[544] Spark MLlib

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Outline

ML Review

Training/Predicting APIs

Demos

Machine Learning, Major Ideas

Categories of Machine Learning:

- **Reinforcement learning**: agent makes series of actions to maximize reword
- **Unsupervised learning**: looking for generate patterns
- **Supervised learning:** train models to predict unknowns

Models are functions that return predictions:

```
def my_model(some_info):
    ...
    return some_prediction
```

numeric (1, 2, 3) is "regression"

categorical (A, B, C) is "classification"

Example:

```
def weather_forecast(temp_today, temp_yesterday):
    ...
    return temp_tomorrow
```

Machine Learning, Major Ideas

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Models are functions that return predictions:

```
def my_model(some_info):
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```
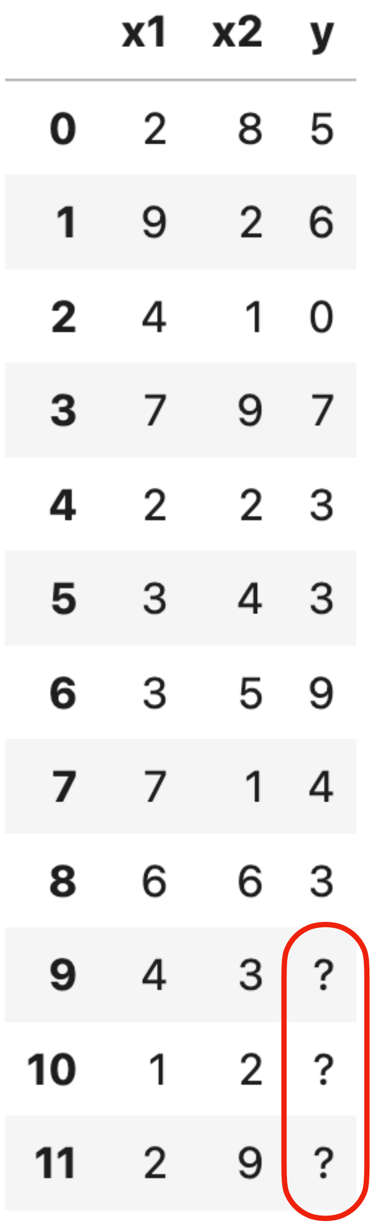

computation usually involves some calculations (multiply, add) with various numbers (parameters). Training is finding parameters that result in good predictions for known training data

Example:

