INTRODUCTION TO PREDICTIVE ANALYTICS IN PYTHON

Variable selection

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Candidate predictors

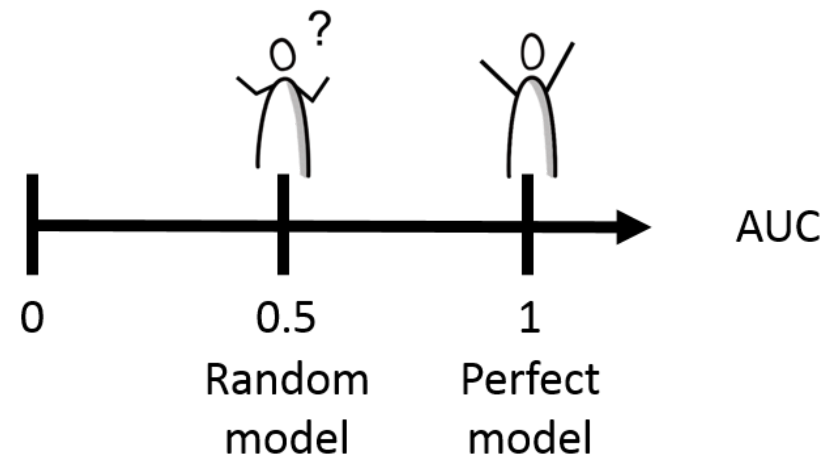
- age
- max_gift
- income_low
- min_gift, mean_gift, median_gift
- country_USA, country_India, country_UK
- number_gift_min50, number_gift_min100, number_gift_min150

Variable selection: motivation

Drawbacks of models with many variables:

- Over-fitting
- Hard to maintain or implement
- Hard to interpret, multi-collinearity

Model evaluation: AUC




```
import numpy as np
from sklearn.metrics import roc_auc_score
roc_auc_score(true_target, prob_target)
```

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Let's practice!

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Forward stepwise variable selection

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The forward stepwise variable selection procedure

- Empty set
- Find best variable v_1
- Find best variable v_2 in combination with v_1
- Find best variable v_3 in combination with v_1, v_2
- ...

(Until all variables are added or until predefined number of variables is added)

Functions in Python

```
def function_sum(a,b):

    s = a + b
    return(s)

print(function_sum(1,2))

3
```

Implementation of the forward stepwise procedure

- Function `auc` that calculates AUC given a certain set of variables
- Function `best_next` that returns next best variable in combination with current variables
- Loop until desired number of variables

Implementation of the AUC function

```
from sklearn import linear_model
from sklearn.metrics import roc_auc_score

def auc(variables, target, basetable):

    X = basetable[variables]
    y = basetable[target]

    logreg = linear_model.LogisticRegression()
    logreg.fit(X, y)

    predictions = logreg.predict_proba(X)[:,1]
    auc = roc_auc_score(y, predictions)
    return(auc)
```

```
auc = auc(["age","gender_F"],["target"],basetable)
print(round(auc,2))

0.54
```

Calculating the next best variable

```
def next_best(current_variables,candidate_variables, target, basetable):

    best_auc = -1
    best_variable = None

    for v in candidate_variables:
        auc_v = auc(current_variables + [v], target, basetable)

        if auc_v >= best_auc:
            best_auc = auc_v
            best_variable = v

    return best_variable

current_variables = ["age","gender_F"]
candidate_variables = ["min_gift","max_gift","mean_gift"]
next_variable = next_best(current_variables, candidate_variables, basetable)
print(next_variable)

min_gift
```

The forward stepwise variable selection procedure

```
candidate_variables = ["mean_gift","min_gift","max_gift",
"age","gender_F","country_USA","income_low"]
current_variables = []
target = ["target"]

max_number_variables = 5
number_iterations = min(max_number_variables, len(candidate_variables))
for i in range(0,number_iterations):

    next_var = next_best(current_variables,candidate_variables,target,basetable)

    current_variables = current_variables + [next_variable]
    candidate_variables.remove(next_variable)

print(current_variables)

['max_gift', 'mean_gift', 'min_gift', 'age', 'gender_F']
```

