Business requirements

MACHINE LEARNING FOR BUSINESS

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Scoping business needs

1. What is the business **situation**?
   - *The company plans to expand to new markets*
2. What is the business **opportunity** and how big is it?
   - *Identify the right markets with the biggest demand*
3. What are the business **actions** we will take?
   - *Prioritize and invest more in the markets with higher predicted demand*

Business scope - fraud example

1. **Situation** - The fraud rate has started increasing
2. **Opportunity** - Reduce fraud rate by X %, resulting in Y USD savings
3. **Action** - Work on improving fraud detection system, reduce fraud drivers, and manually review transactions at risk

Business scope - churn example

1. **Situation** - The customers started to churn more
2. **Opportunity** - Reduce churn rate by X %, resulting in Y USD revenue saved
3. **Action** - Work on identifying and improving churn drivers (website errors, too much/little advertising, customer service issues etc.); identify customers at risk and introduce retention campaigns

Business situation - asking the right question

Always **start with inference questions**

> Why has churn started increasing?

> Which information indicates a potential transaction fraud?

> How are our most valuable customers different from others?

Build on inference question to **define prediction questions**

> Can we identify customers at risk of churning?

> Can we flag potentially risky transactions?

> Can we predict early on which customers are likely to become highly valuable?

Business opportunity

Would you spend 1 million USD to earn extra 5000 USD each year? (~200 year return on investment)

- **Size** up the opportunity
- Once you know the drivers of the outcome, how much will it **cost** changing them, and what will be the value of doing that?
- Finally, how do you know if you can **affect** the predicted outcome? (**hint** - experiments, experiments, and more experiments)

Actionable machine learning

*Finally, how do you know if you can **affect** the predicted outcome? (hint - experiments, experiments, and more experiments)*

- First, look at historical levels (churn, fraud, # of high value customers)
- Run experiments e.g. target customers at risk with a discount, manually review top 10% riskiest transactions. Repeat experiments multiple times, see if you get a repeated pattern of desired results
- **If yes**, use that to calculate opportunity and make decision if it's a worthwhile investment
- **If no** - 1) collect more data, 2) qualitative research, 3) narrow down business question

Let's practice!

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Model training

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Modeling dataset

Input A	Input B	Input ... X	Target Y

Full dataset

Input A	Input B	Input ... X	Target Y

Splitting data for training

Input A	Input B	Input ... X	Target Y

Randomly sampled dataset for model **training**

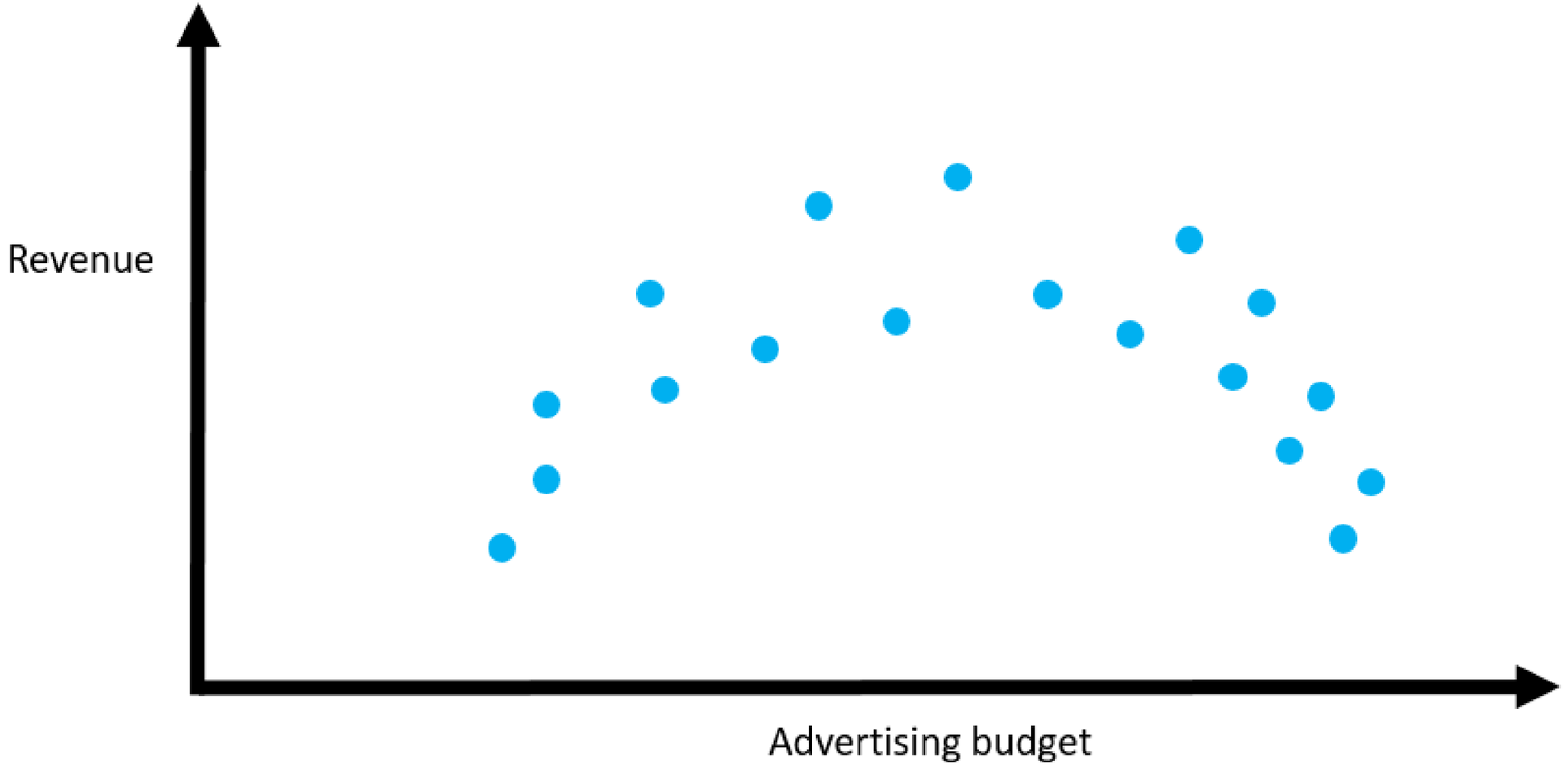
Test

Input A	Input B	Input ... X	Target Y

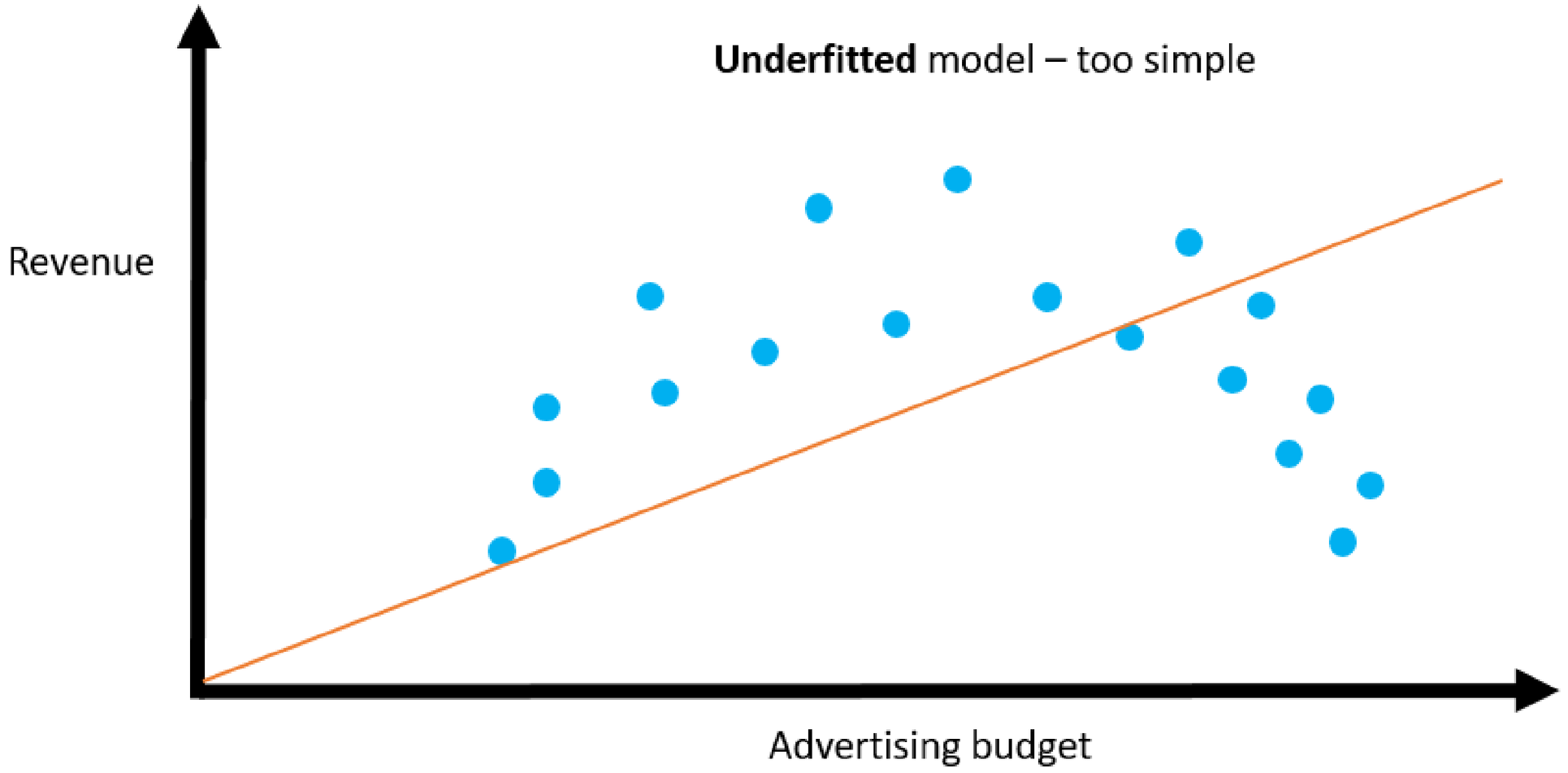
Randomly sampled dataset
for model **training**