```
def weather_forecast(temp_today, temp_yesterday):
    ...
    return temp_tomorrow
```

Learning from Data

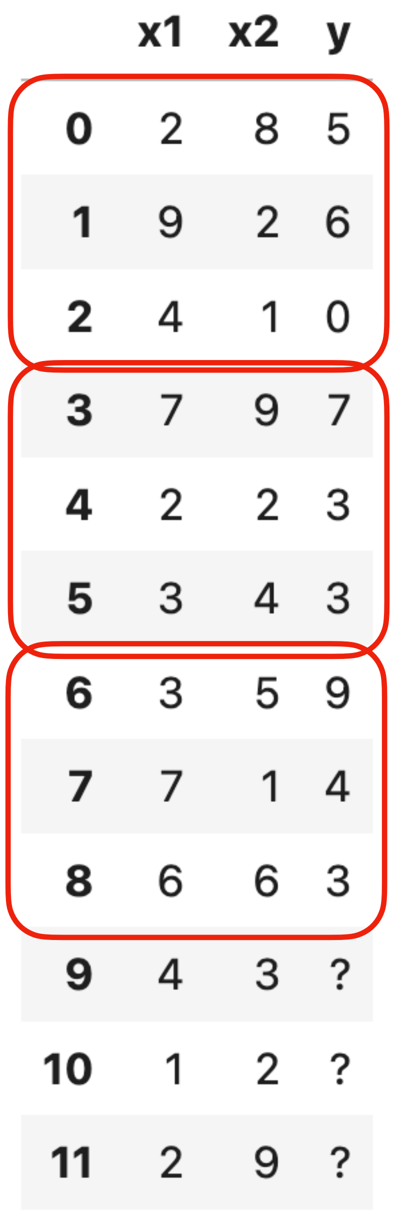


	x1	x2	y
0	2	8	5
1	9	2	6
2	4	1	0
3	7	9	7
4	2	2	3
5	3	4	3
6	3	5	9
7	7	1	4
8	6	6	3
9	4	3	?
10	1	2	?
11	2	9	?

- feature columns: x1 and x2
- label column: y

how can the cases where we DO know y help us predict the cases where we do not?

Learning from Data



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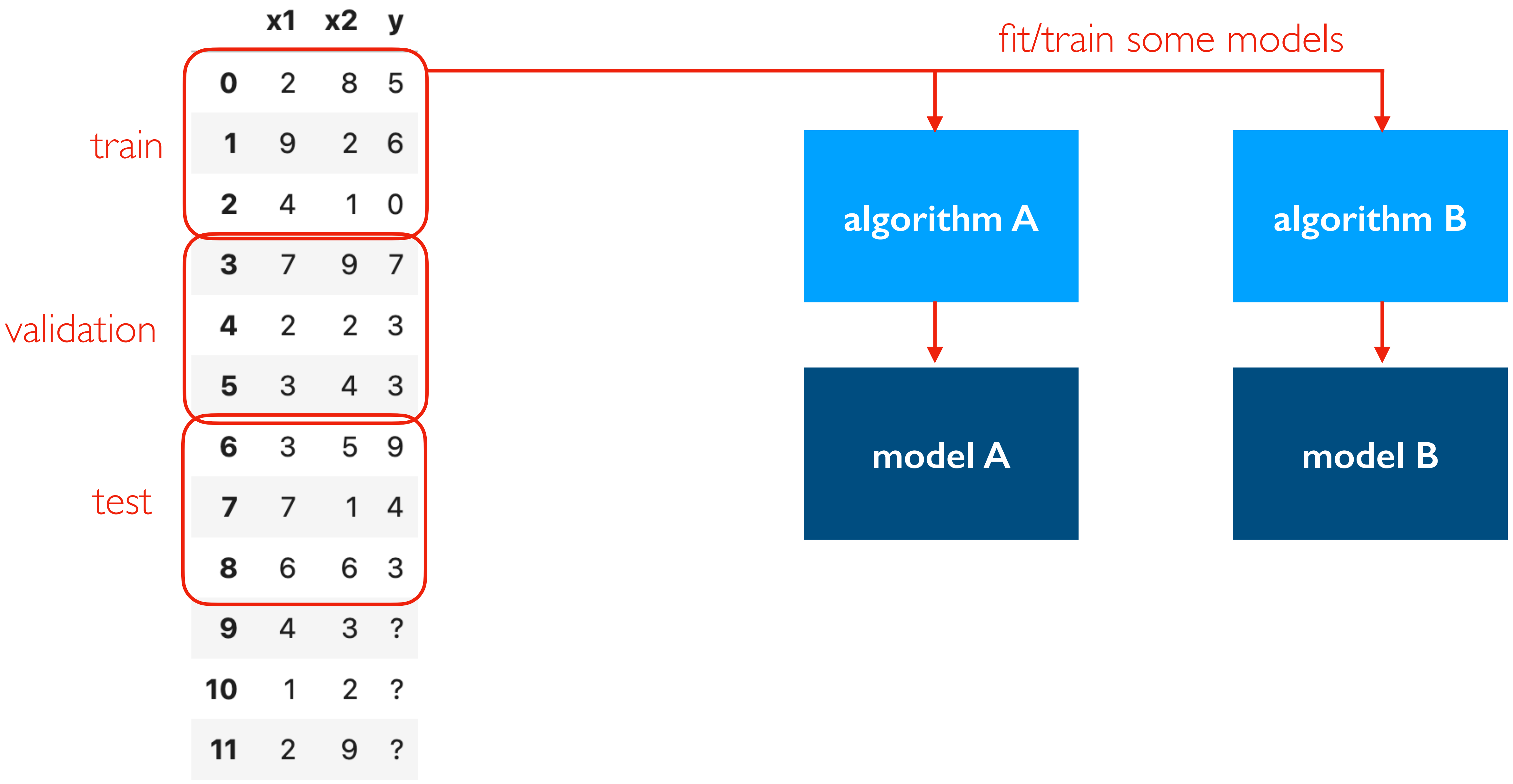