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Deciding on the number of variables

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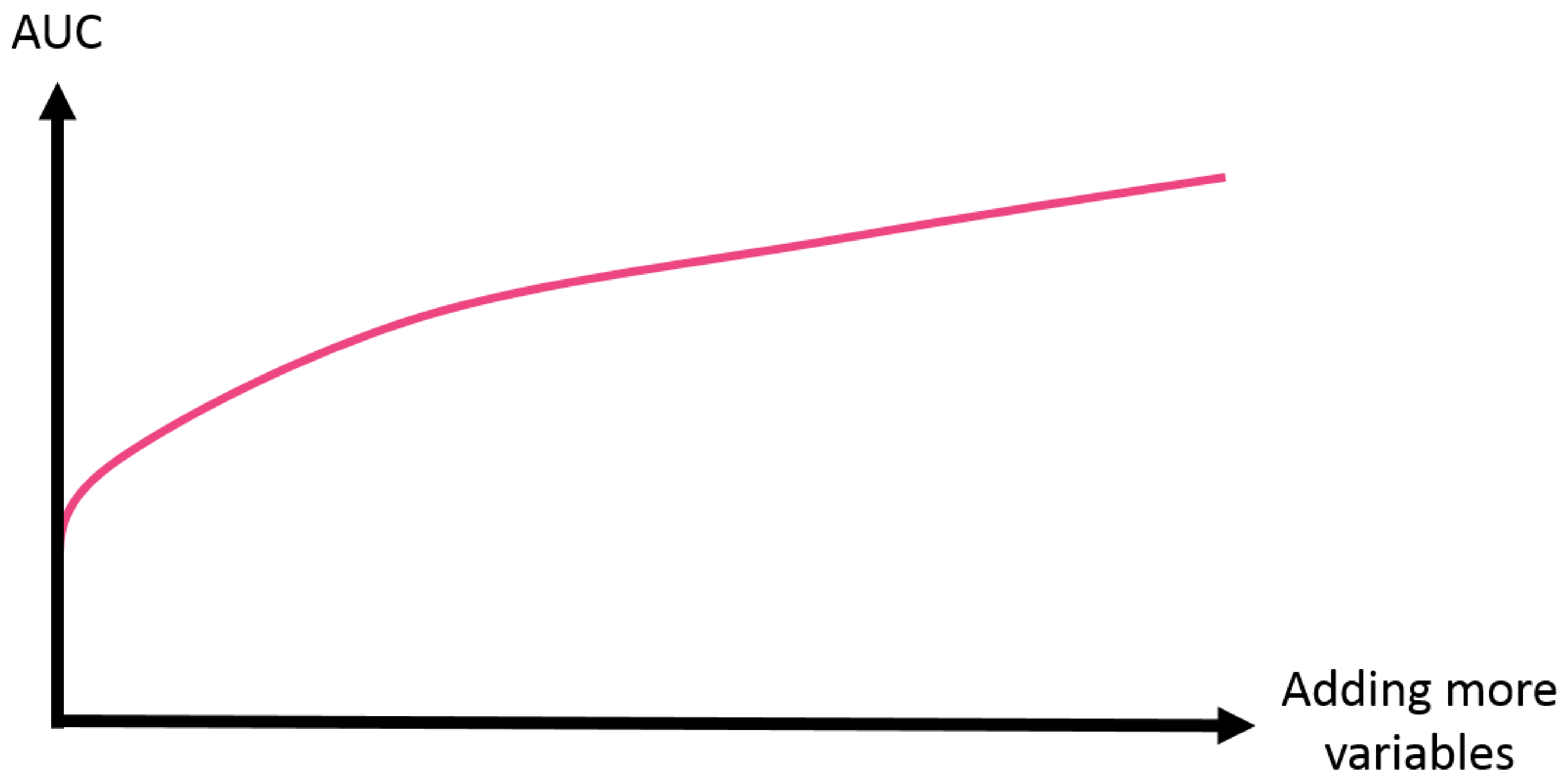
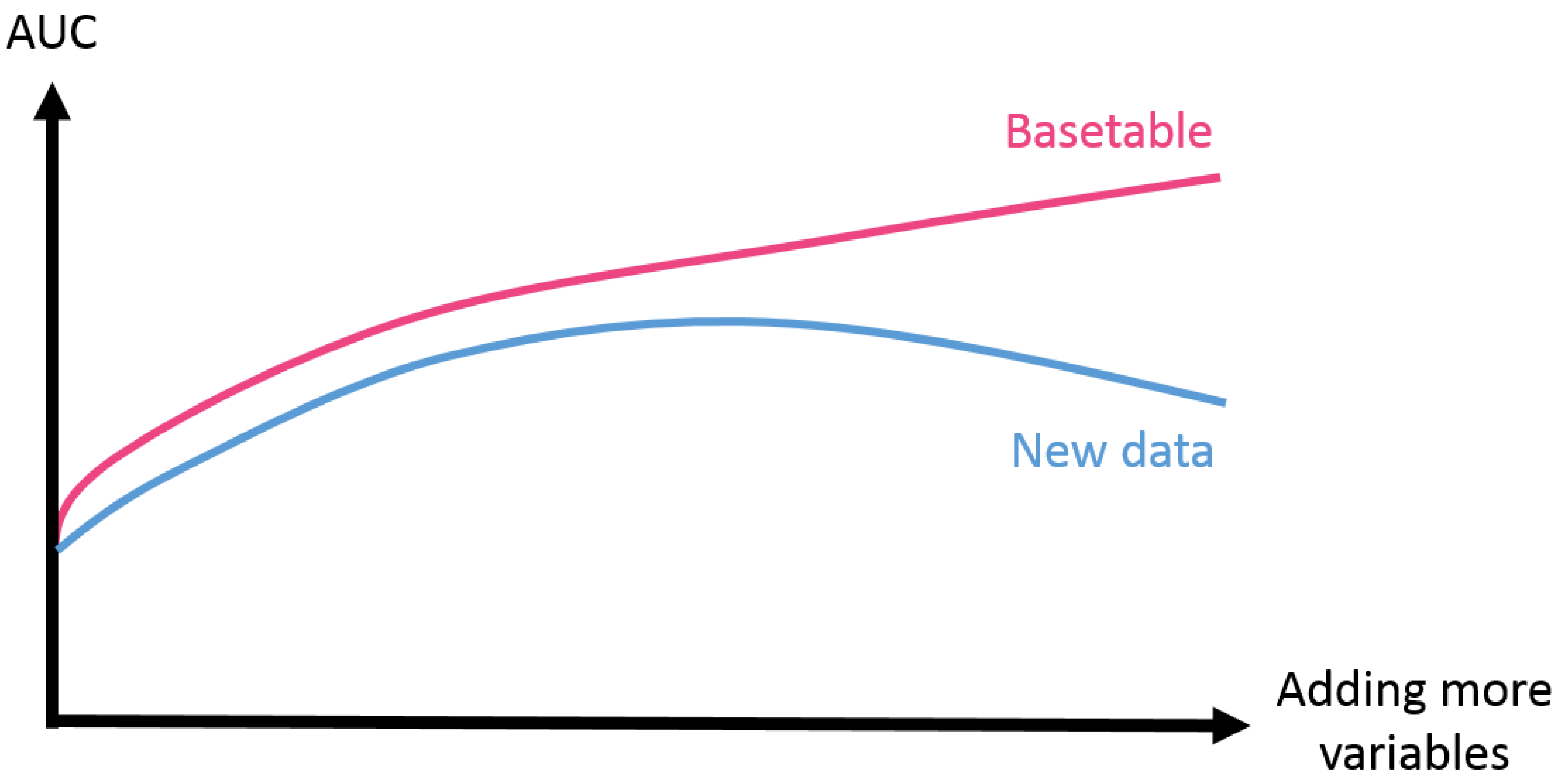
Evaluating the AUC

```
auc_values = []
variables_evaluate = []

for v in variables_forward:
    variables_evaluate.append(v)
    auc_value = auc(variables_evaluate, ["target"], basetable)
    auc_values.append(auc_value)
```