Randomly sampled dataset
for model **performance** measurement

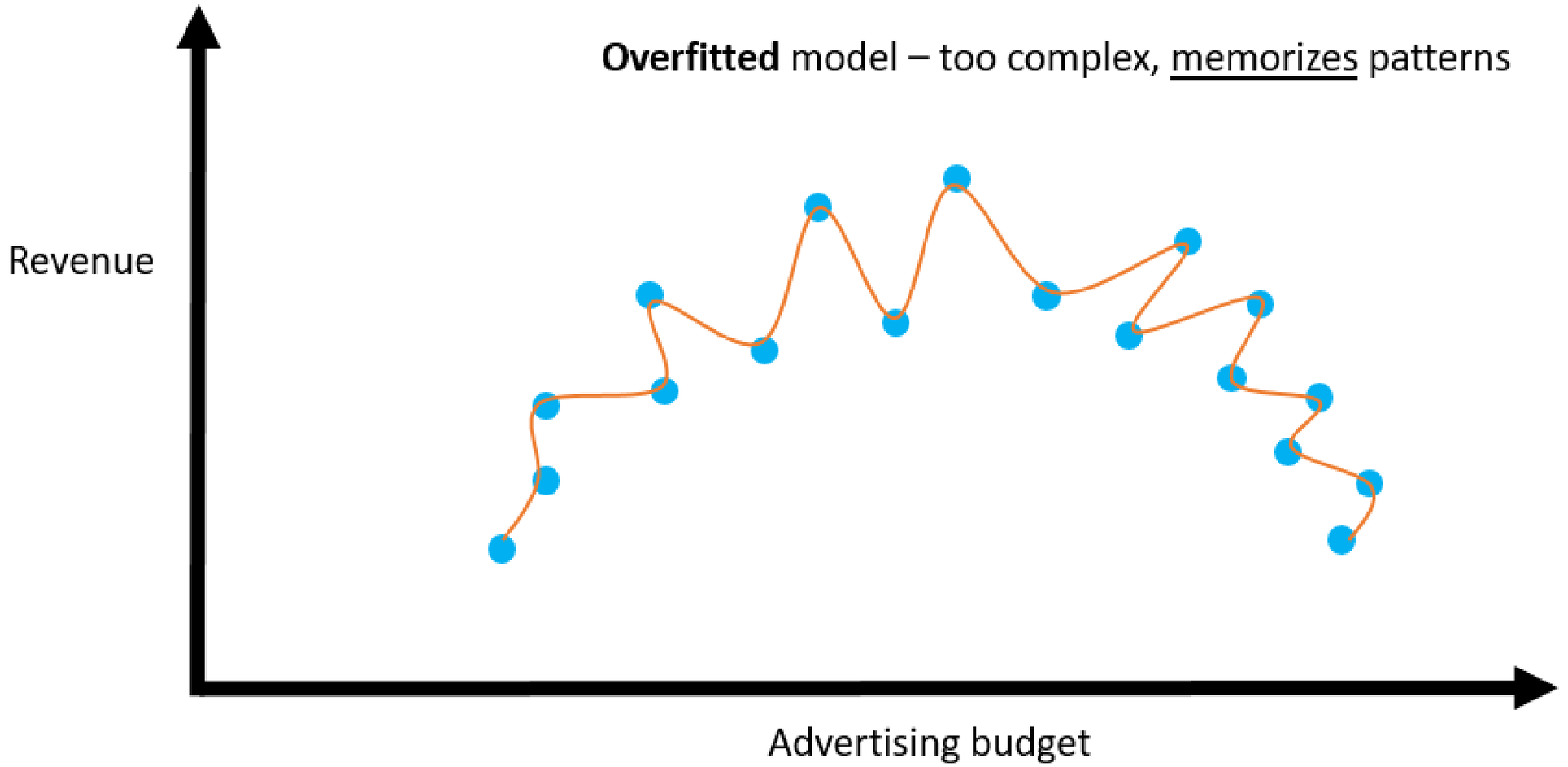
Overfitting and underfitting



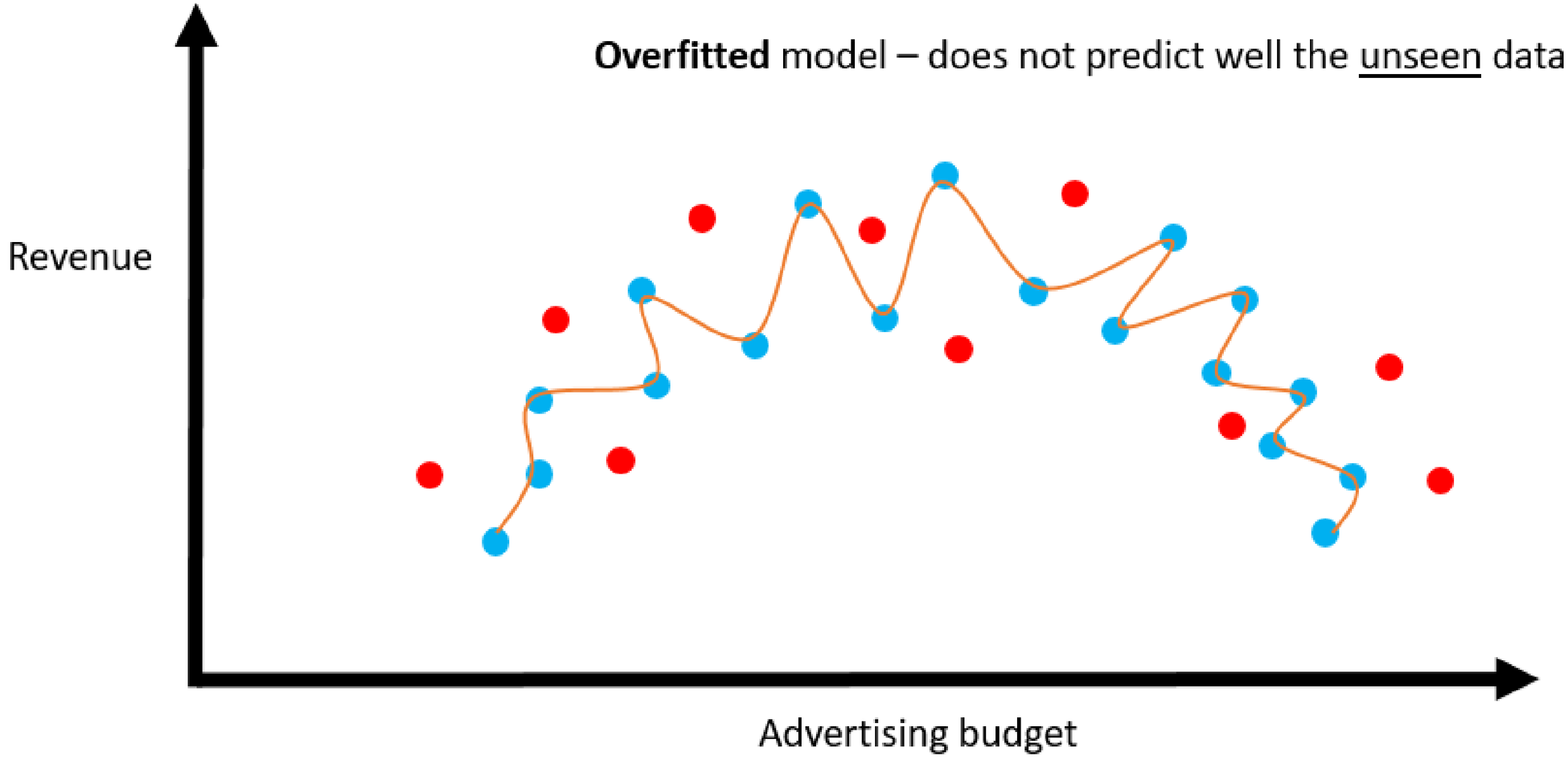
Underfitting



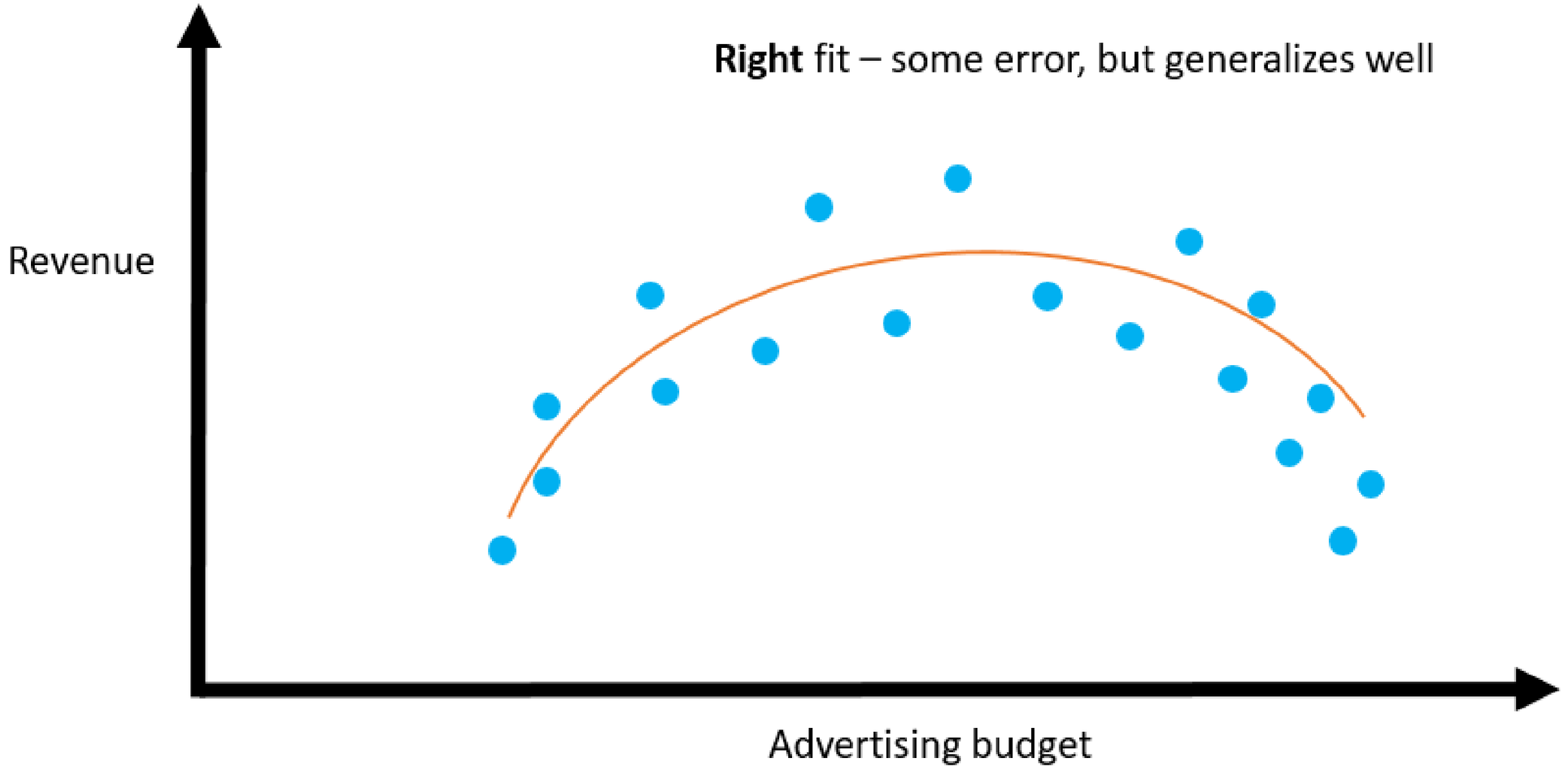
Overfitting 1



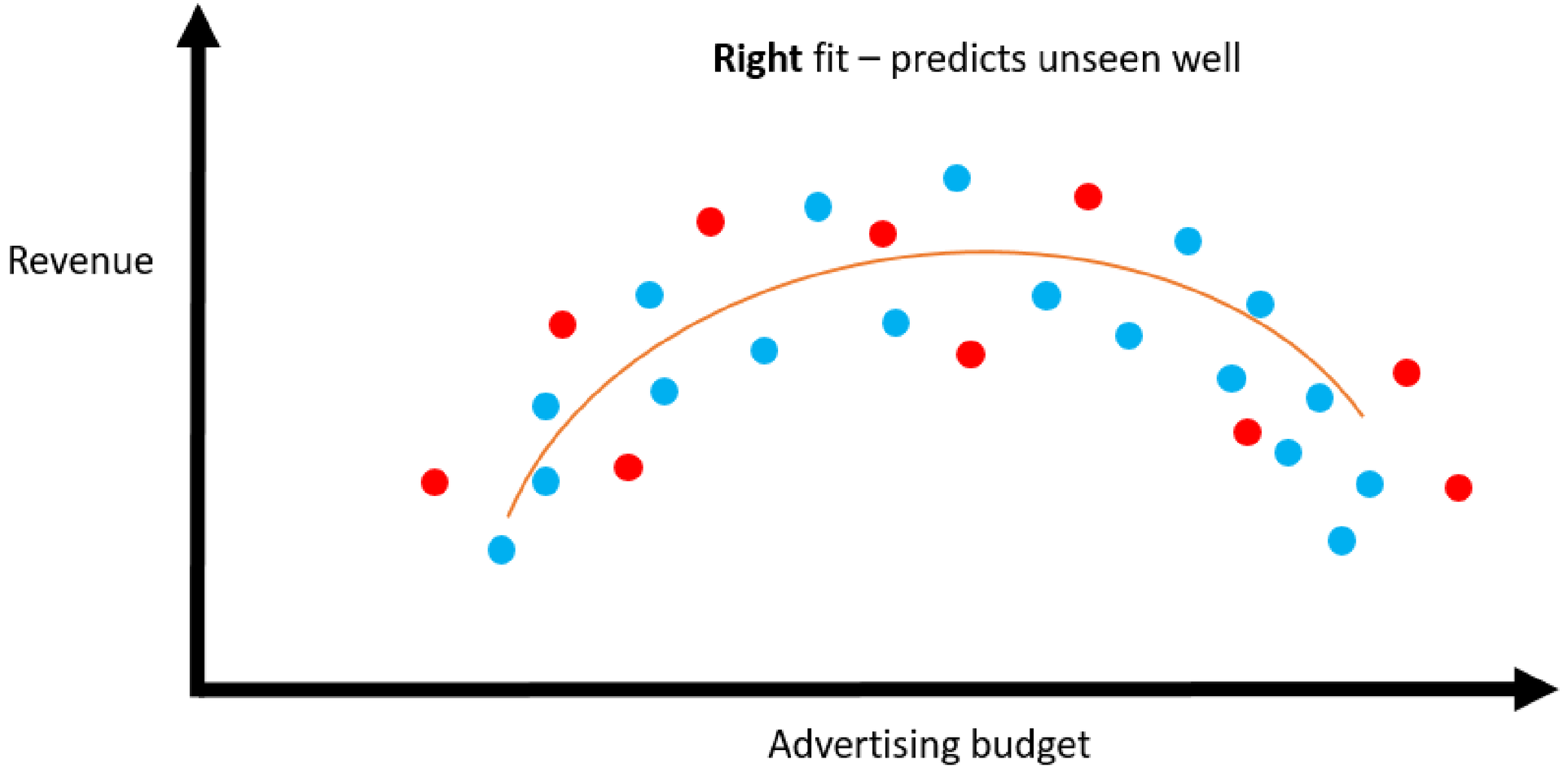
Overfitting 2



Right model fit 1



Right model fit 2



Model training

Input A	Input B	Input ... X	Target Y

Build a model which learns the rules How to use **inputs A, B ... X to** predict **target Y**

Assess model performance on test

Input A	Input B	Input ... X	Target Y