train

validation

test

random split

Learning from Data



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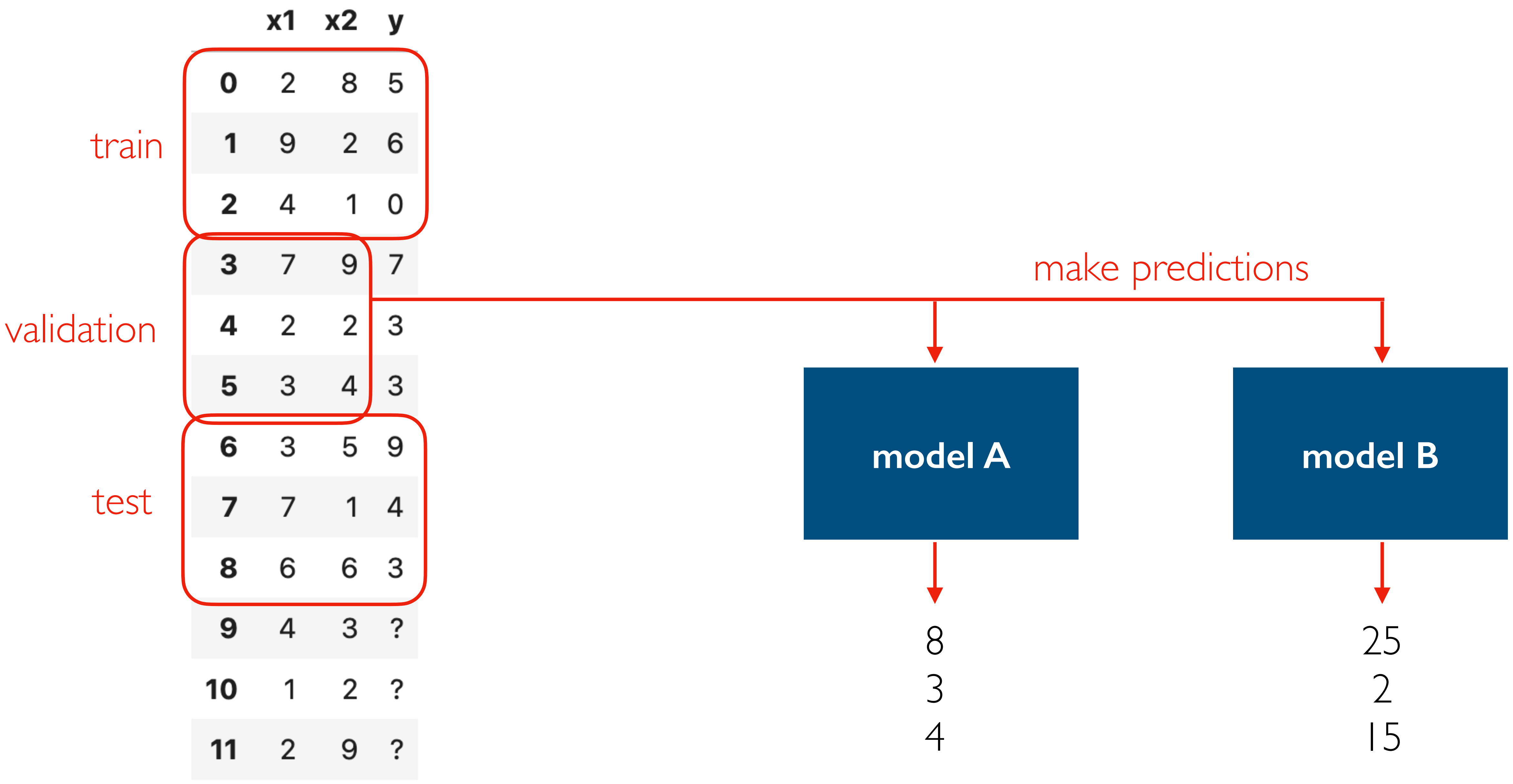
Learning from Data



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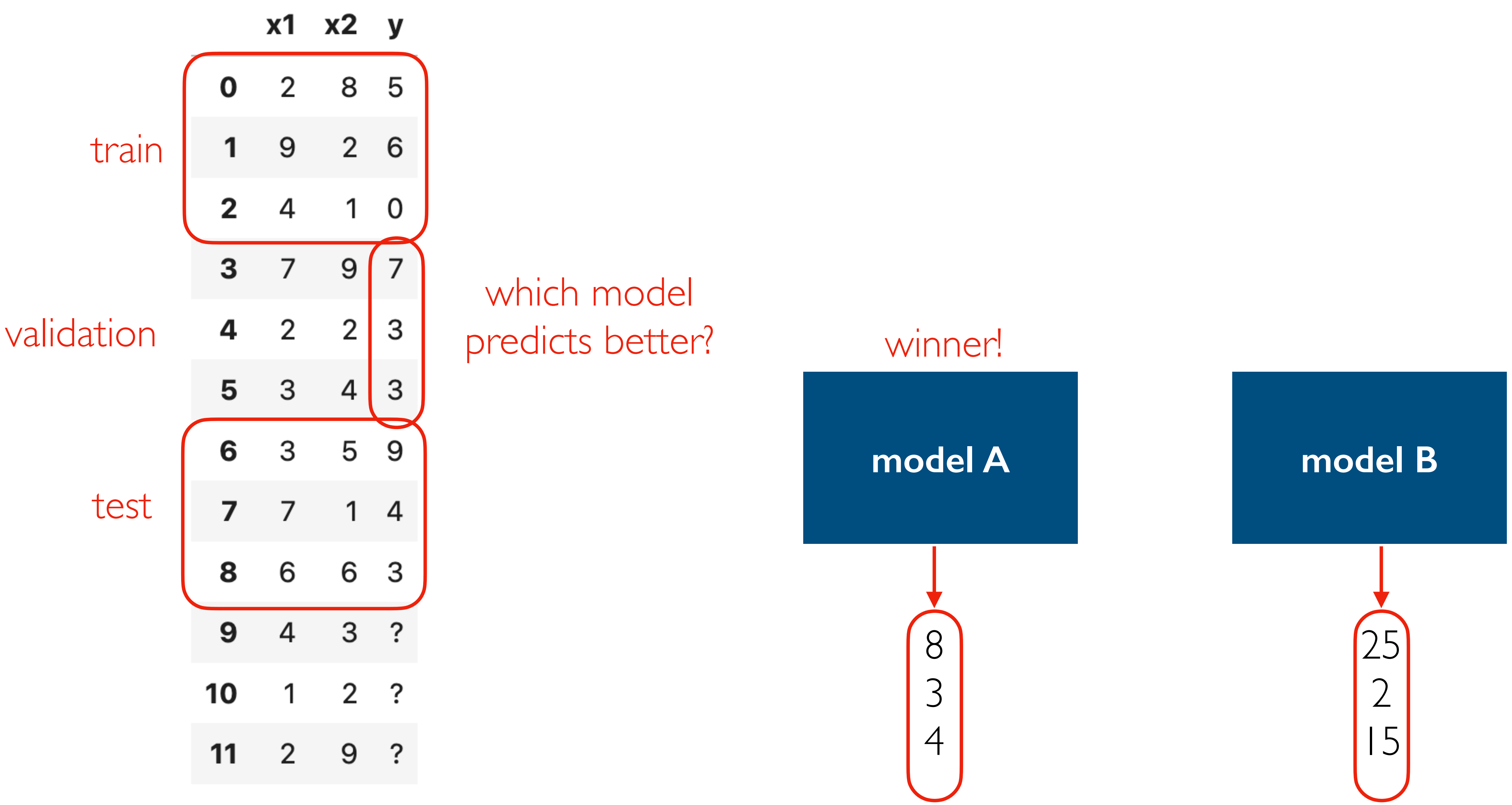
Learning from Data



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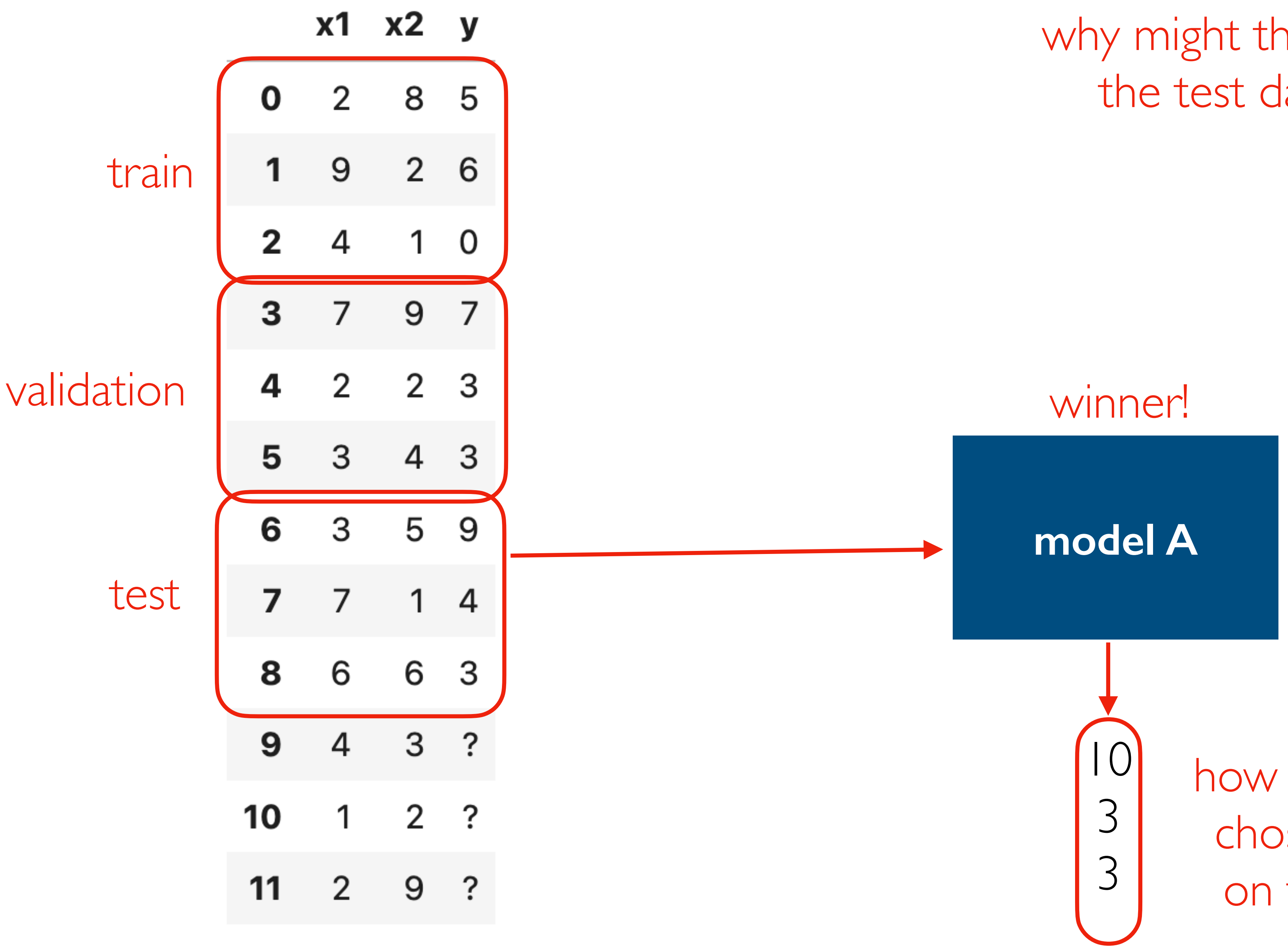
Learning from Data

why might the winning model do worse on the test data than the validation data?



