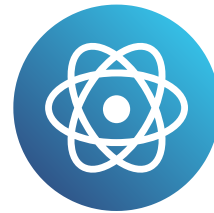


Business requirements

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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)*

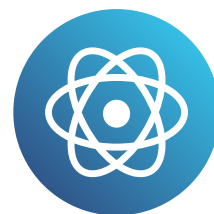
- First, look at historical levels (churn, fraud, # of high value customers)
- Run experiments e.g. target customers at risk with a discount, manually review top 10% riskiest transactions. Repeat experiments multiple times, see if you get a repeated pattern of desired results
- **If yes**, use that to 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

Full dataset

Splitting data for training

Input A	Input B	Input ... X	Target Y

Randomly sampled dataset
for model **training**

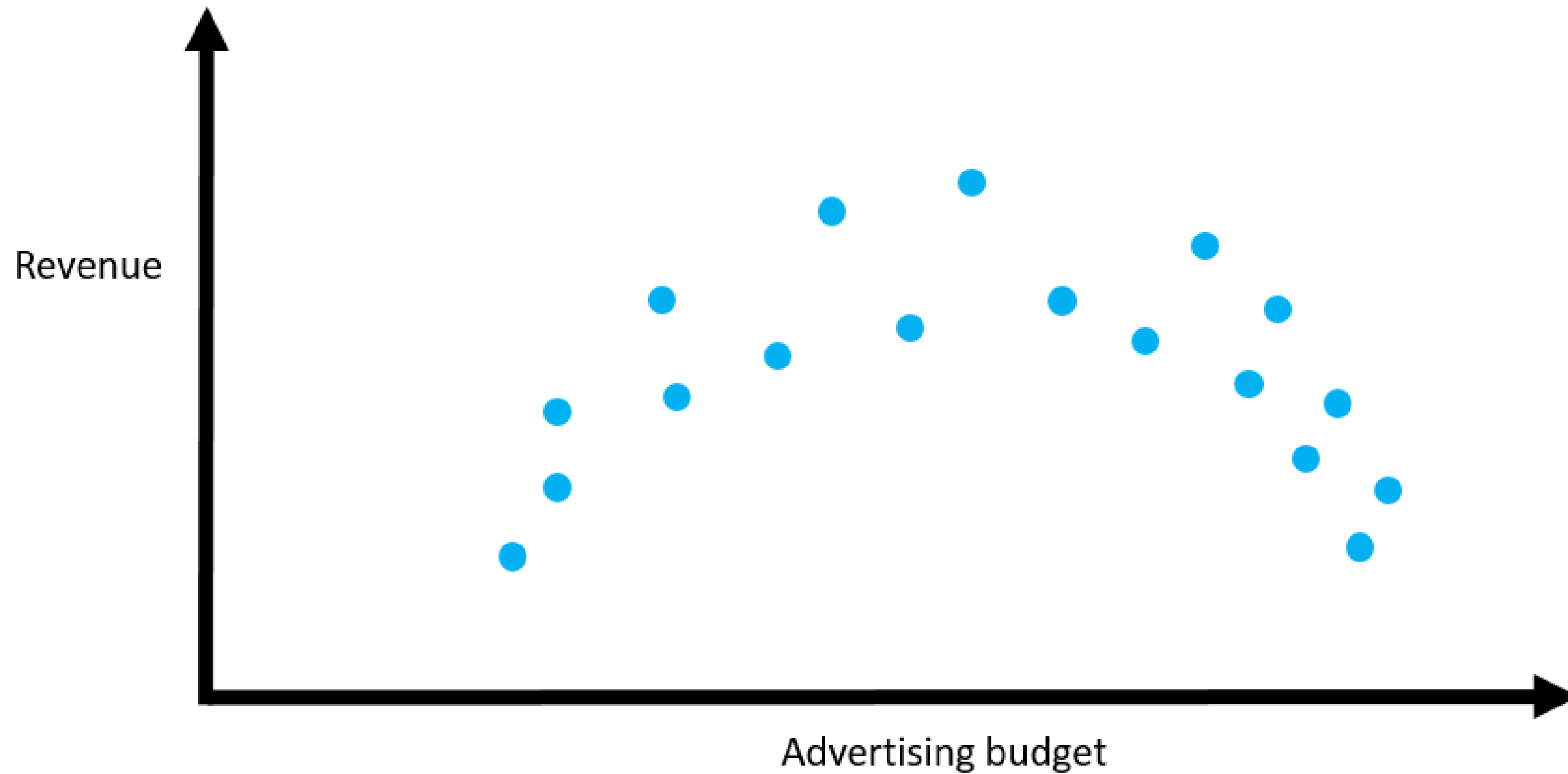
Test

Input A	Input B	Input ... X	Target Y

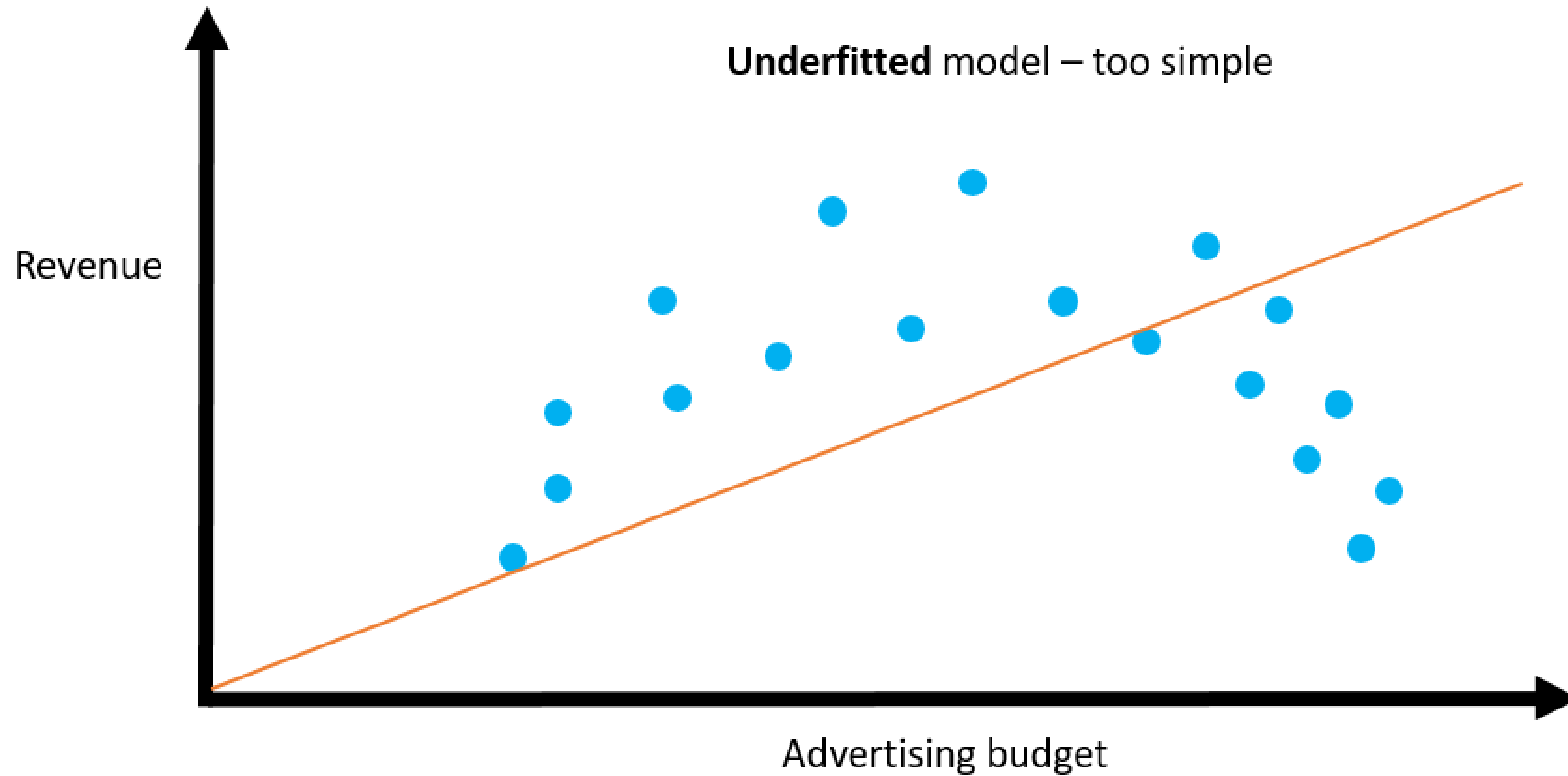
Randomly sampled dataset
for model **training**