Build a model which learns the rules How to use **inputs A, B ... X to** predict **target Y**

Measure model performance on unseen **test** data

Try a few models

Input A	Input B	Input ... X	Target Y

Build a model which learns the rules How to use **inputs A, B ... X to** predict **target Y**

Repeat until the best model is found

Measure model performance on unseen **test** data

Let's practice!

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Model performance measurement

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Performance measurement types

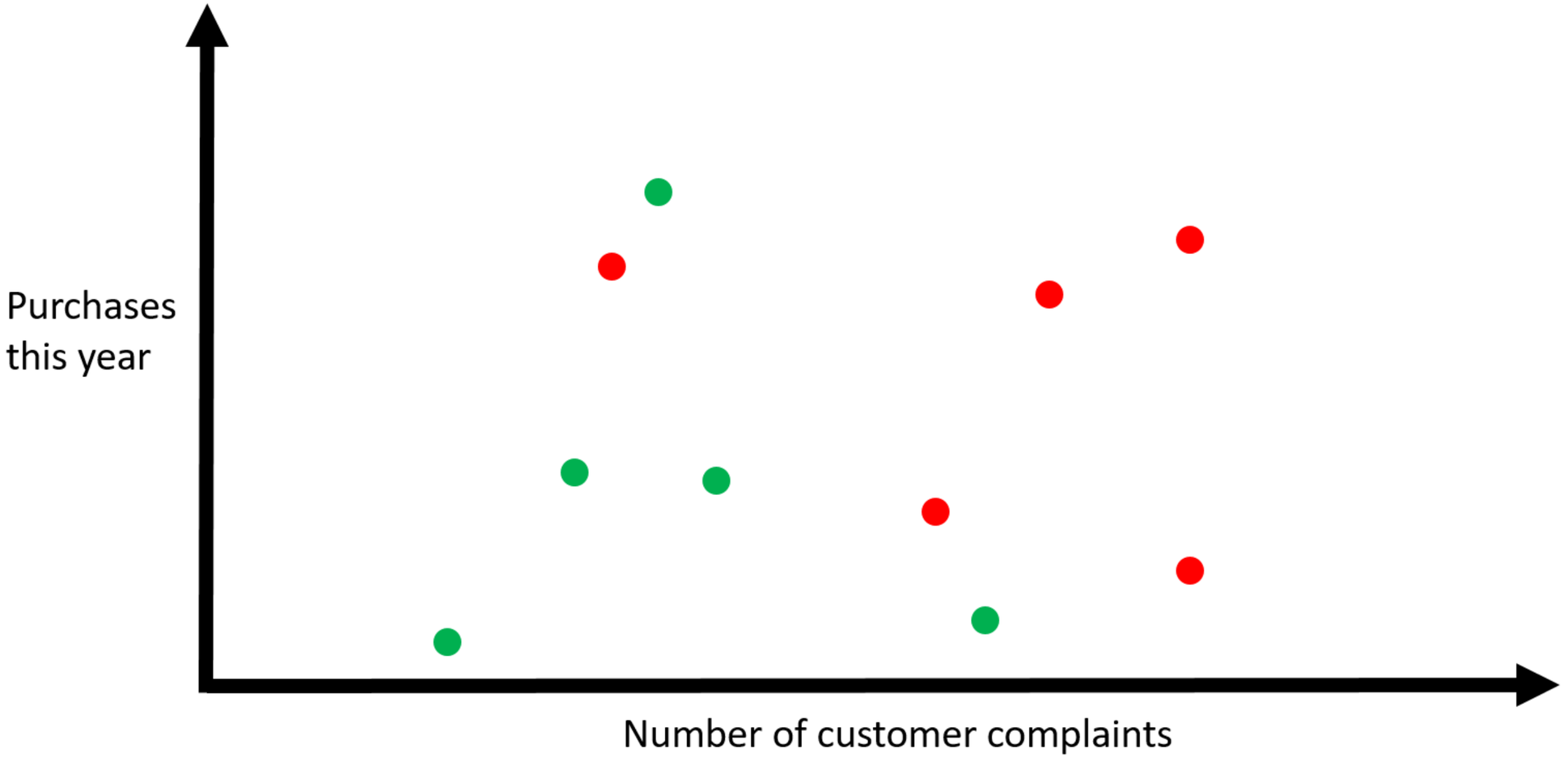
Two key supervised learning metrics:

1. **Accuracy** --> classification
2. **Error** --> regression

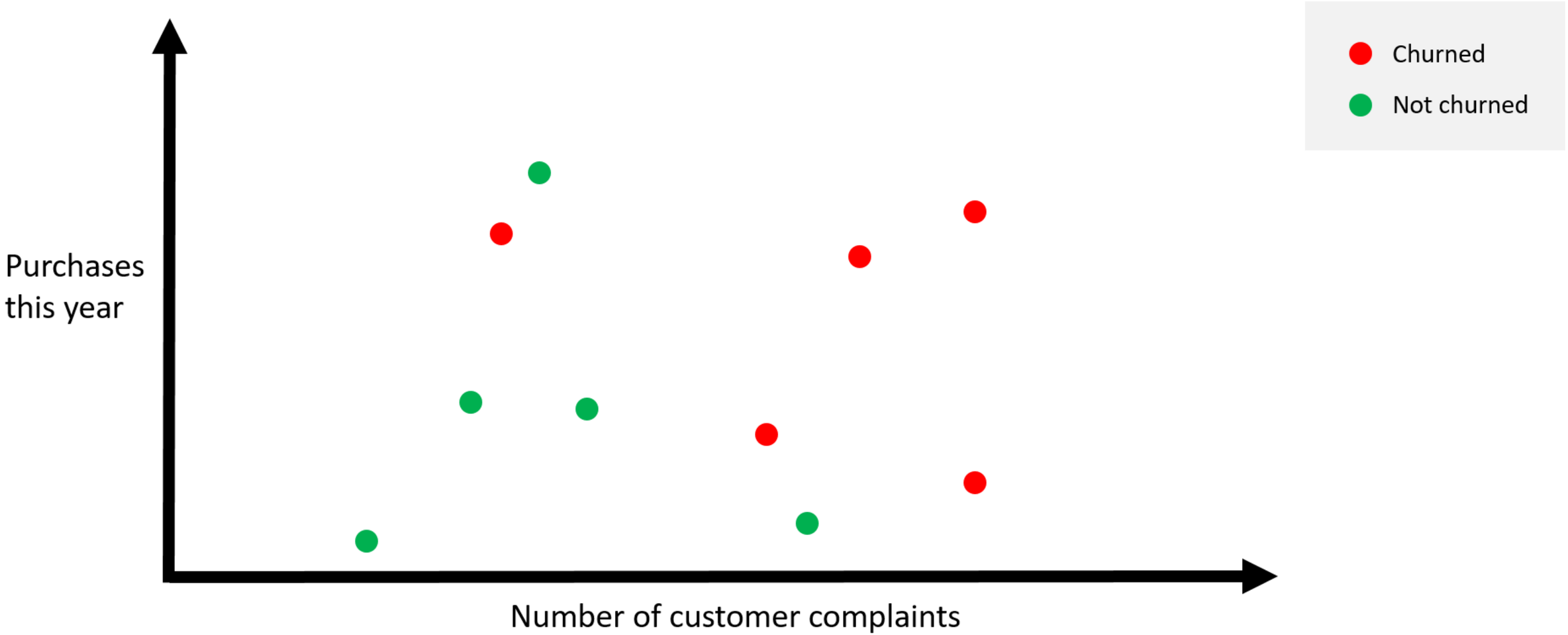
Classification performance

- Accuracy
- Recall
- Precision

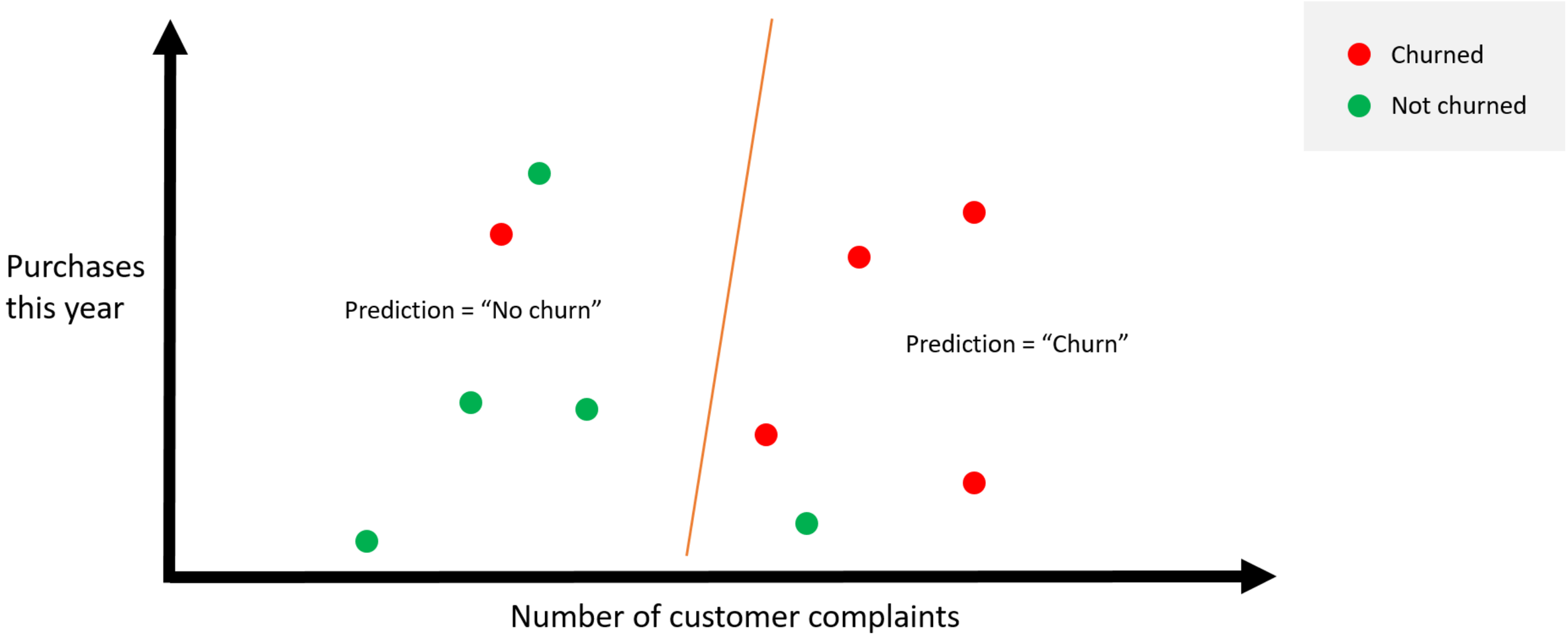
Churn example



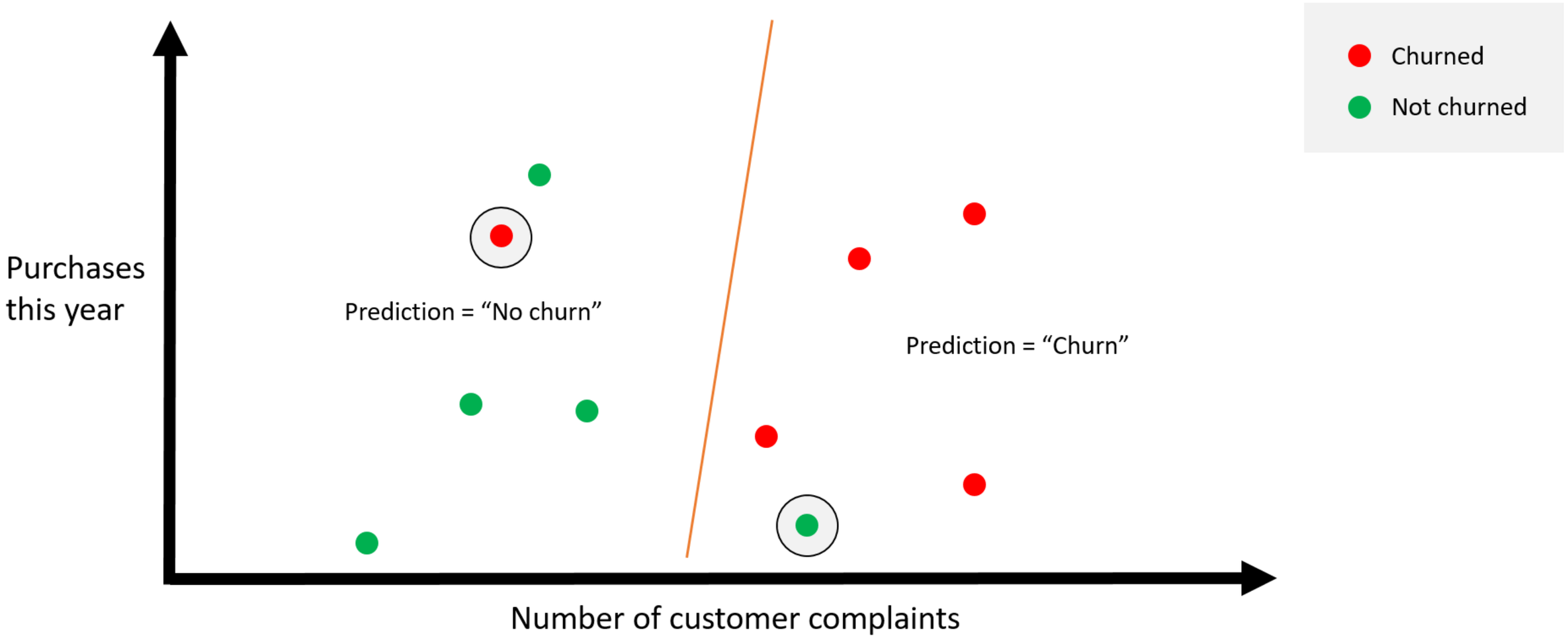
Churn example