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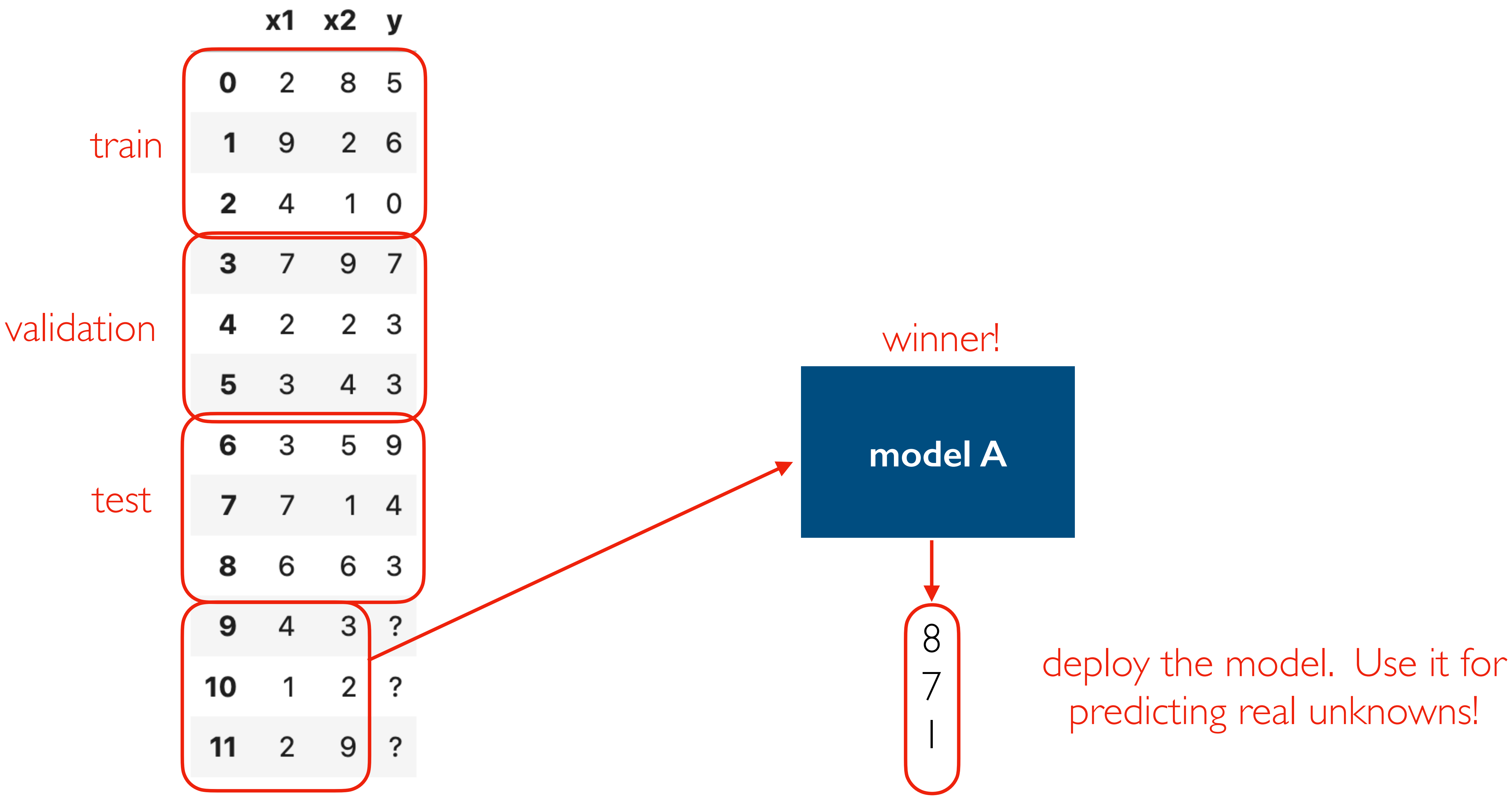
how good does the chosen model do on the test data?

models that do good on train data but bad on validation/test data have "overfitted"

Learning from Data



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train

validation

test

winner!

model A

8
7
1

deploy the model. Use it for predicting real unknowns!

Outline

ML Review

Training/Predicting APIs

- sklearn
- PyTorch
- Spark MLlib

Demos

Training

scikit-learn