Randomly sampled dataset
for model **performance** measurement

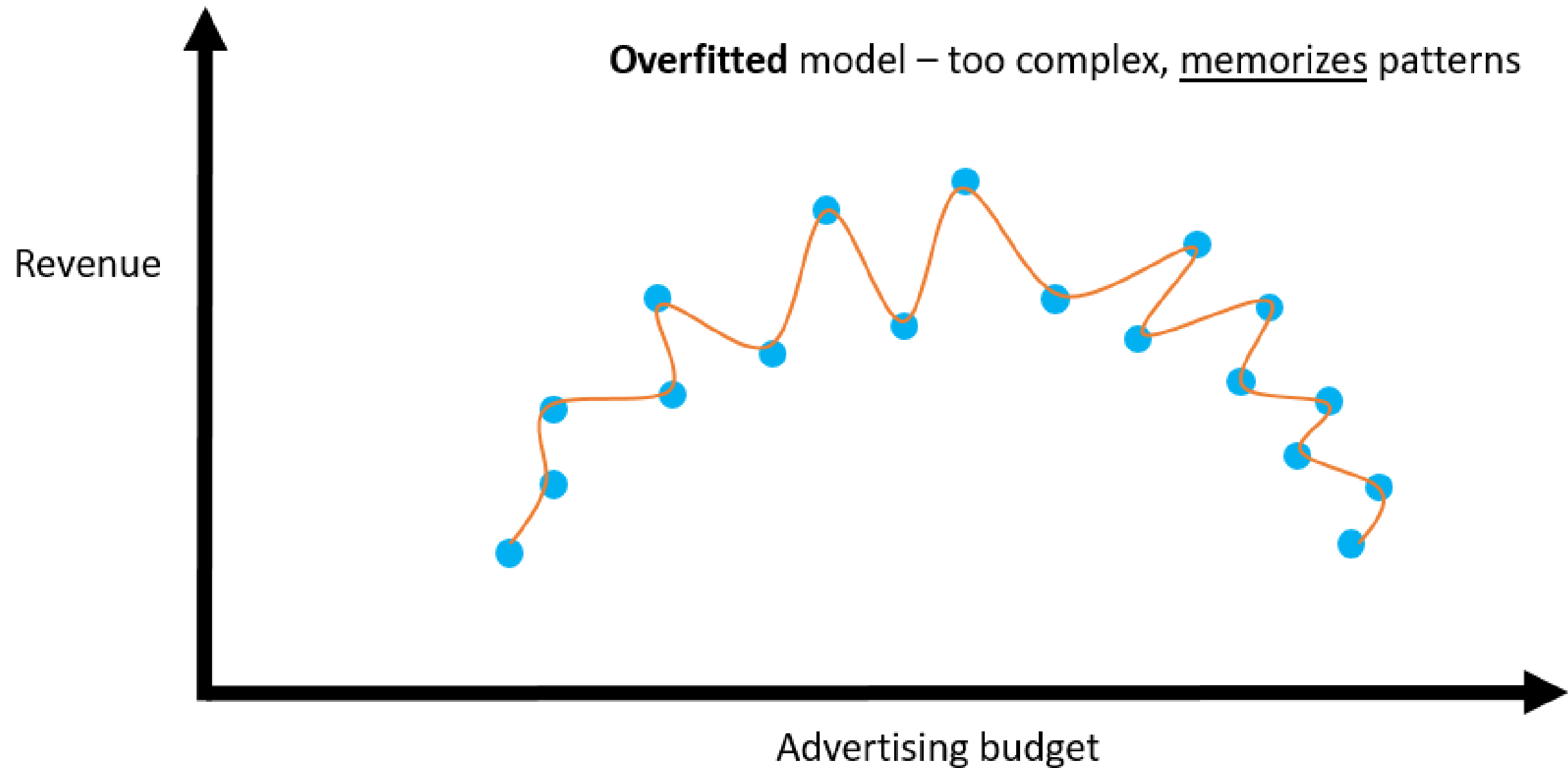
Overfitting and underfitting



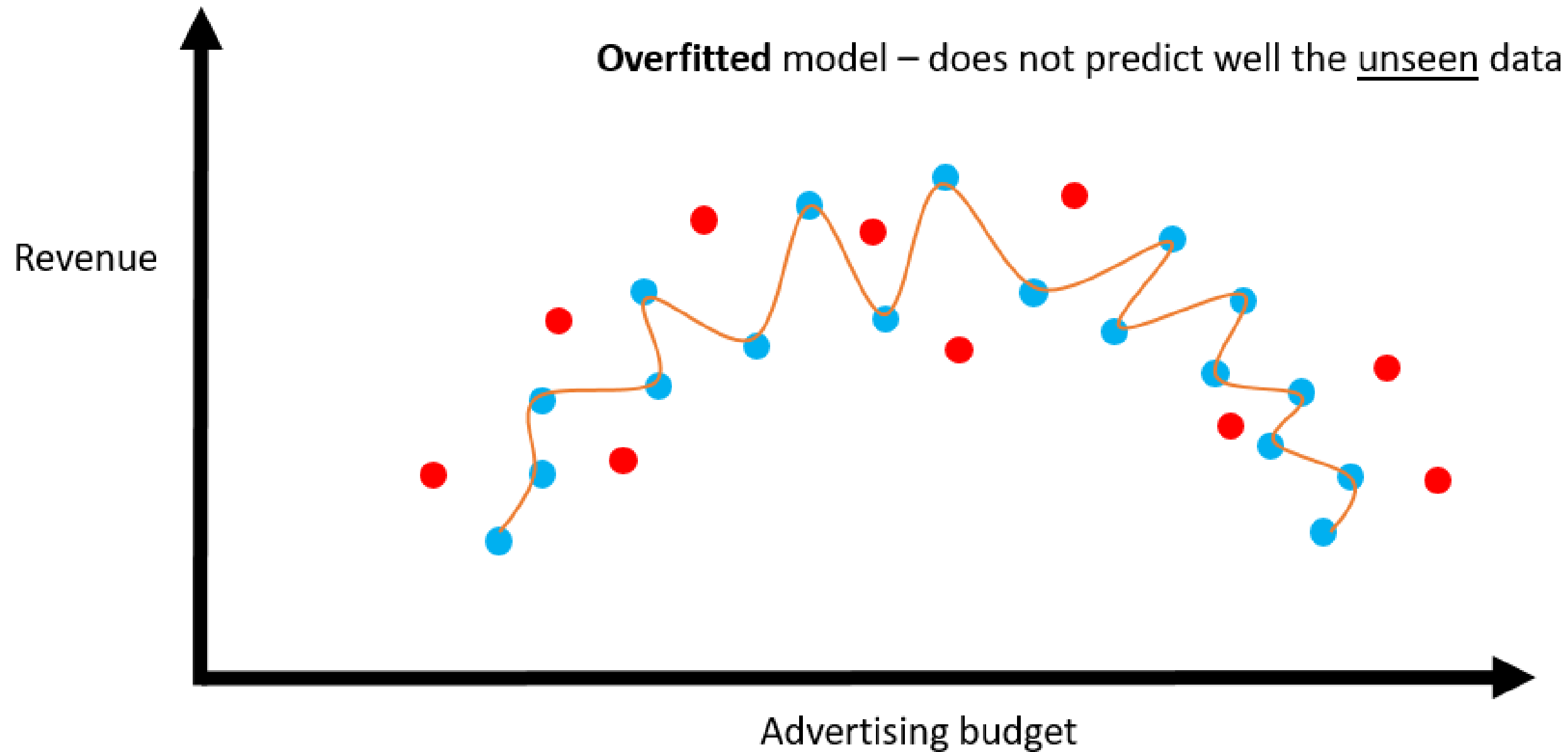
Underfitting



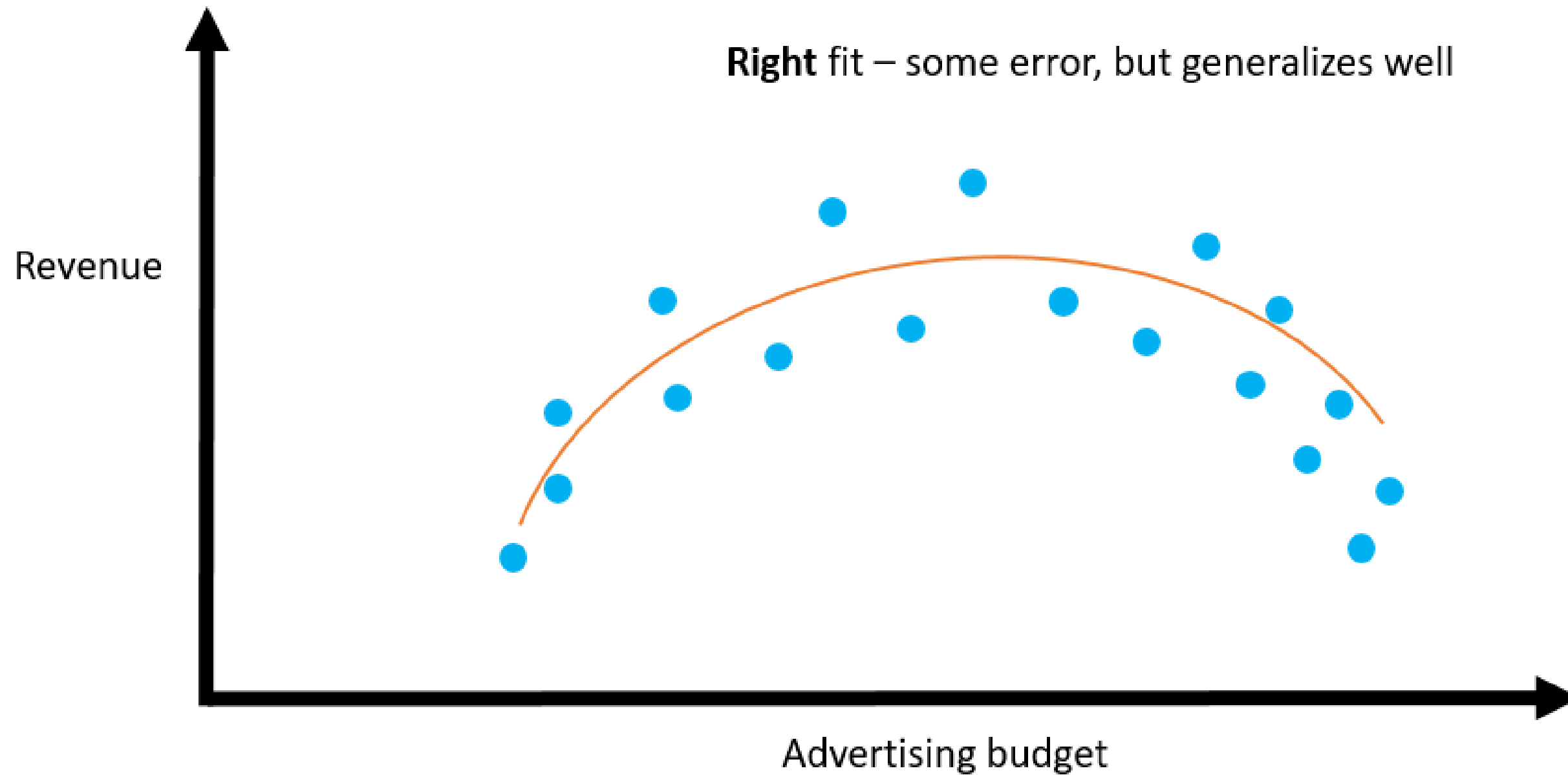
Overfitting 1



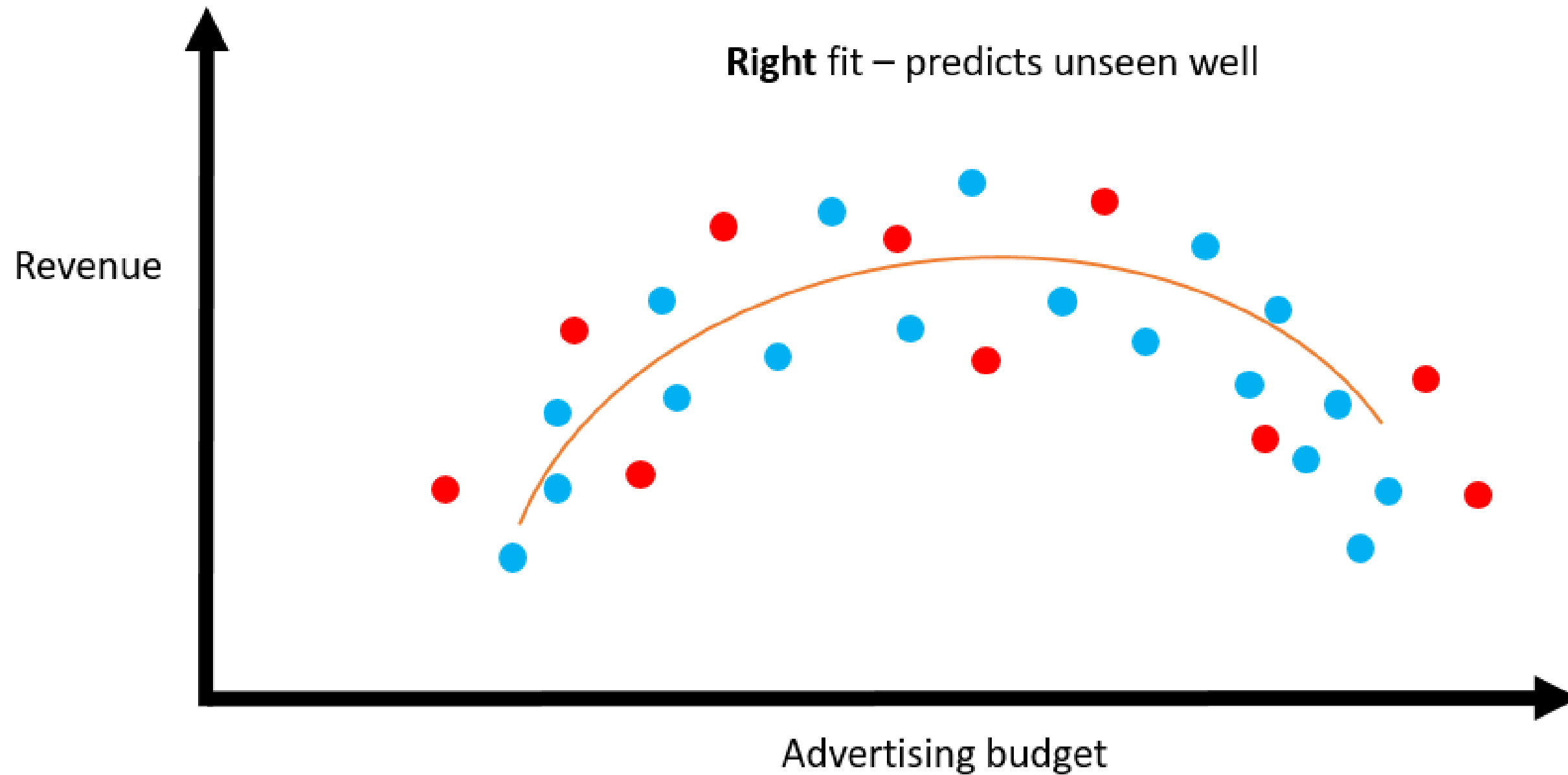
Overfitting 2



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