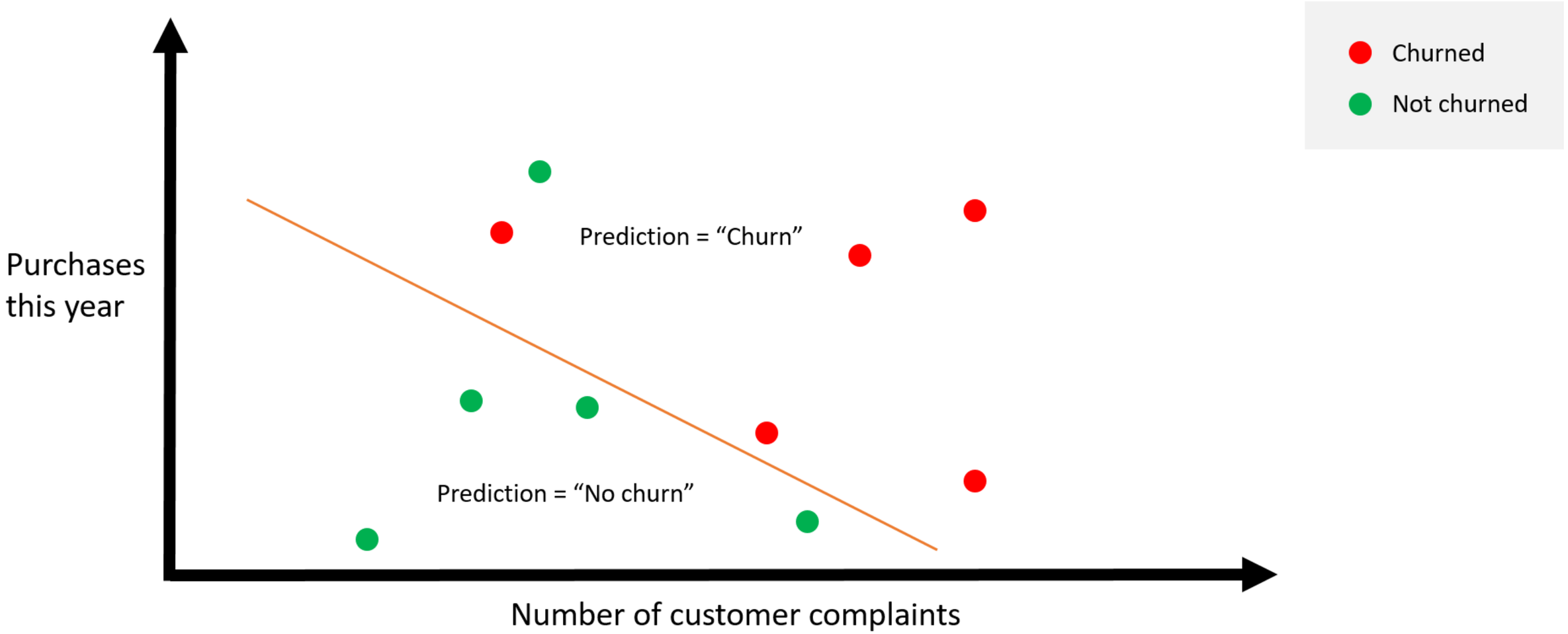
Churn prediction



Mis-classified items

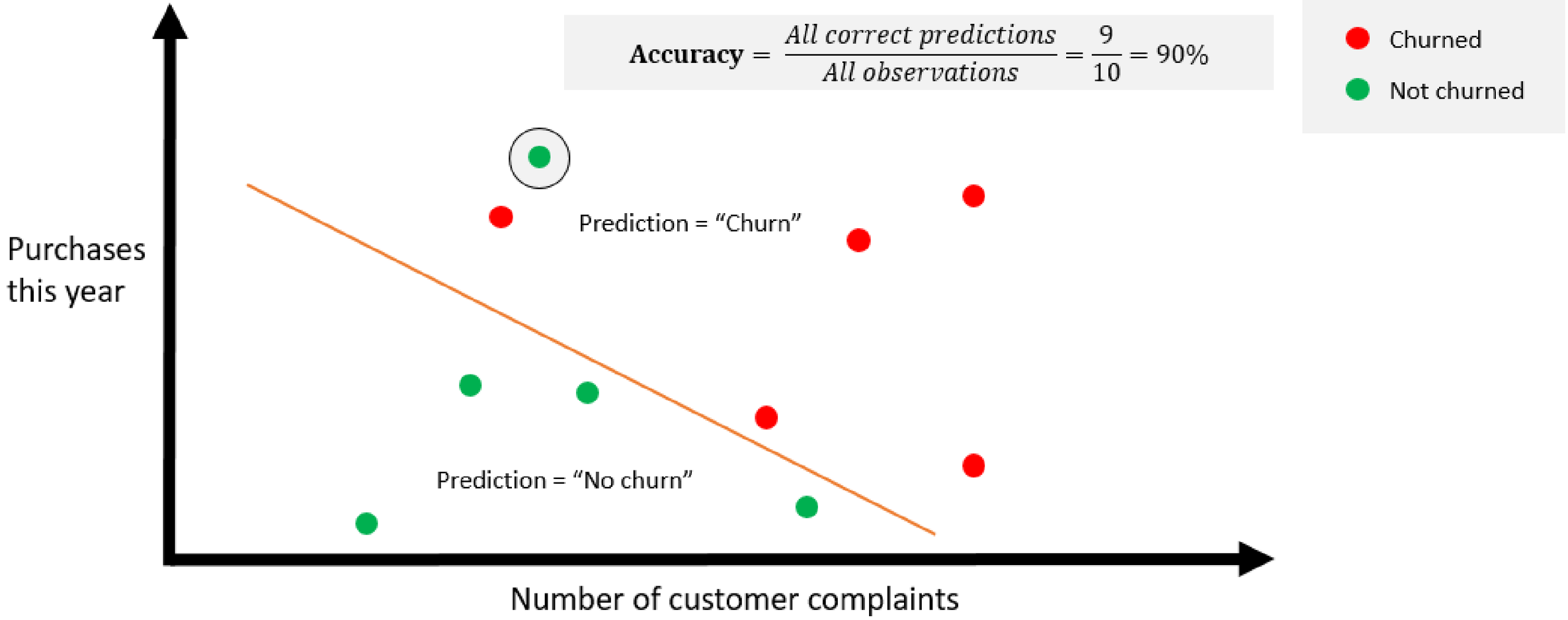


Another churn prediction



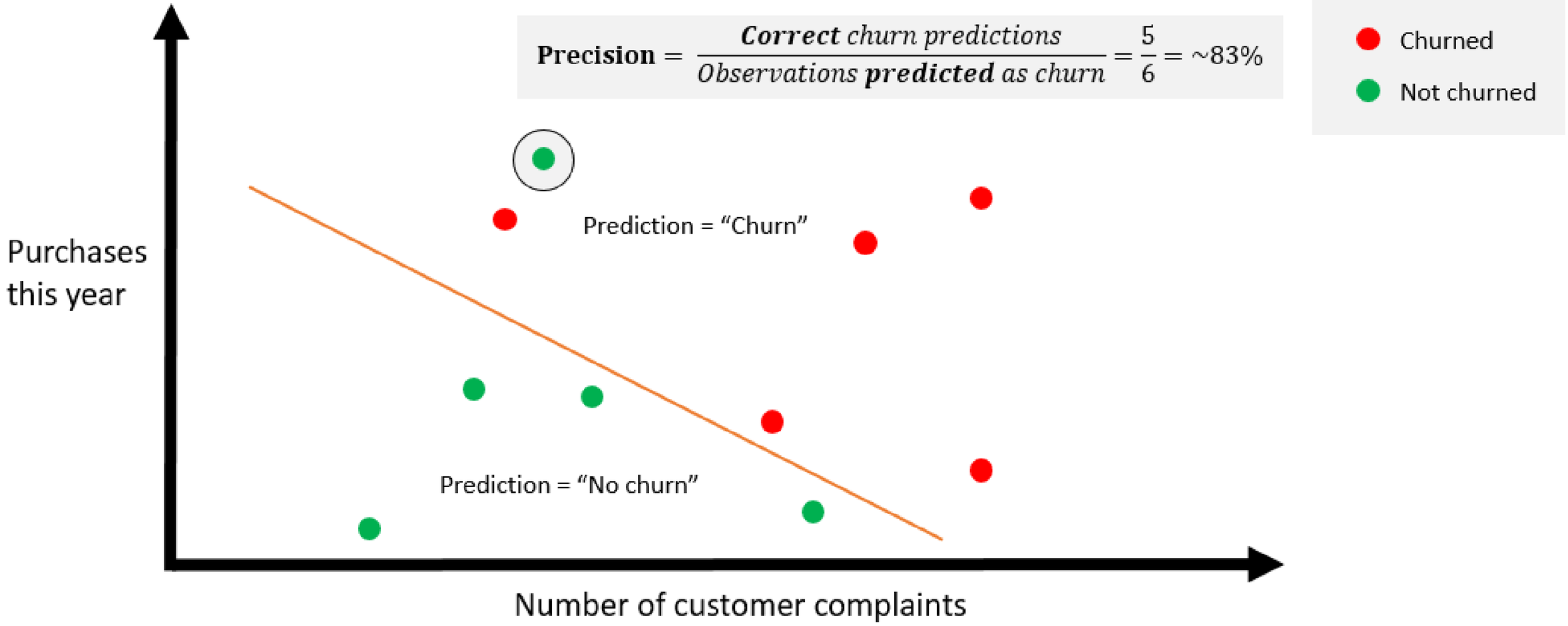
Accuracy

$$\textbf{Accuracy} = \frac{All\ correct\ predictions}{All\ observations} = \frac{9}{10} = 90\%$$



