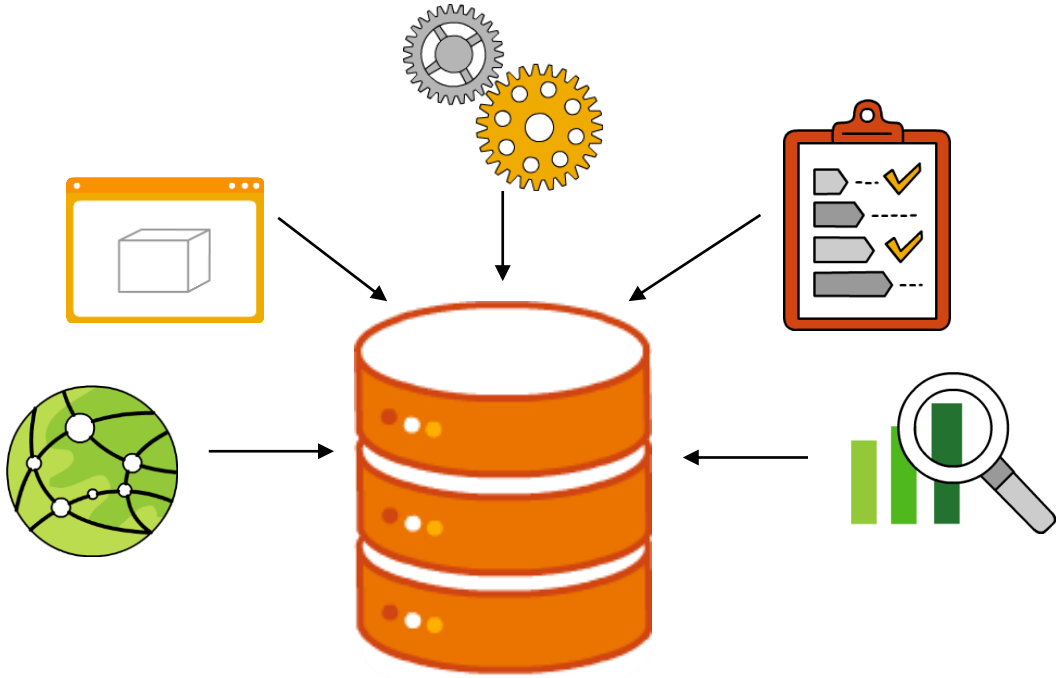


**Missing and outlier values in training data can reduce accuracy**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Feature engineering



**Creating new features can improve accuracy**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Feature selection

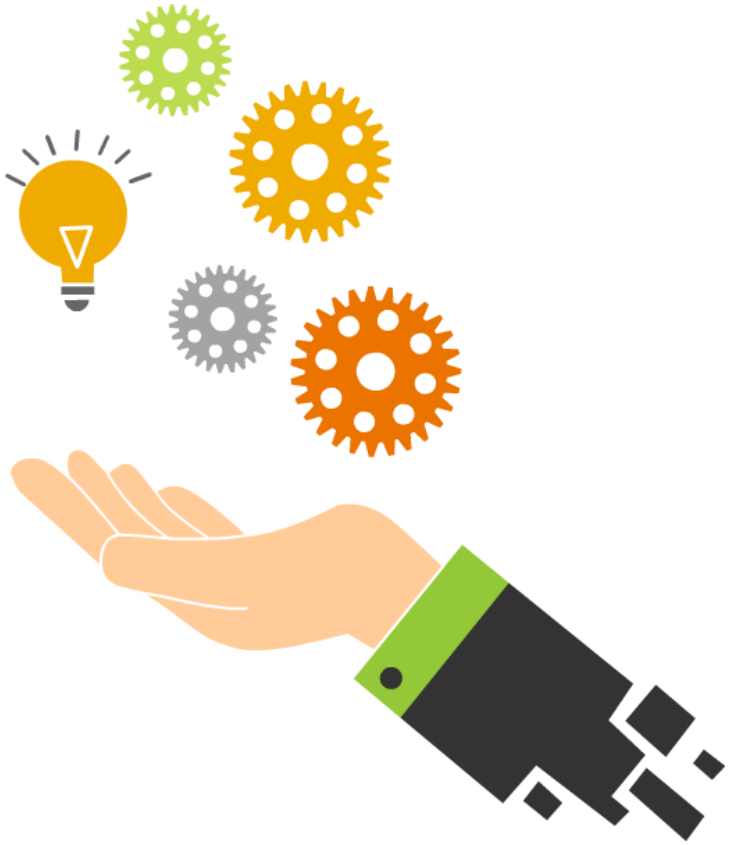
**Find the explanatory variables that best explain the target**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Using multiple algorithms