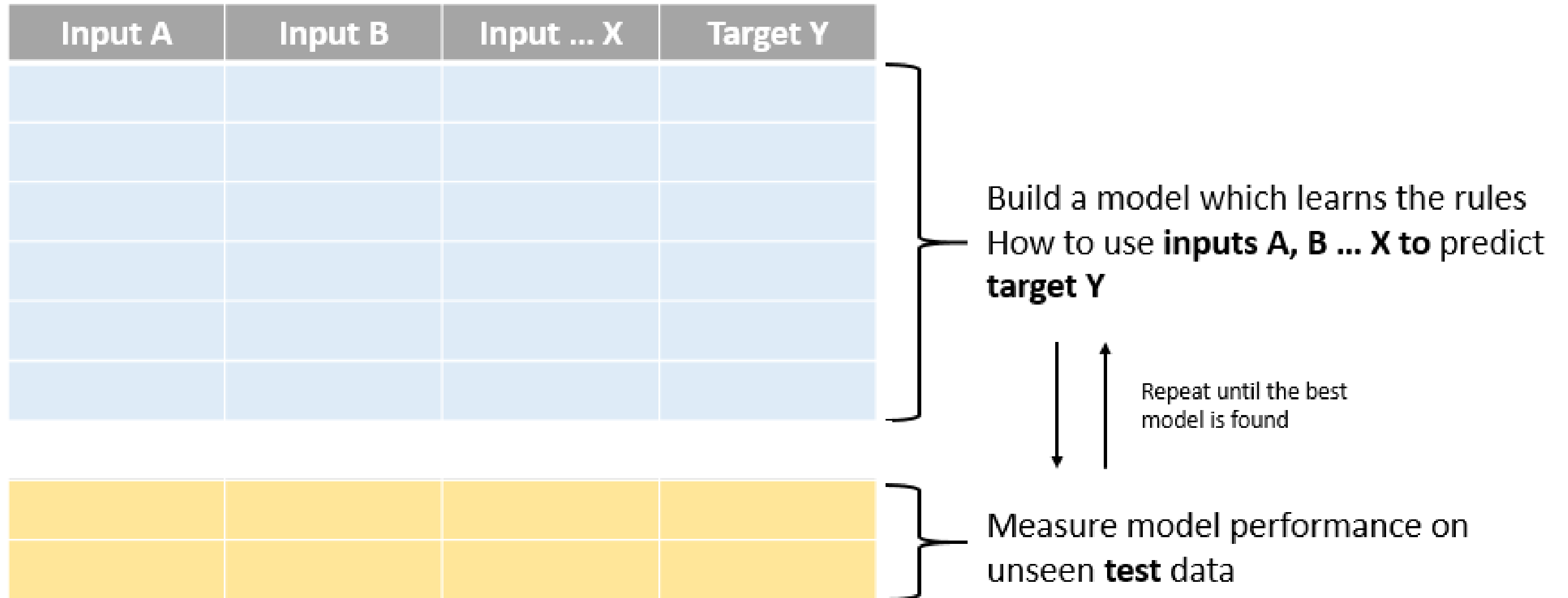
Asses model performance on test

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

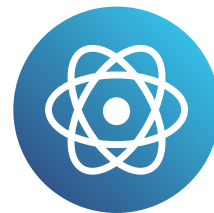


Let's practice!

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Model performance measurement

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Performance measurement types