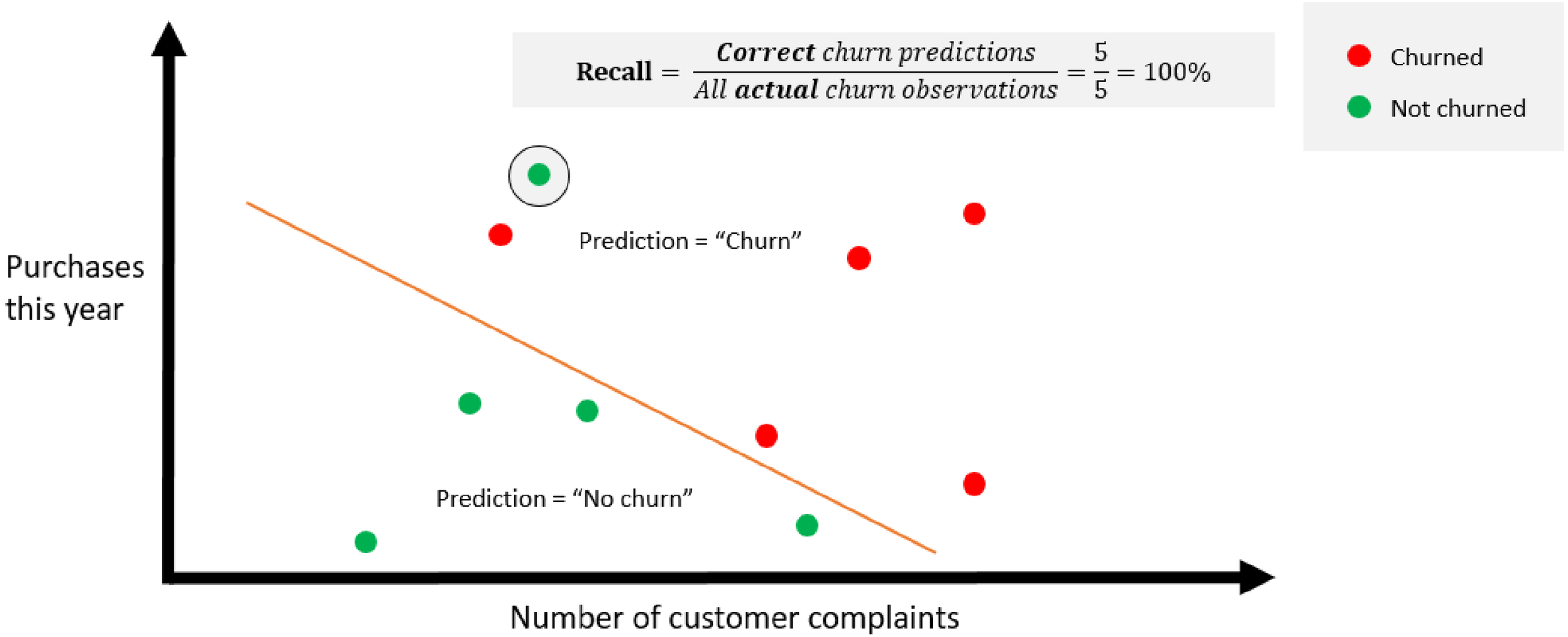
Precision

$$\textbf{Precision} = \frac{\textbf{\textit{Correct churn predictions}}}{\textit{Observations } \textbf{\textit{predicted}} \textit{ as churn}} = \frac{5}{6} = \sim 83\%$$



Recall

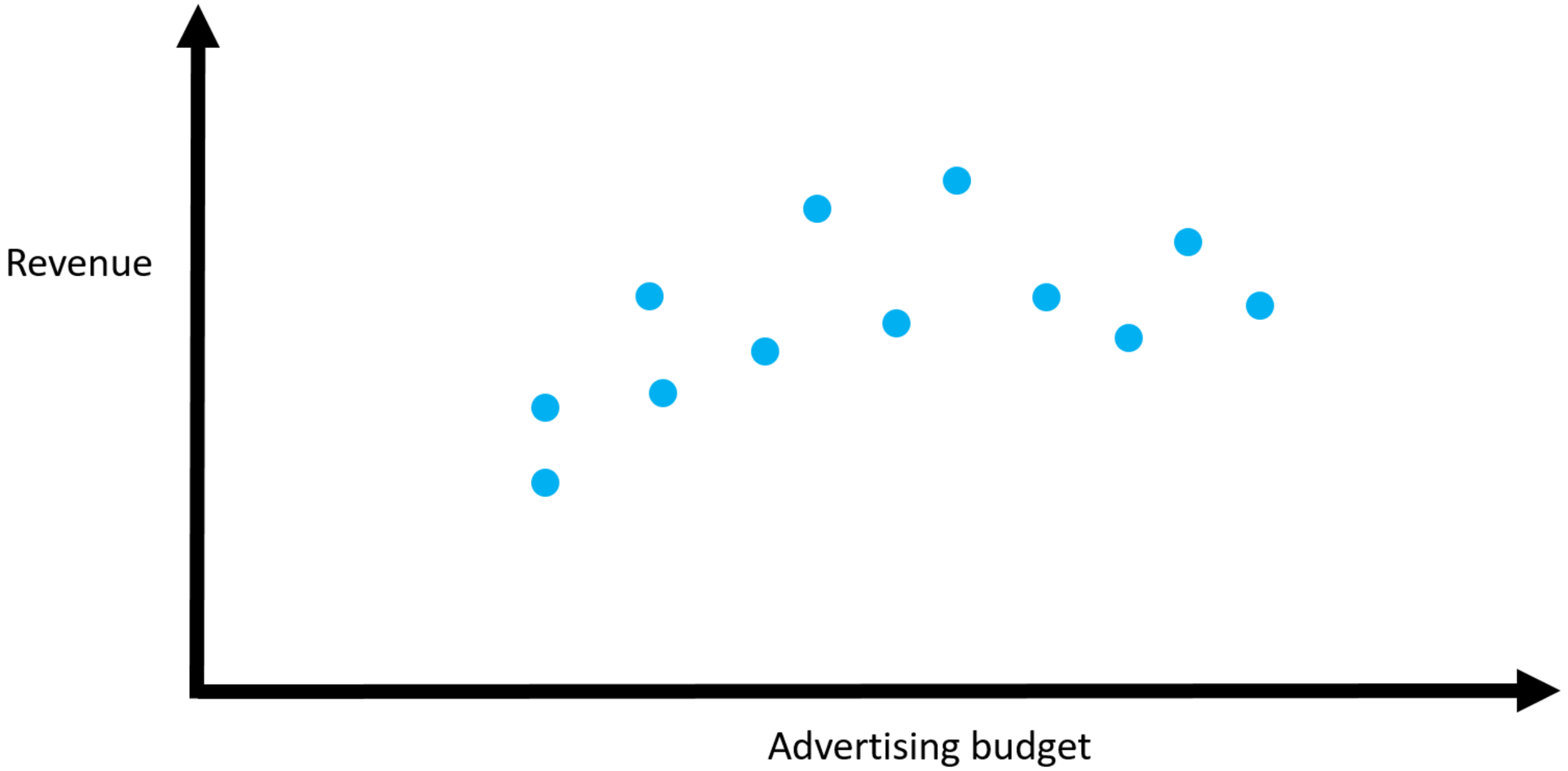
$$\textbf{Recall} = \frac{\textbf{\textit{Correct}}\ churn\ predictions}{All\ \textbf{\textit{actual}}\ churn\ observations} = \frac{5}{5} = 100\%$$