```
model = ????
model.fit(X, y)
# model parameters can relate X to y
```

pytorch

```
model = ????
# TODO: optimizer, loss function
# training loop
for epoch in range(????):
    for X, y in ????:
        ...
# model parameters can relate X to y
```

- models are mutable
- fitting sets/improves params

Spark MLlib

```
unfit_model = ????
fit_model = unfit_model.fit(df)
# fit_model params can relate x to y
```

- models are immutable
- fitting returns new model object

Predicting

scikit-learn

```
y = model.predict(X)
```

pytorch

```
y = model(X)
```

Spark MLlib

```
df2 = fit_model.transform(df)
```

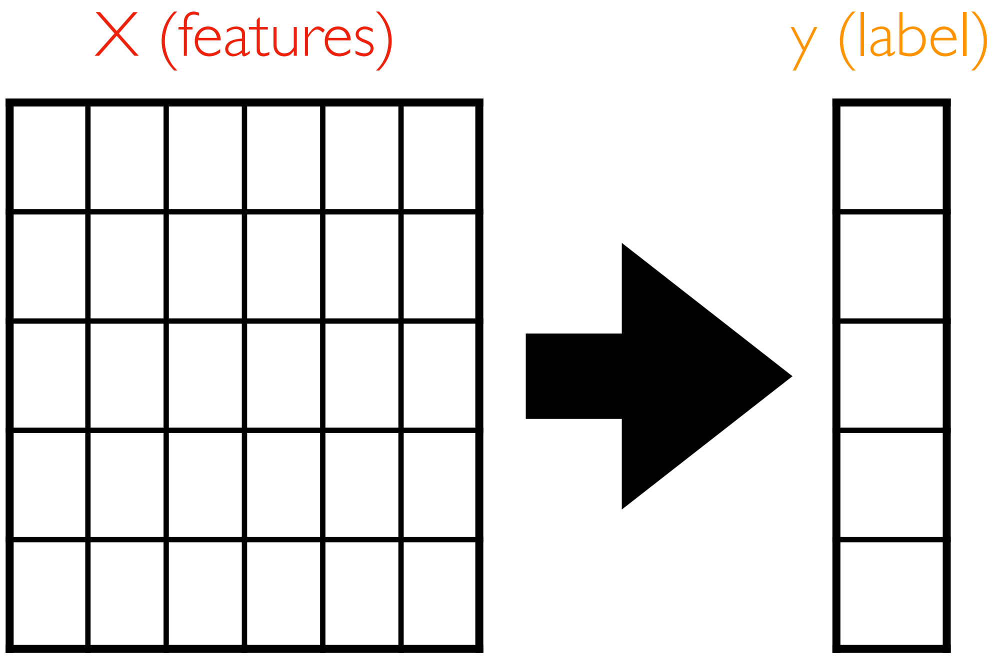
Data

scikit-learn