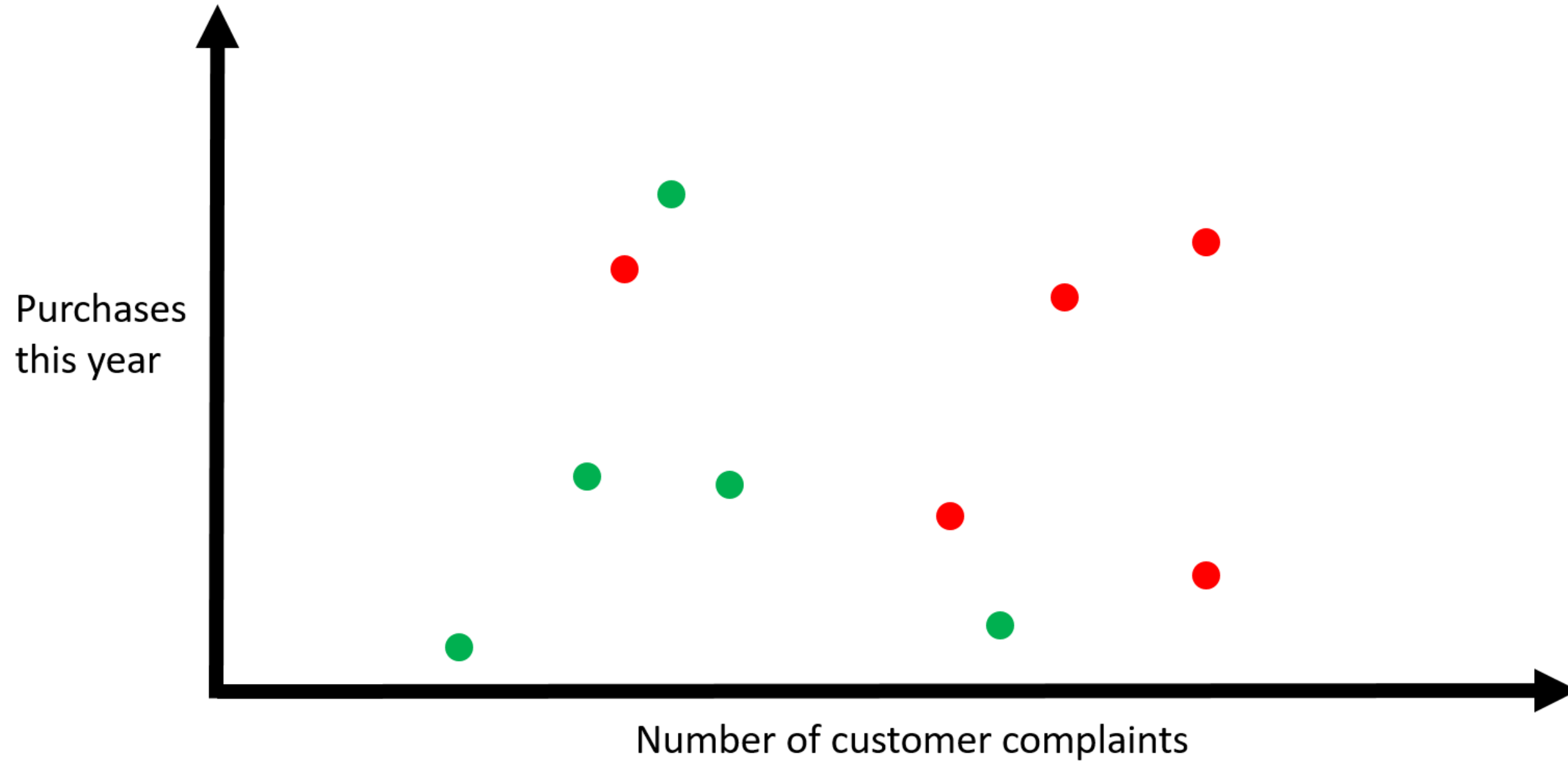
Two key supervised learning metrics:

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

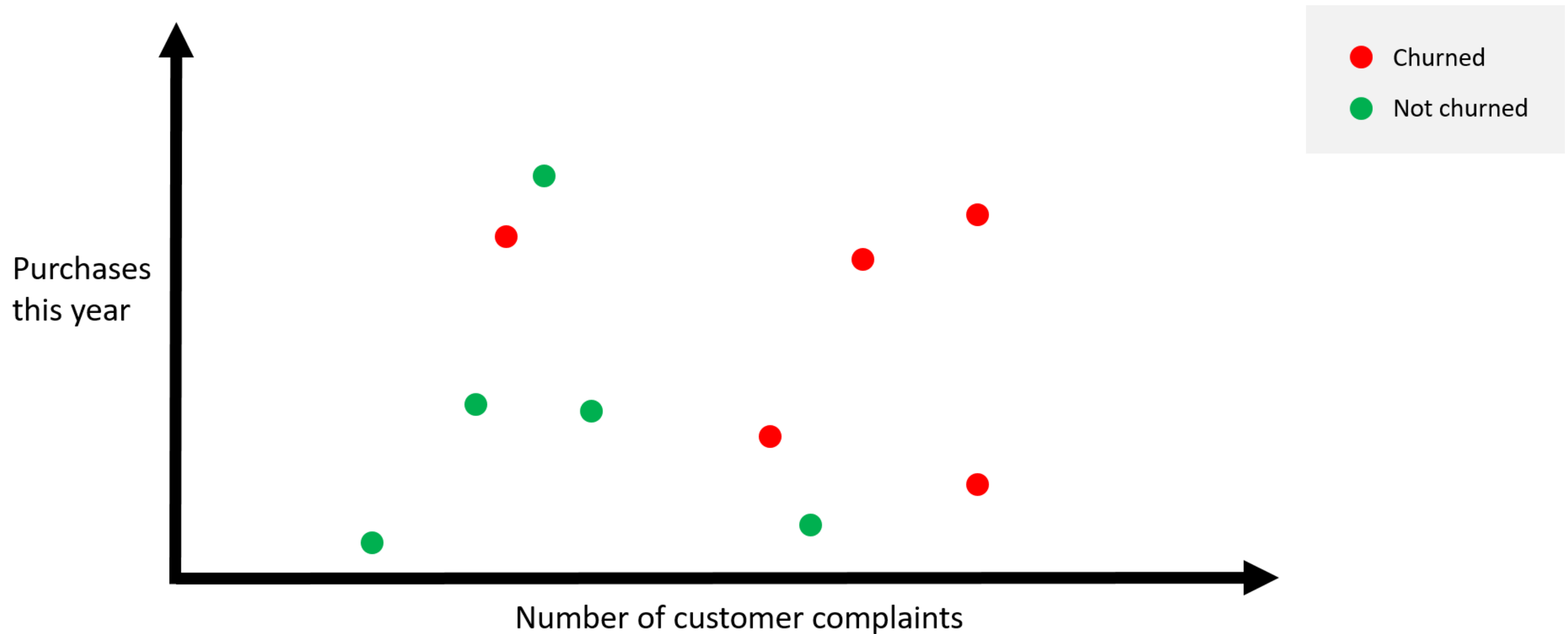
Classification performance

- Accuracy
- Recall
- Precision

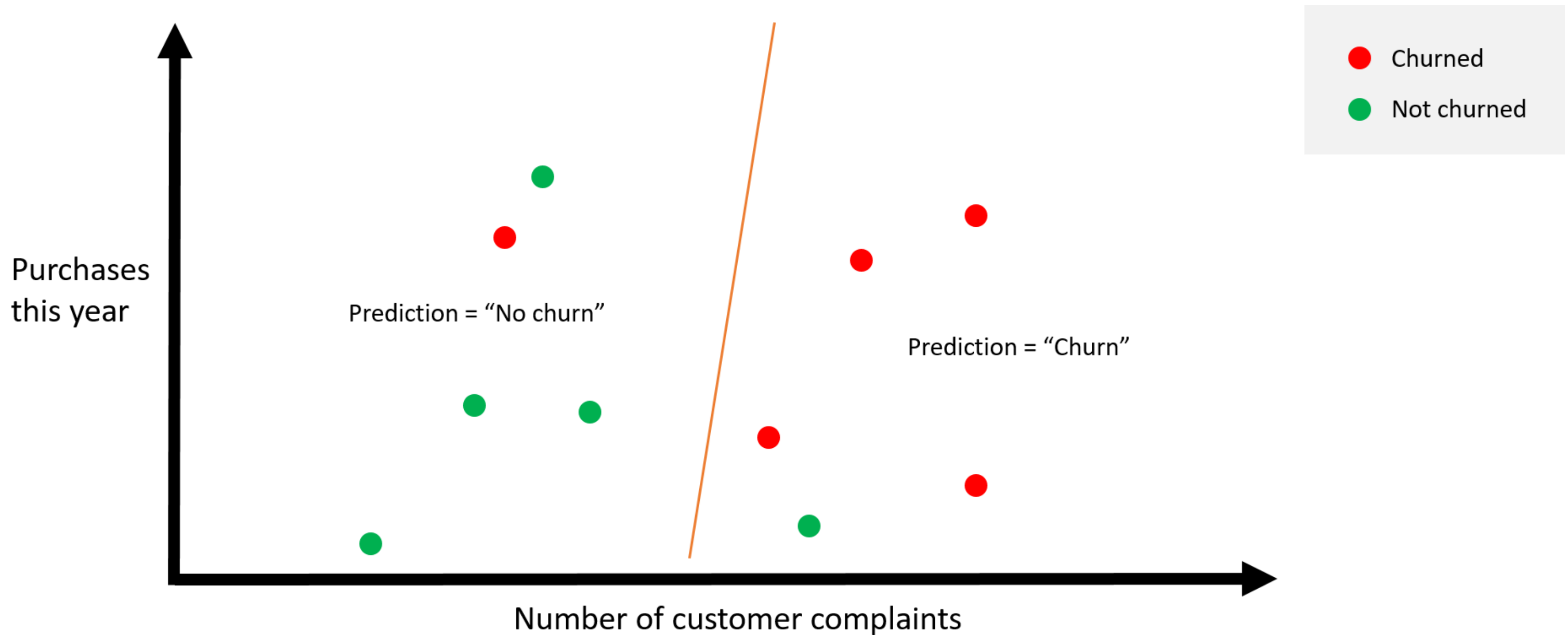
Churn example



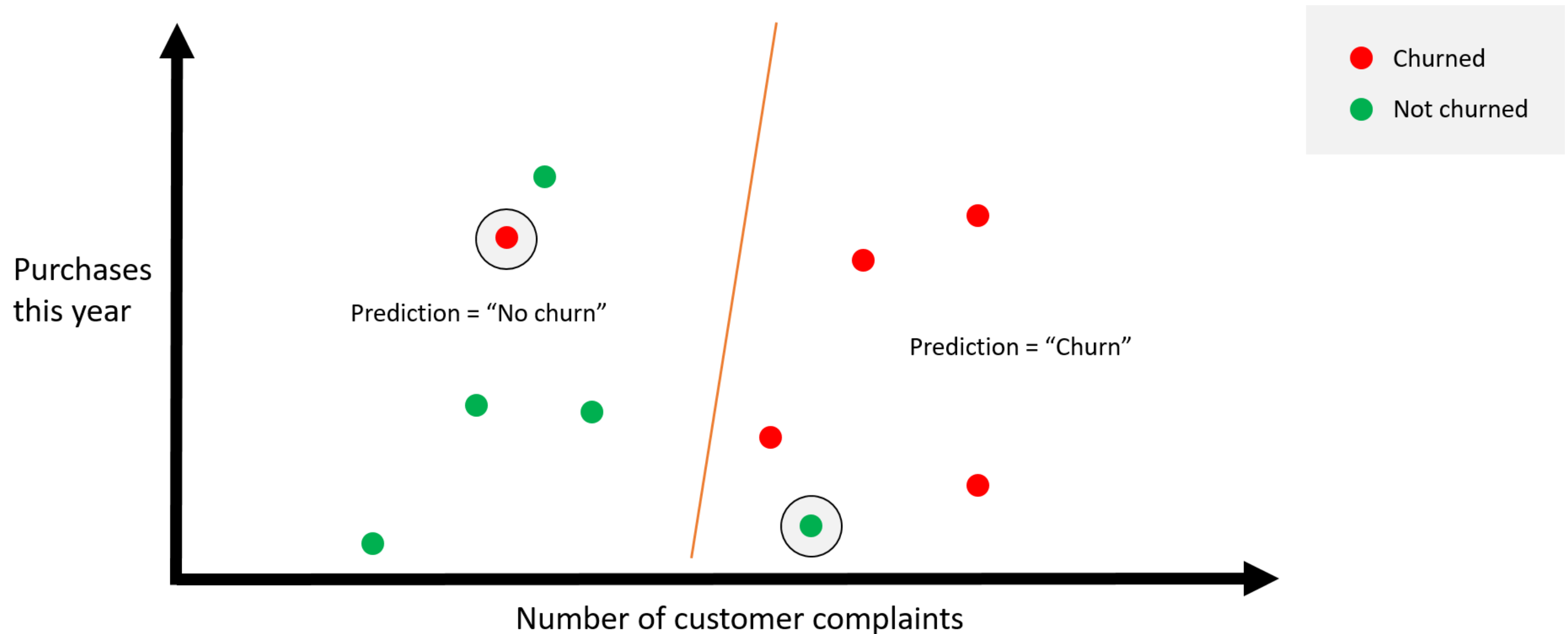
Churn example



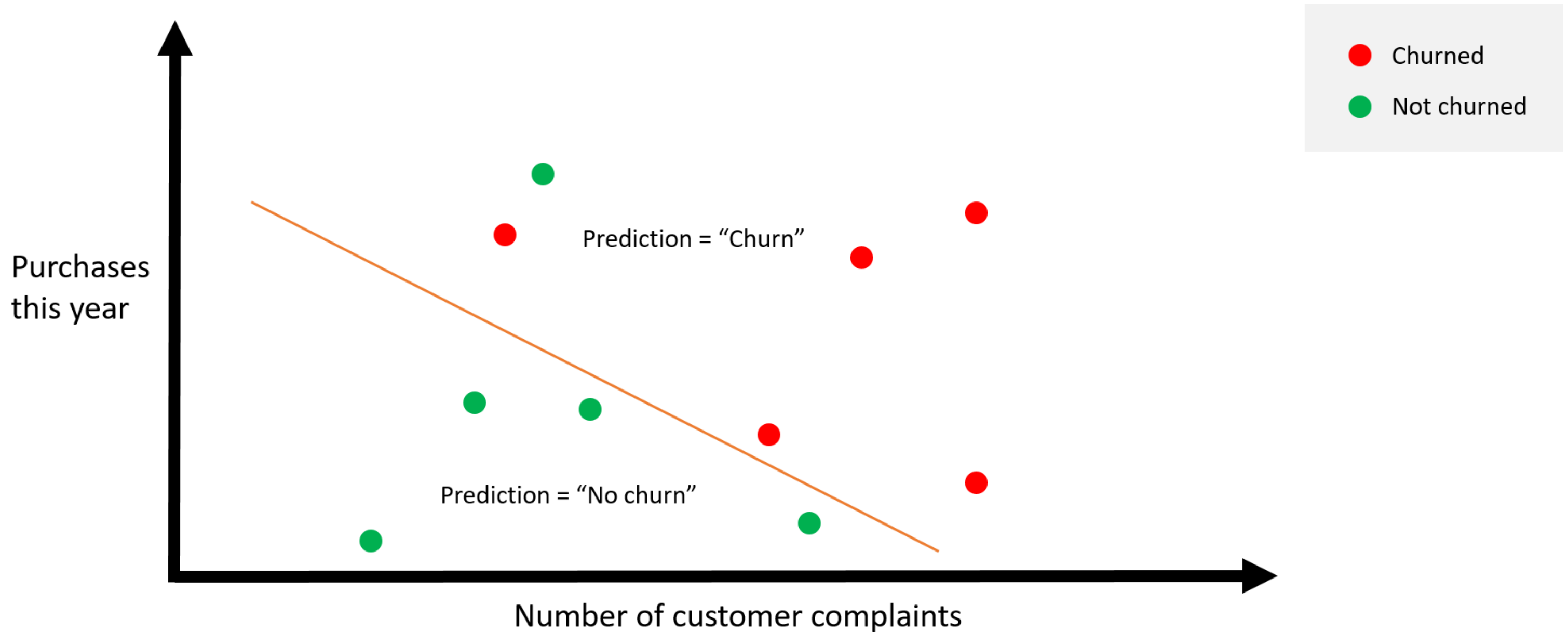
Churn prediction



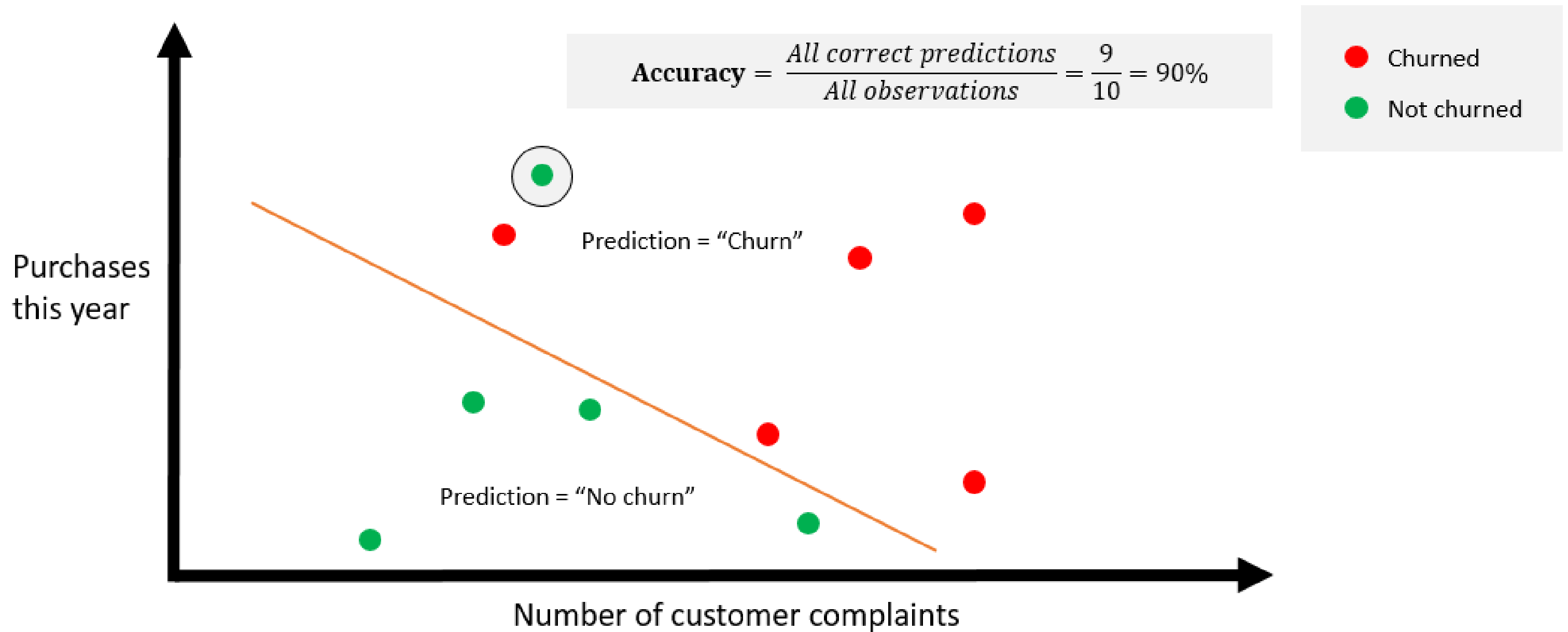