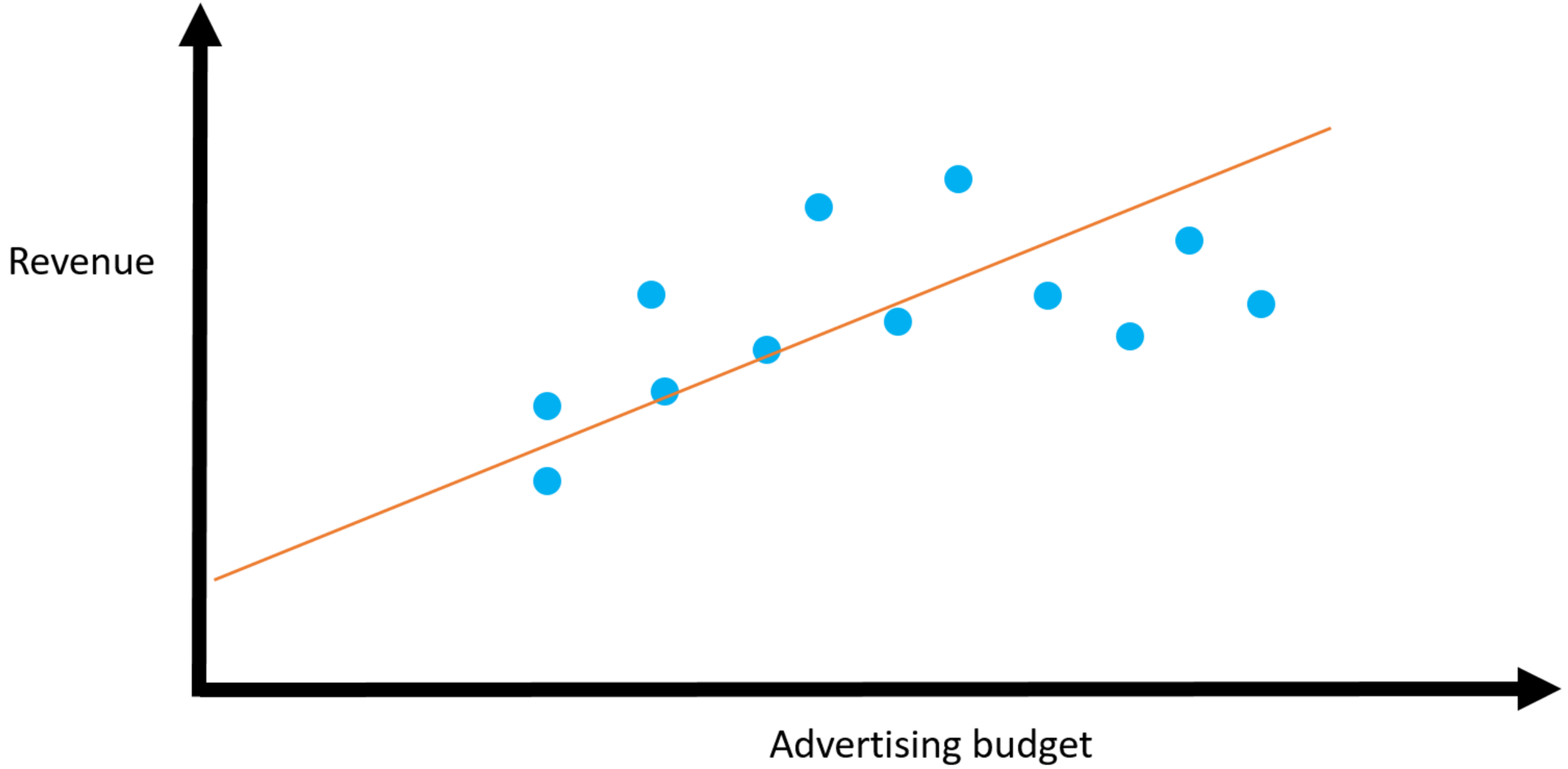
Regression performance

- Error

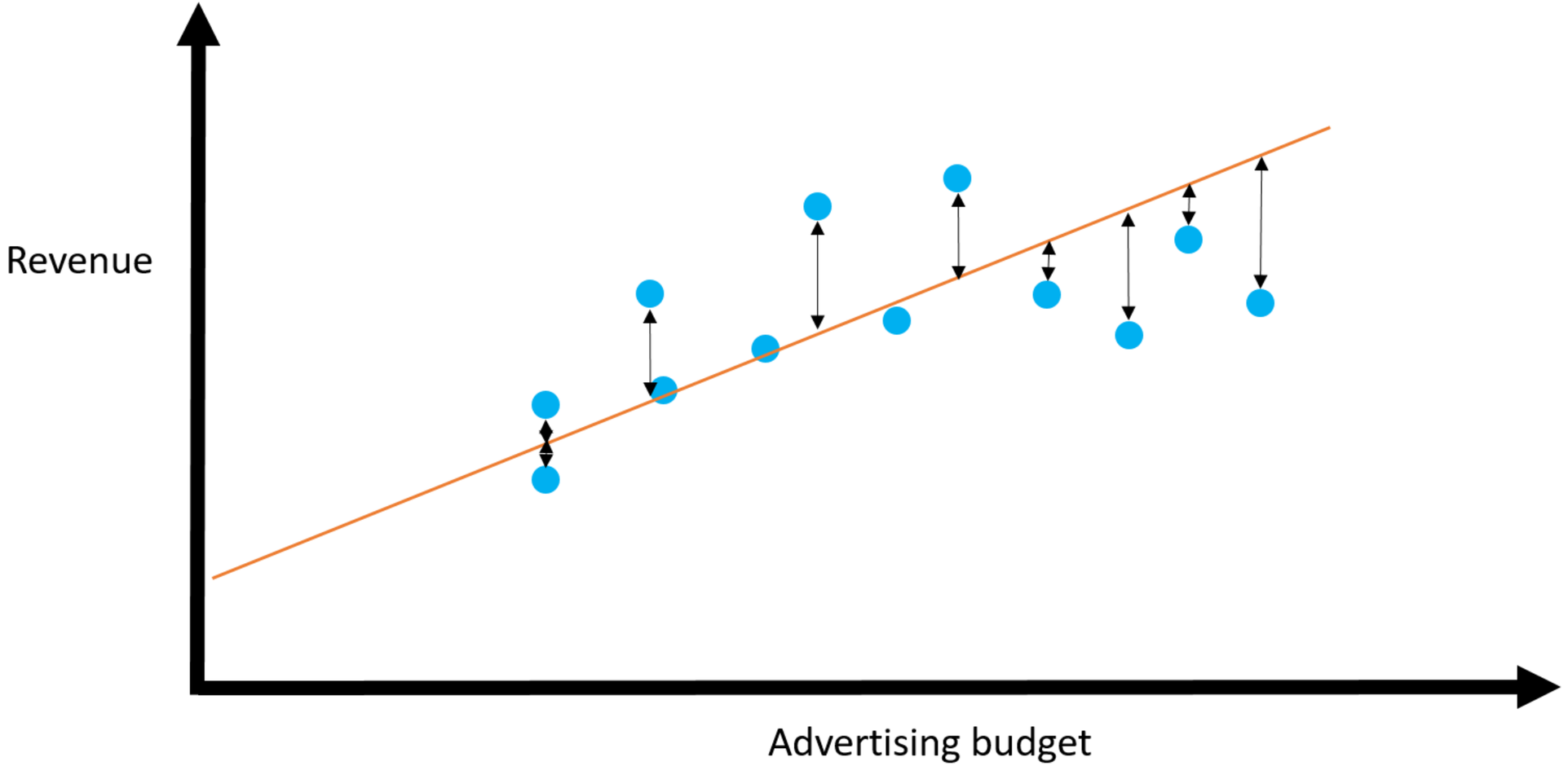
Regression example



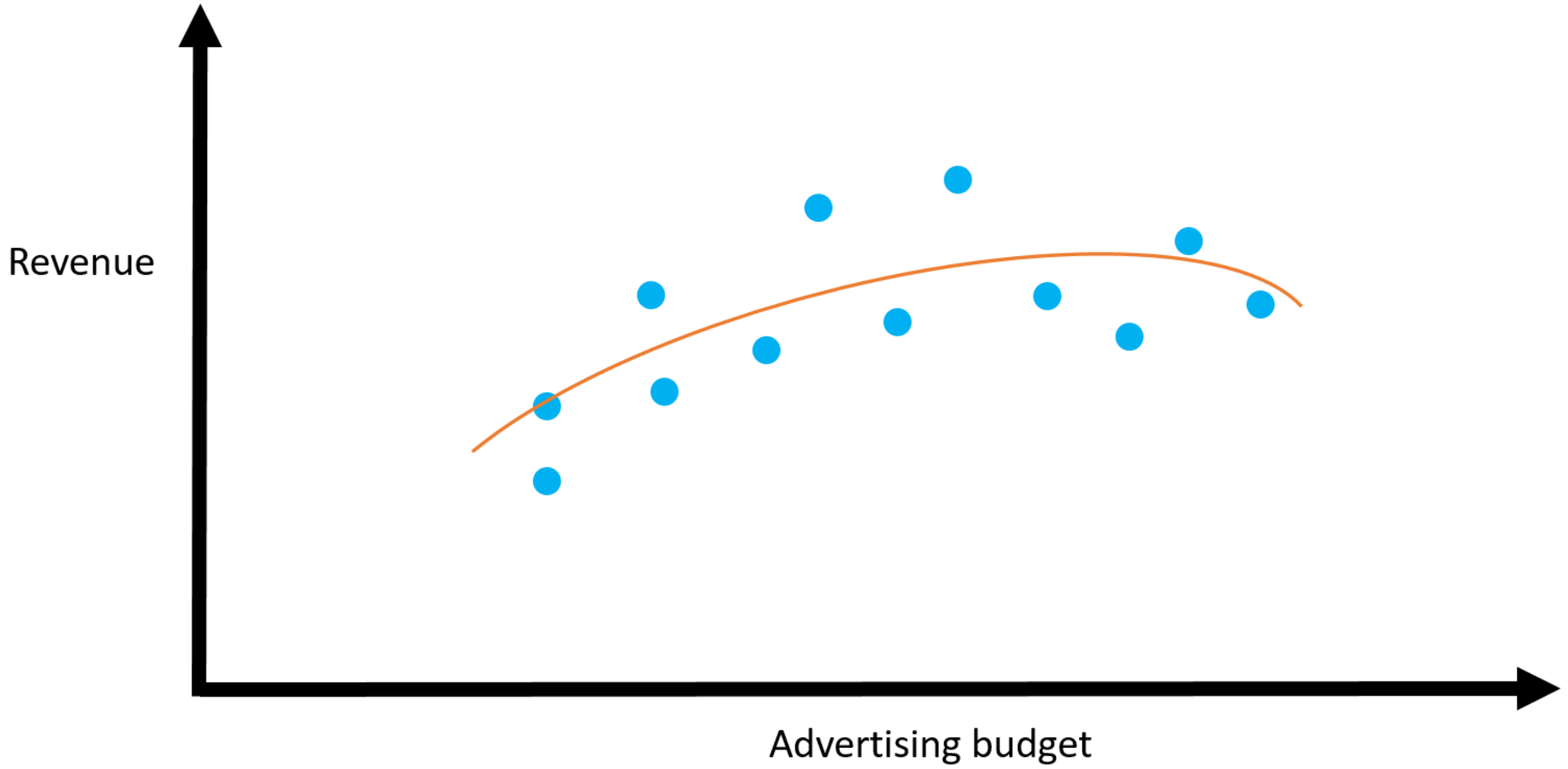
Predicting revenue with a line



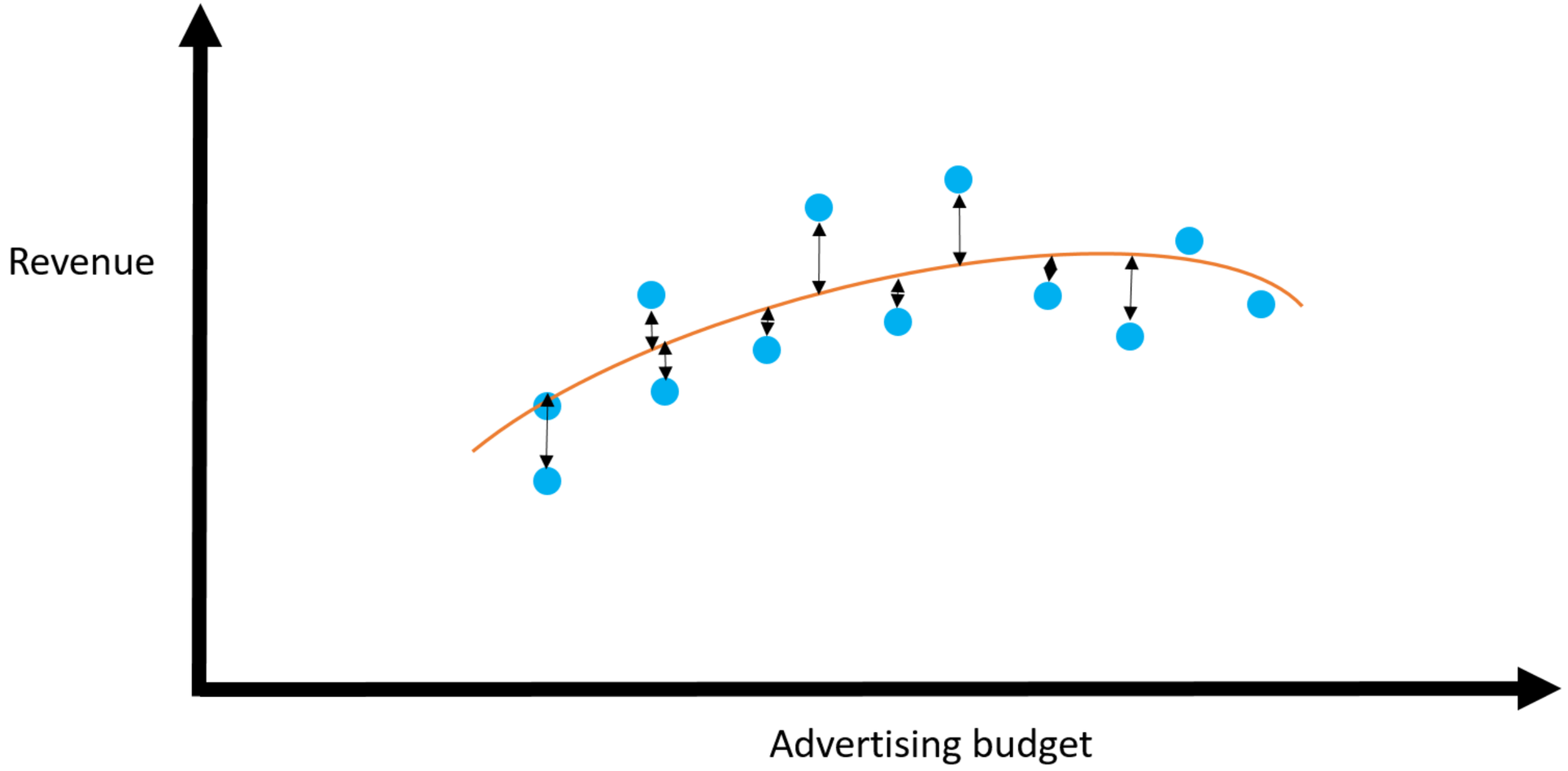
Regression error



Testing non-linear models



Error improvements



Actionable models - A/B testing

Good models are not always actionable:

> Churn prediction, purchase prediction, machine failure prediction

Test if using models helps improve outcomes:

> Target customers predicted to churn with incentives (discounts, coupons, promotions)

> Send reminder emails and product details to customers likely to purchase

_Did this result in decreased churn, increased purchase rate and reduced machine failures? If **yes**, build into automated process. If **no**, collect more data, improve models, and test again. _

Let's practice!

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Machine learning risks

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Poor performance

Some models perform poorly (make sure you review **test** performance, not **training**):

- Low precision
- Low recall
- Large error

Low precision

Low precision - a lot of misclassified items in the class of interest = a lot of **false positives**