```
y = model.predict(X)
```

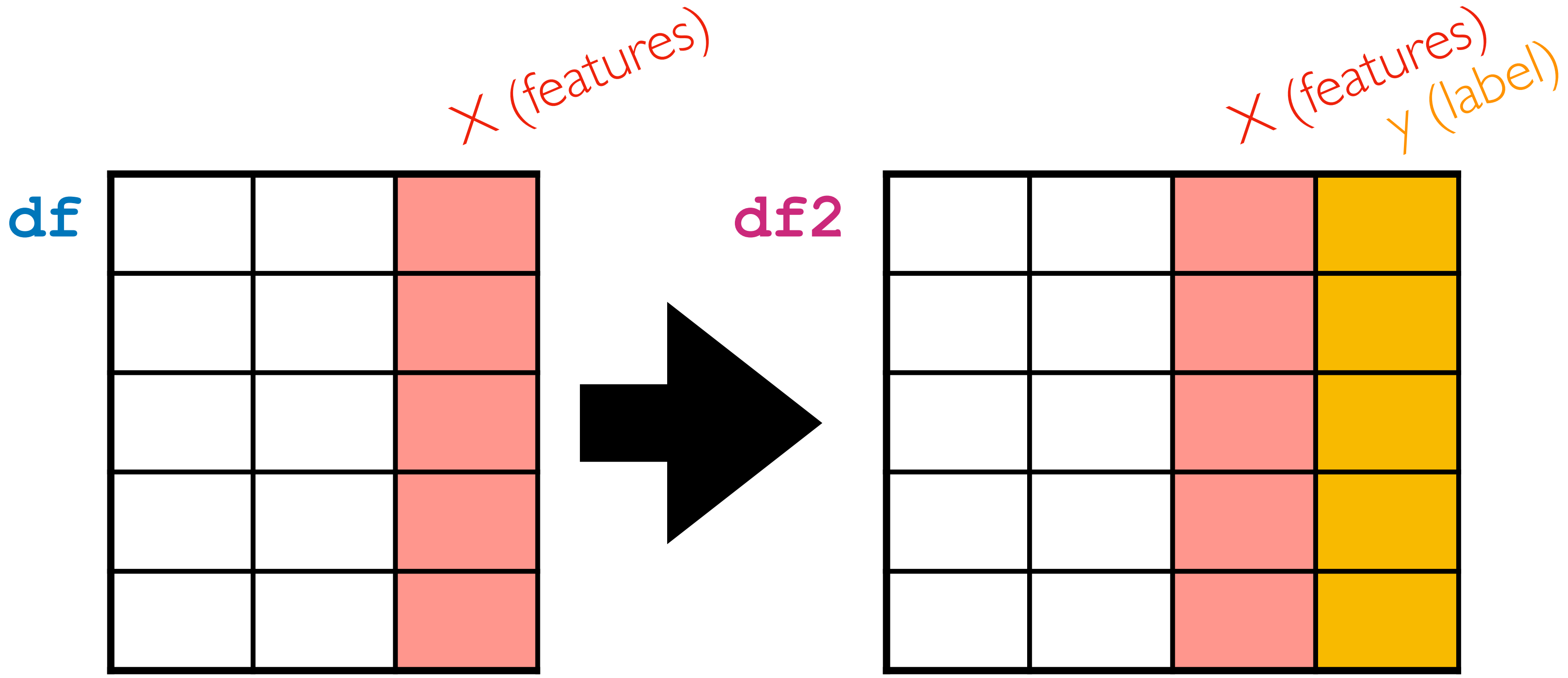
pytorch

```
y = model(X)
```



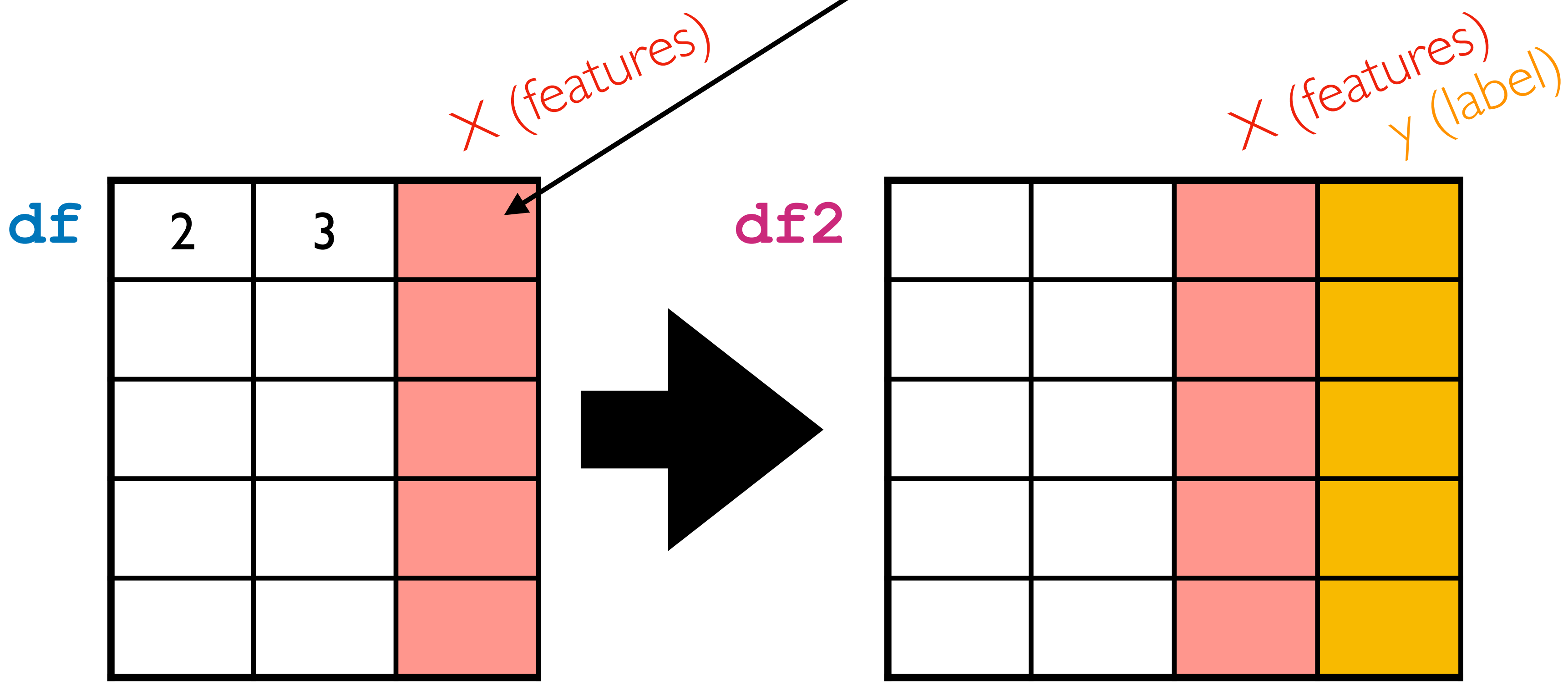
Spark MLlib

```
df2 = fit_model.transform(df)
```



Features Column

- we only get one features column
- it usually contains vectors
- those vectors typically contain values from other columns
- example:
  `(2,3)`



Terminology

Spark and scikit-learn use many of the same terms, with very different meaning.

Transformer (scikit-learn)

- has .tranform method
- takes a DataFrame, returns a differerent DataFrame