Mis-classified items



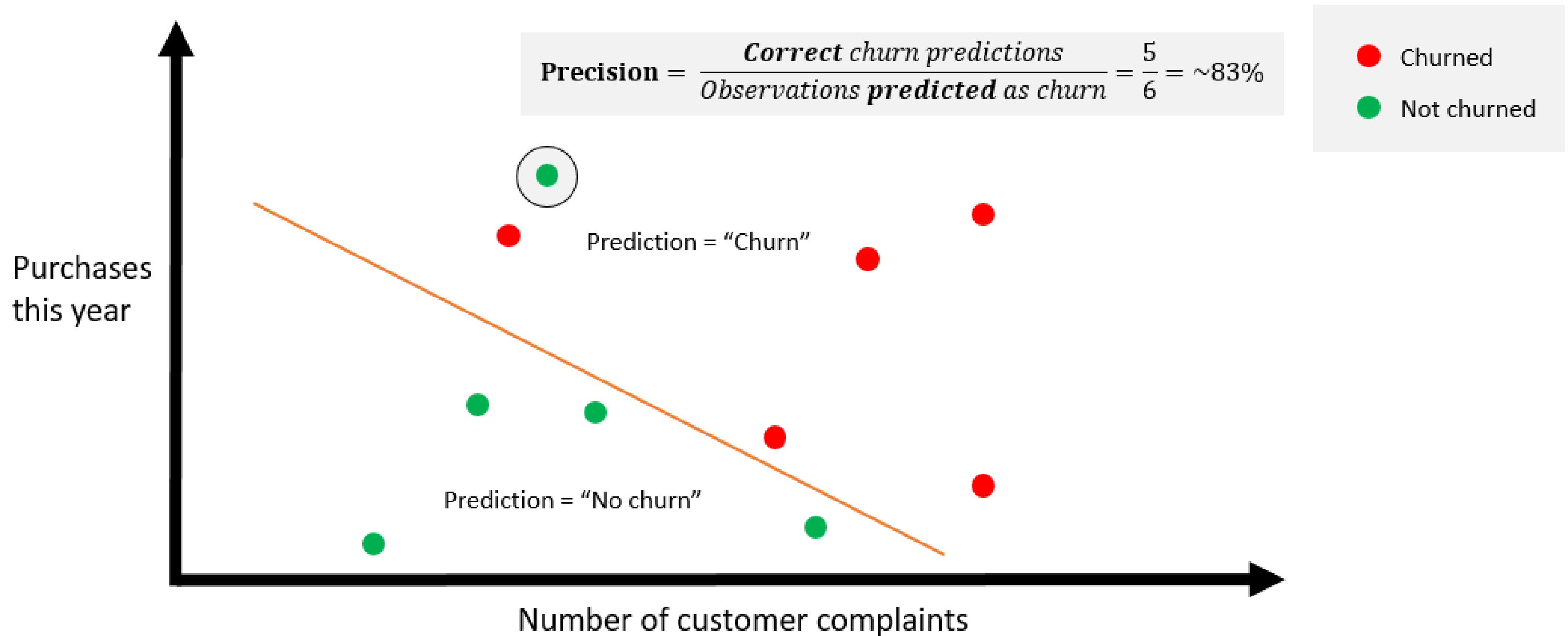
Another churn prediction



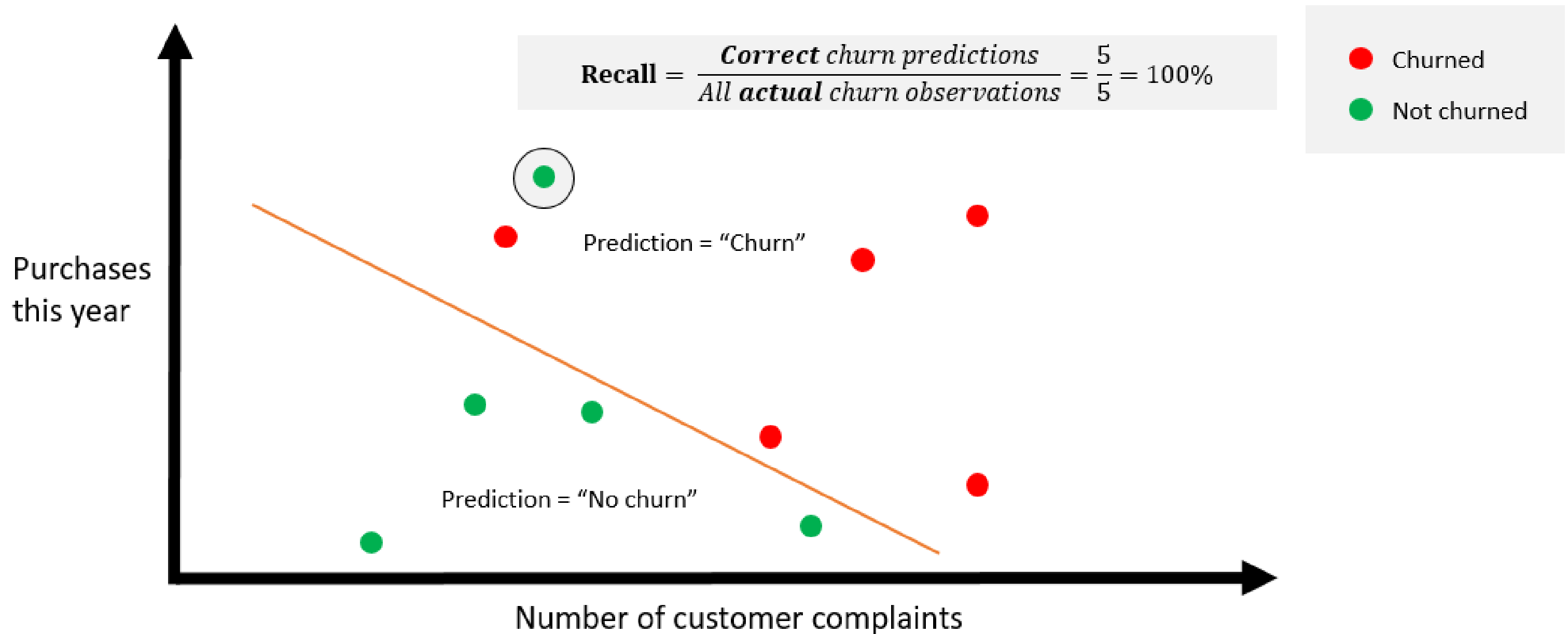
Accuracy



Precision



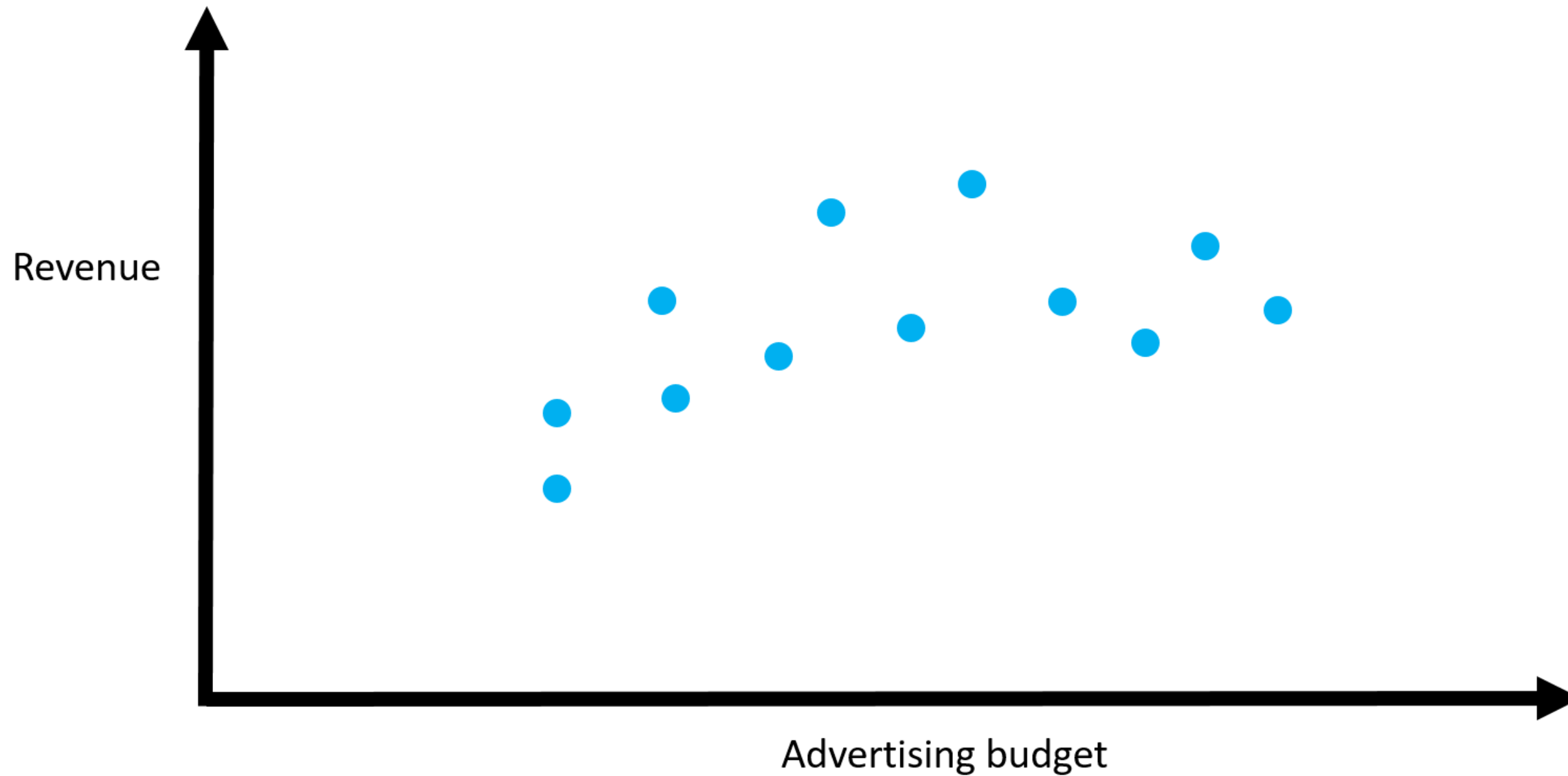
Recall



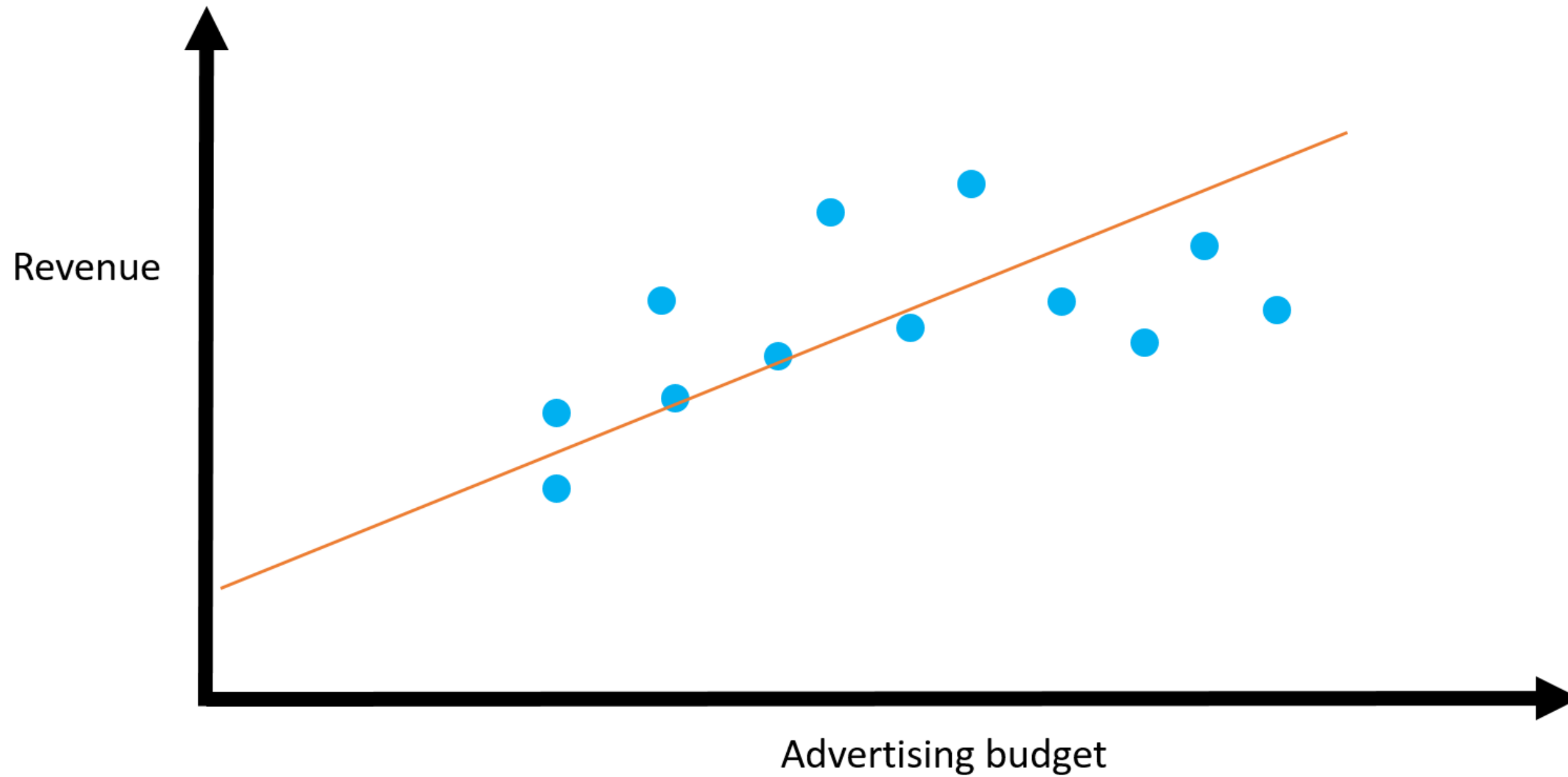
Regression performance

- Error

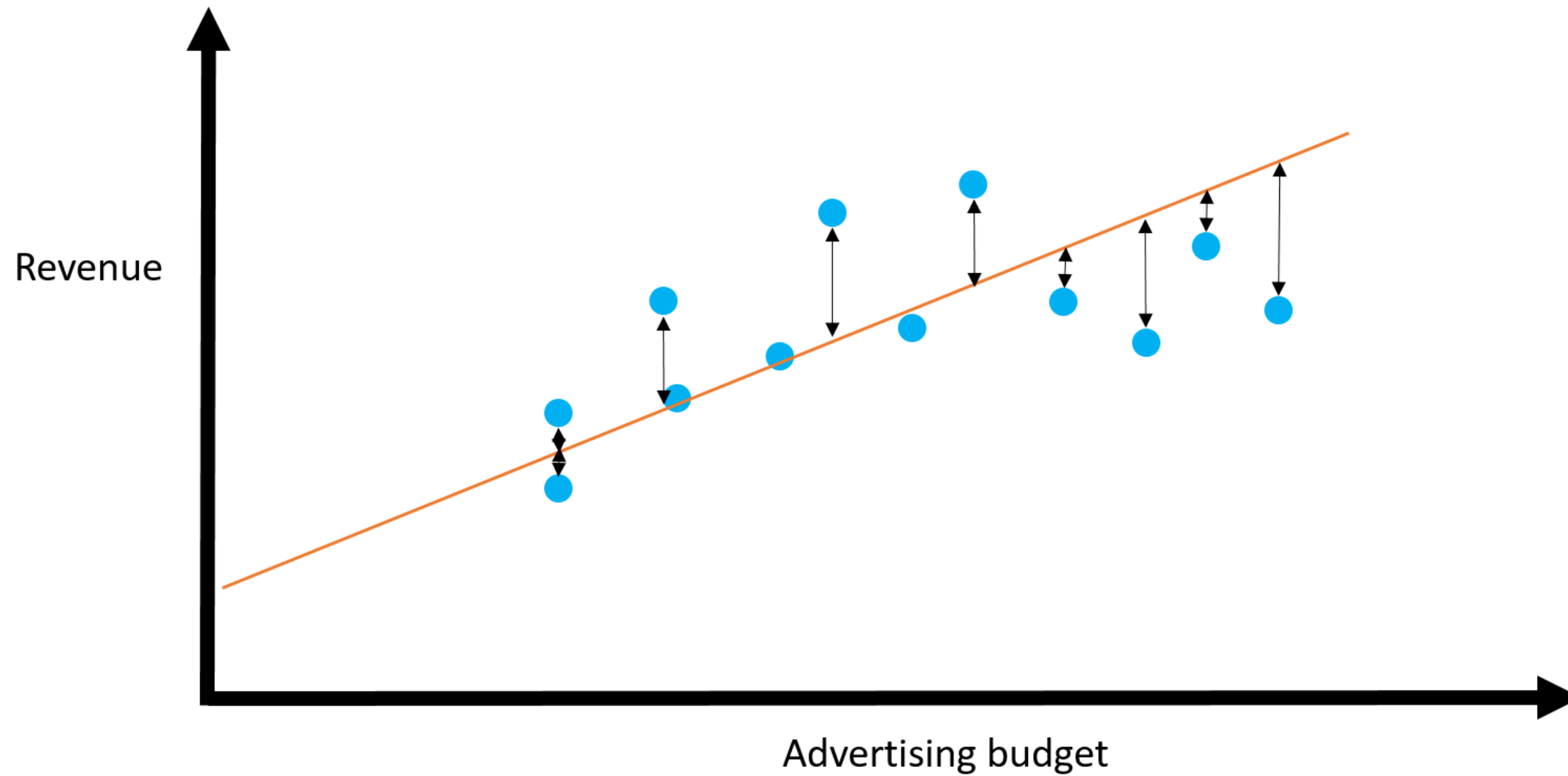
Regression example



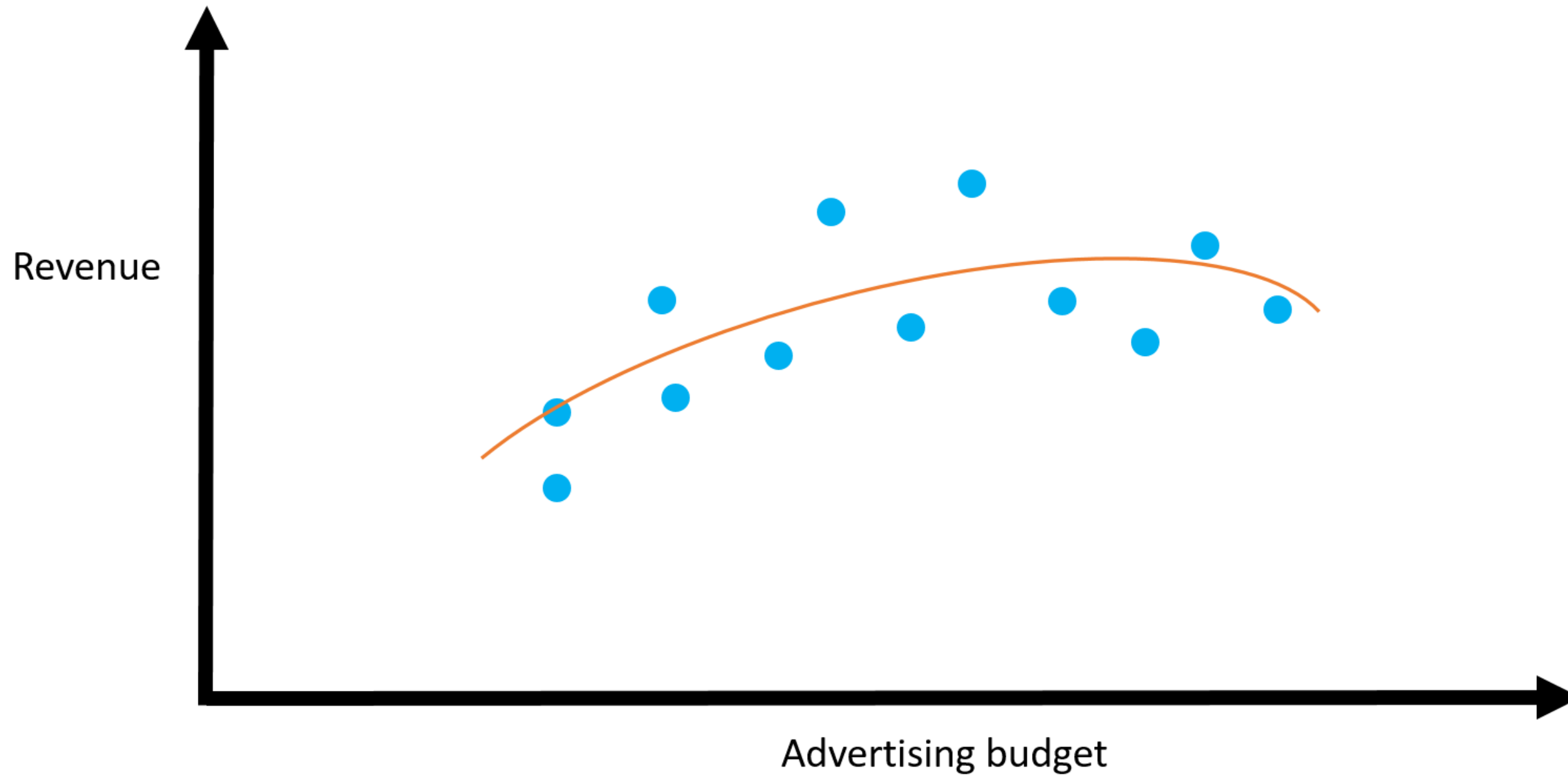