Example - only 10% of customers identified as likely to purchase actually purchased the product

Low recall

Low recall - only a small fraction of all observations in the class have been correctly captured (recalled) by the model

Example - only 25% of all fraudulent transactions identified by the model

Large error

Large error - large differences between predicted and actual values

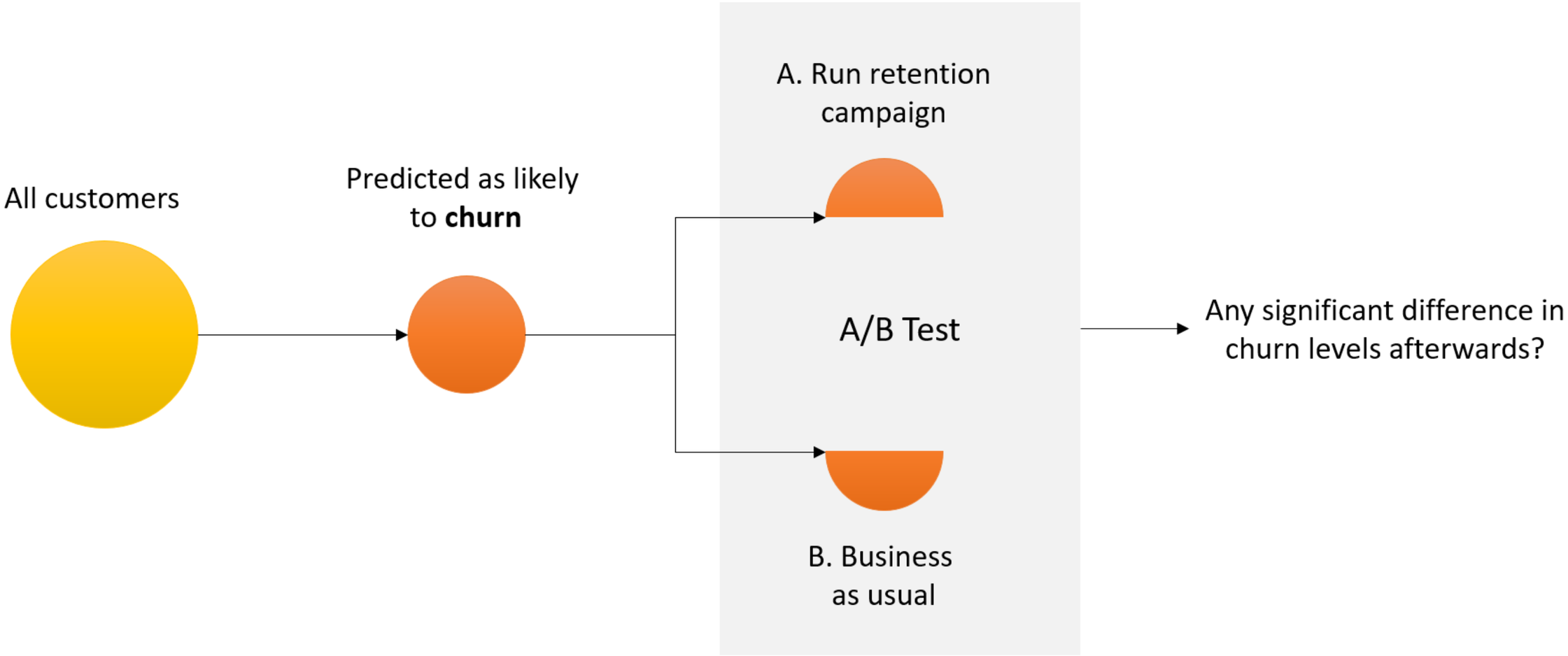
Example - the average error for the customer satisfaction rating prediction is 3.5 units or 70% in percentage points

Non-actionable model use cases

Q: How to test the models correctly?

A: Run tests / experiments to validate their performance e.g. churn prevention emails, product promotions, manual machine maintenance, manual transaction review

A/B testing


A. Run retention campaign
All customers
Predicted as likely to **churn**
A/B Test
Any significant difference in churn levels afterwards?
B. Business as usual

What if tests don't work?

- Get more data - business has to be involved
- Build causal models to understand drivers
- Run qualitative research (surveys etc.)
- Change the scope of the problem
  - Narrow
  - Widen
  - Different question

Let's practice!

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