- used as preprocessing step for a model

Transformer (Spark)

- has .tranform method
- takes a DataFrame, returns original with 1 or more additional columns
- a fitted model is a transformer that adds a prediction column

Estimator (scikit-learn)

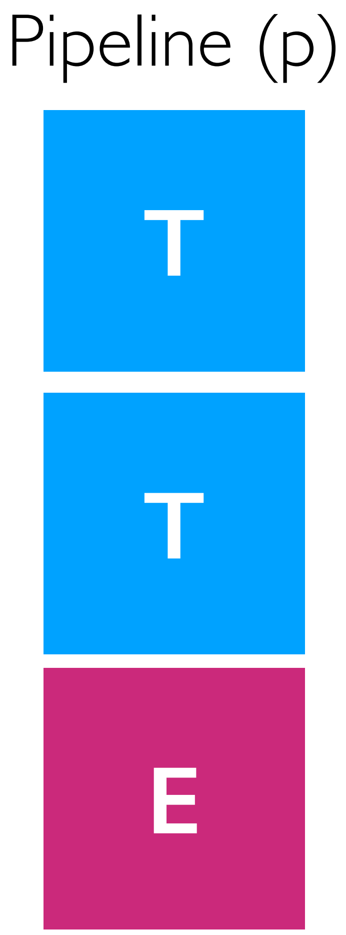
- has .fit and .predict methods
- .fit **modifies** the object
- makes predictions after learning params

Estimator (scikit-learn)

- has .fit method that **returns new object**
- an unfitted model is an estimator; calling .fit returns a fitted model (a transformer)