Predicting revenue with a line



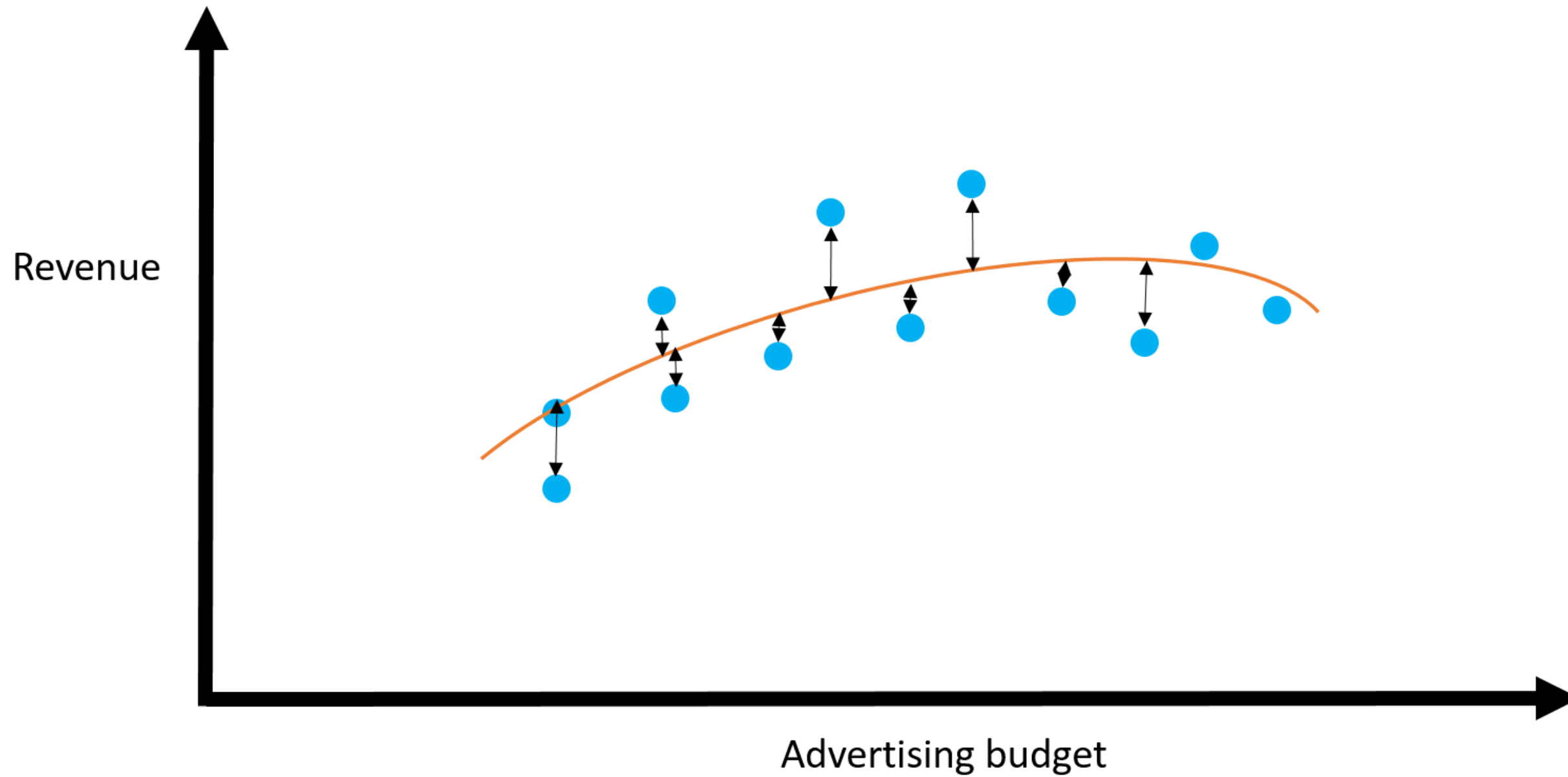
Regression error



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

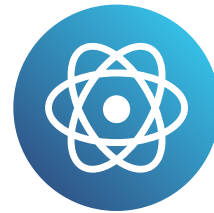
*Did this result in decreased churn, increased purchase rate and reduced machine failures? If **yes**, build into automated process. If **no**, collect more data, improve models, and test again.*