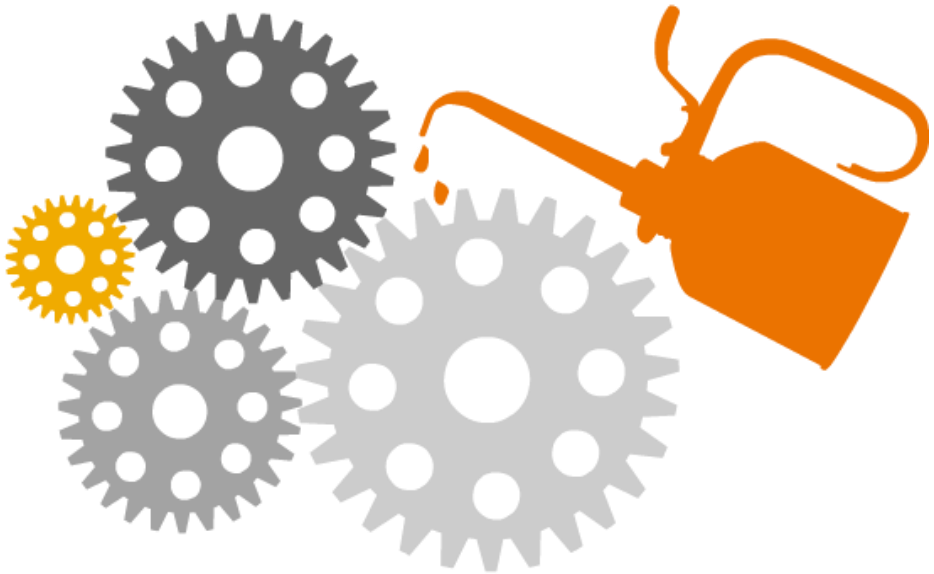
**Multiple algorithms might increase accuracy**



© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Algorithm tuning

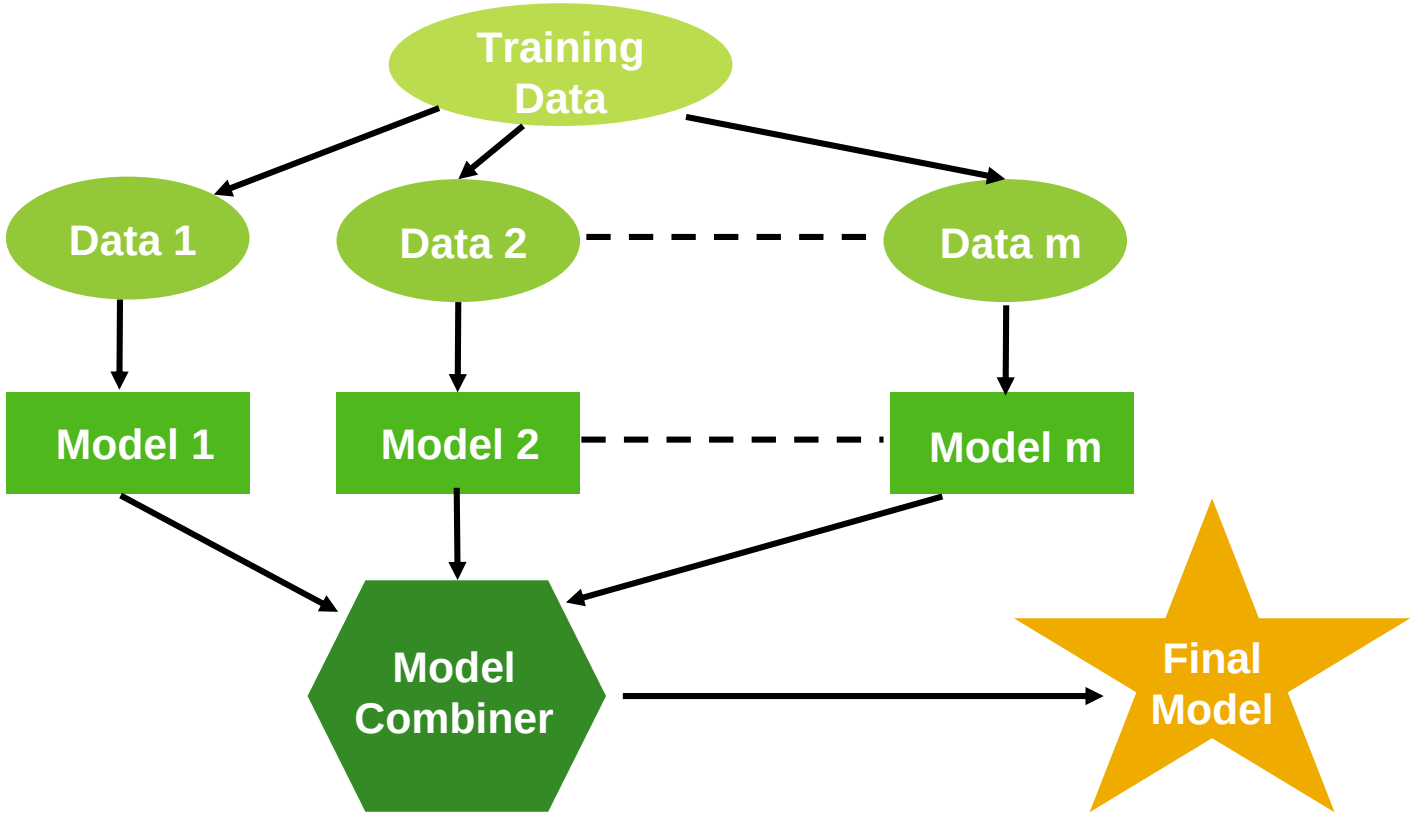


**Find the optimum value for each parameter to improve accuracy**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Ensemble methods

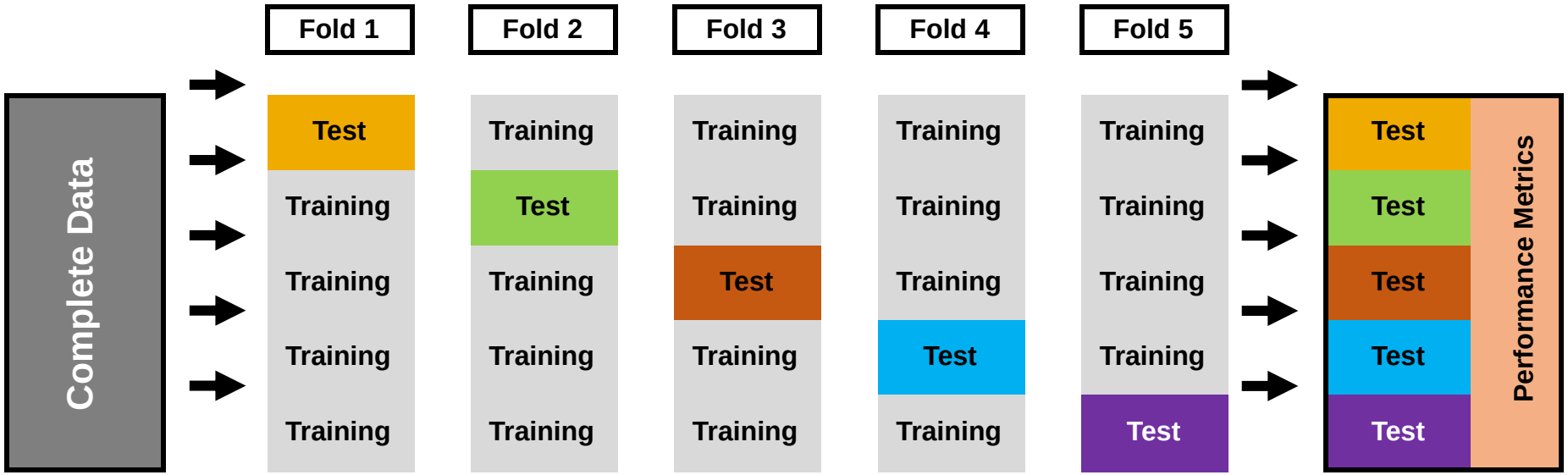



**Ensemble methods can improve accuracy and robustness**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Improving Model Performance

## Cross-validation




**Cross-validation assesses how the model will generalize**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

# Thank you

**Contact information:**

**open@sap.com**

openSAP
open.sap.com

# © 2016 SAP SE or an SAP affiliate company. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP SE or an SAP affiliate company.

SAP and other SAP products and services mentioned herein as well as their respective logos are trademarks or registered trademarks of SAP SE (or an SAP affiliate company) in Germany and other countries. Please see http://global12.sap.com/corporate-en/legal/copyright/index.epx for additional trademark information and notices.

Some software products marketed by SAP SE and its distributors contain proprietary software components of other software vendors.

National product specifications may vary.

These materials are provided by SAP SE or an SAP affiliate company for informational purposes only, without representation or warranty of any kind, and SAP SE or its affiliated companies shall not be liable for errors or omissions with respect to the materials. The only warranties for SAP SE or SAP affiliate company products and services are those that are set forth in the express warranty statements accompanying such products and services, if any. Nothing herein should be construed as constituting an additional warranty.

In particular, SAP SE or its affiliated companies have no obligation to pursue any course of business outlined in this document or any related presentation, or to develop or release any functionality mentioned therein. This document, or any related presentation, and SAP SE's or its affiliated companies' strategy and possible future developments, products, and/or platform directions and functionality are all subject to change and may be changed by SAP SE or its affiliated companies at any time for any reason without notice. The information in this document is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. All forward-looking statements are subject to various risks and uncertainties that could cause actual results to differ materially from expectations. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates, and they should not be relied upon in making purchasing decisions.