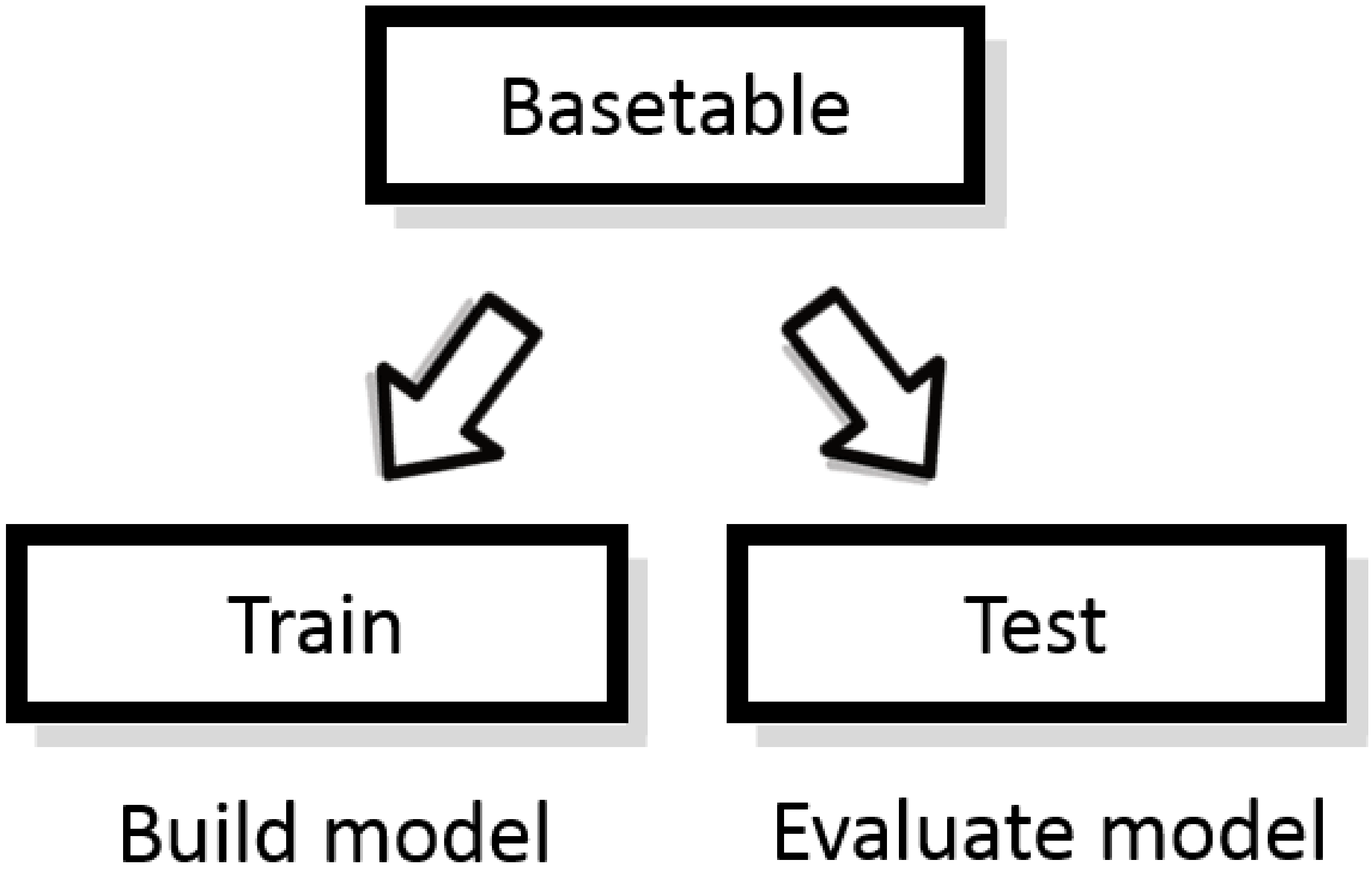
Evaluating the AUC



Over-fitting



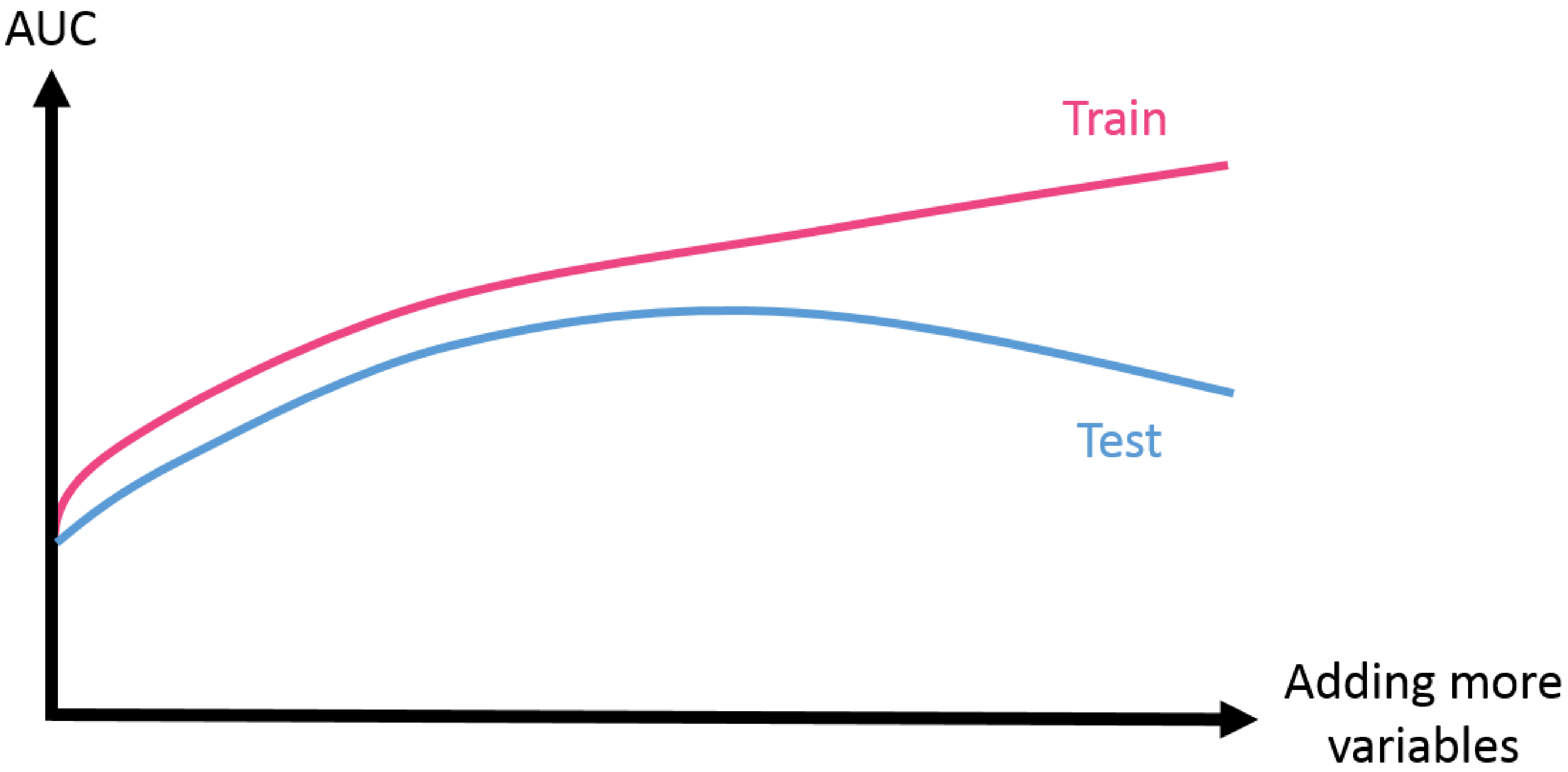
Detecting over-fitting



Partitioning

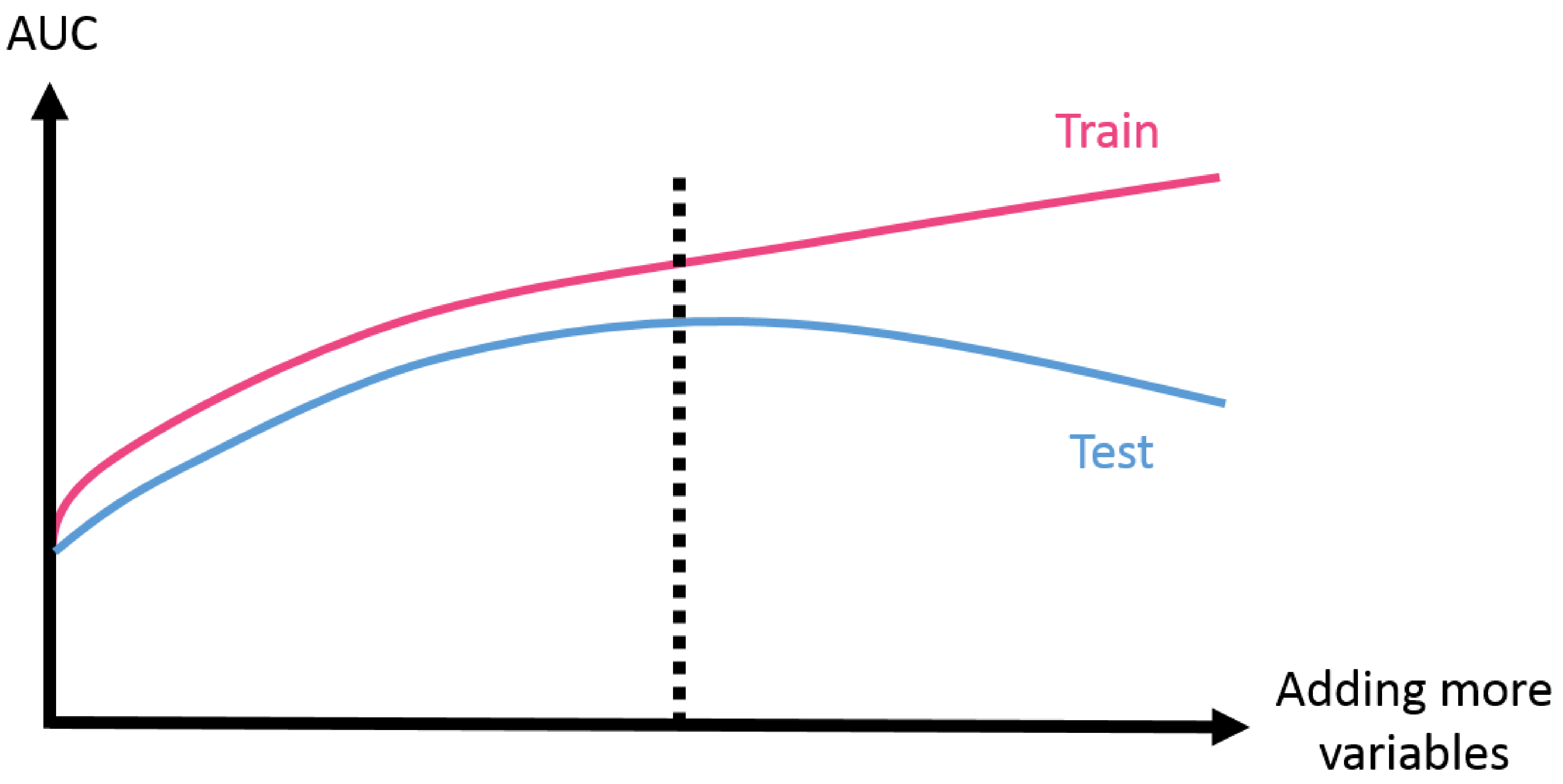
```
from sklearn.cross_validation import train_test_split

X = basetable.drop("target", 1)
y = basetable["target"]

X_train, X_test, y_train, y_test =
    train_test_split(X, y, test_size=0.4, stratify = Y)

train = pd.concat([X_train, y_train], axis=1)
test = pd.concat([X_test, y_test], axis=1)
```

Deciding the cut-off



- High test AUC
- Low number of variables

Deciding the cut-off



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