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

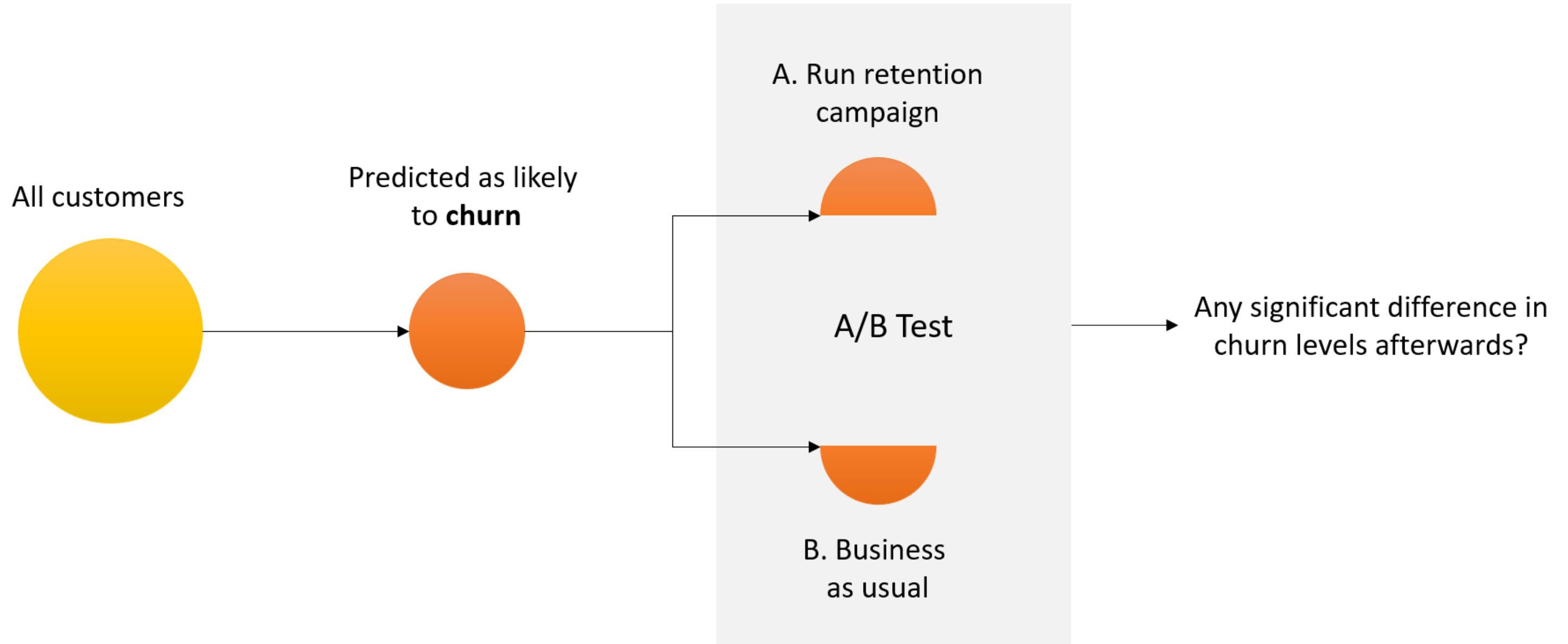
Example - the average error for the customer satisfaction rating prediction is 3.5 units or 70% in percentage points

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



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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