Pipeline

Both scikit-learn and Spark: a pipeline is a series of stages (transformers/estimators). fit/transform/etc. are called as appropriate on each stage.



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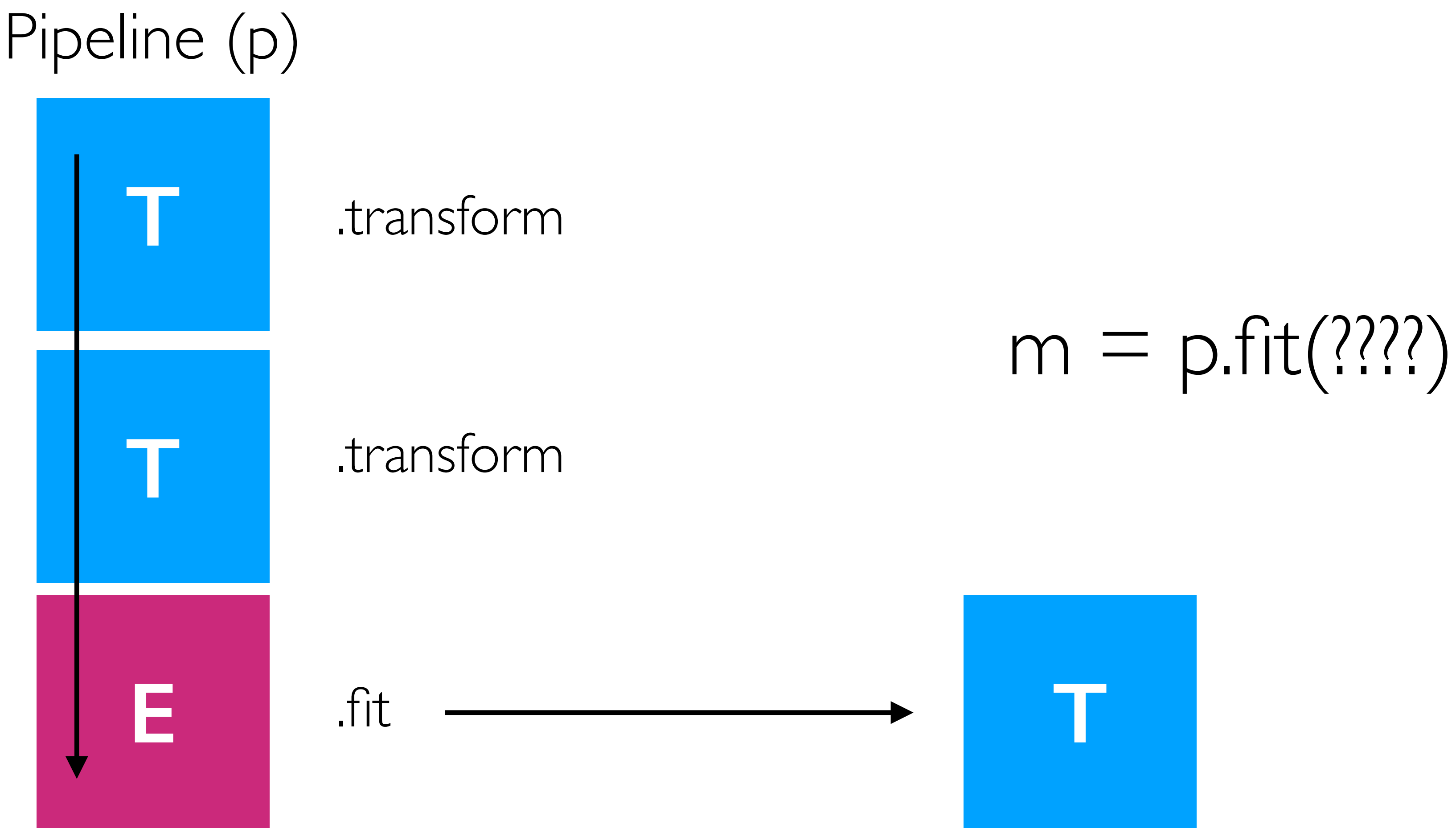

Pipeline (p)

T

.transform

T

.transform

E

.fit

T

m = p.fit(????)

Pipeline

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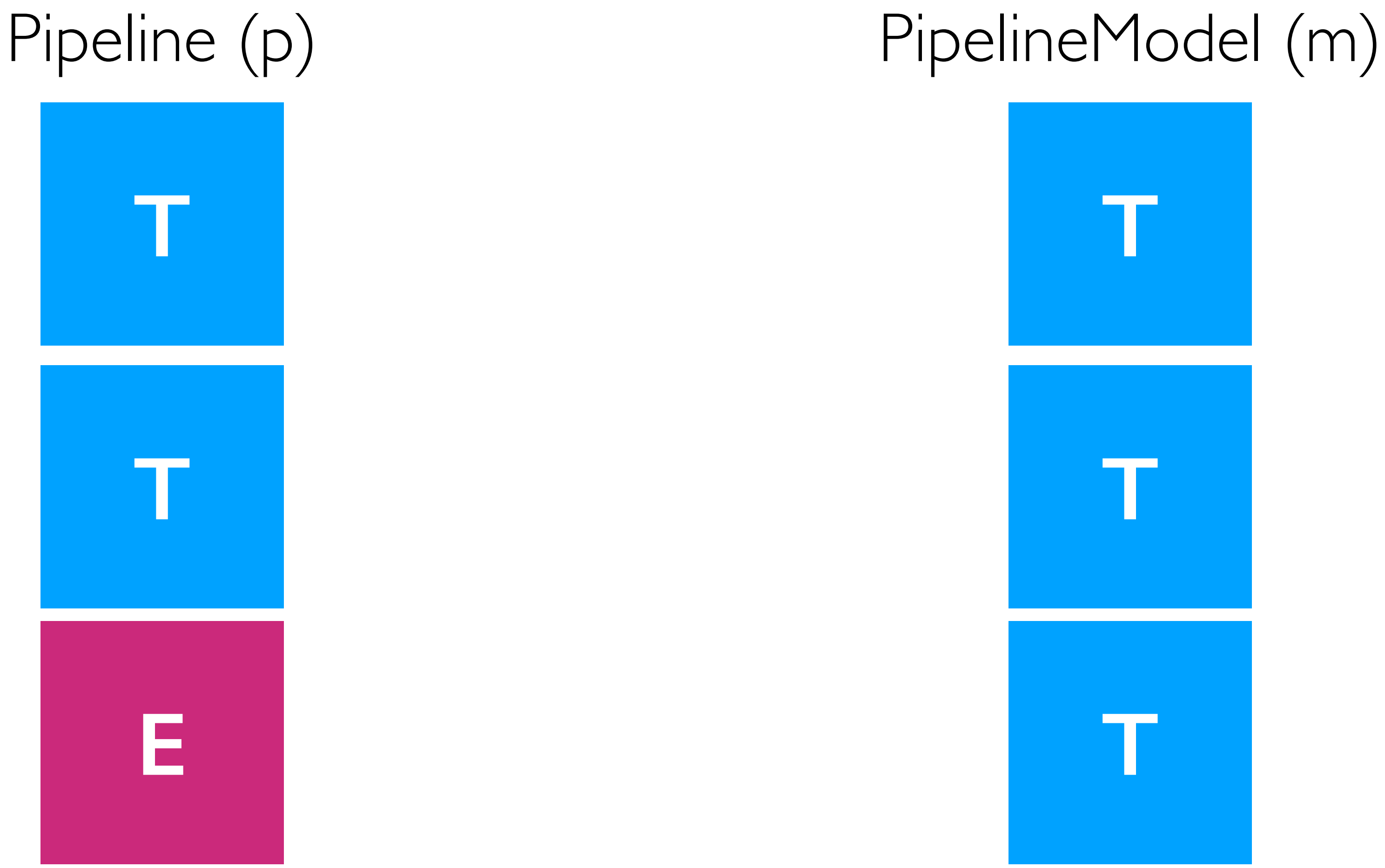

Pipeline (p)

T

T

E

PipelineModel (m)

T

T

T

Pipeline

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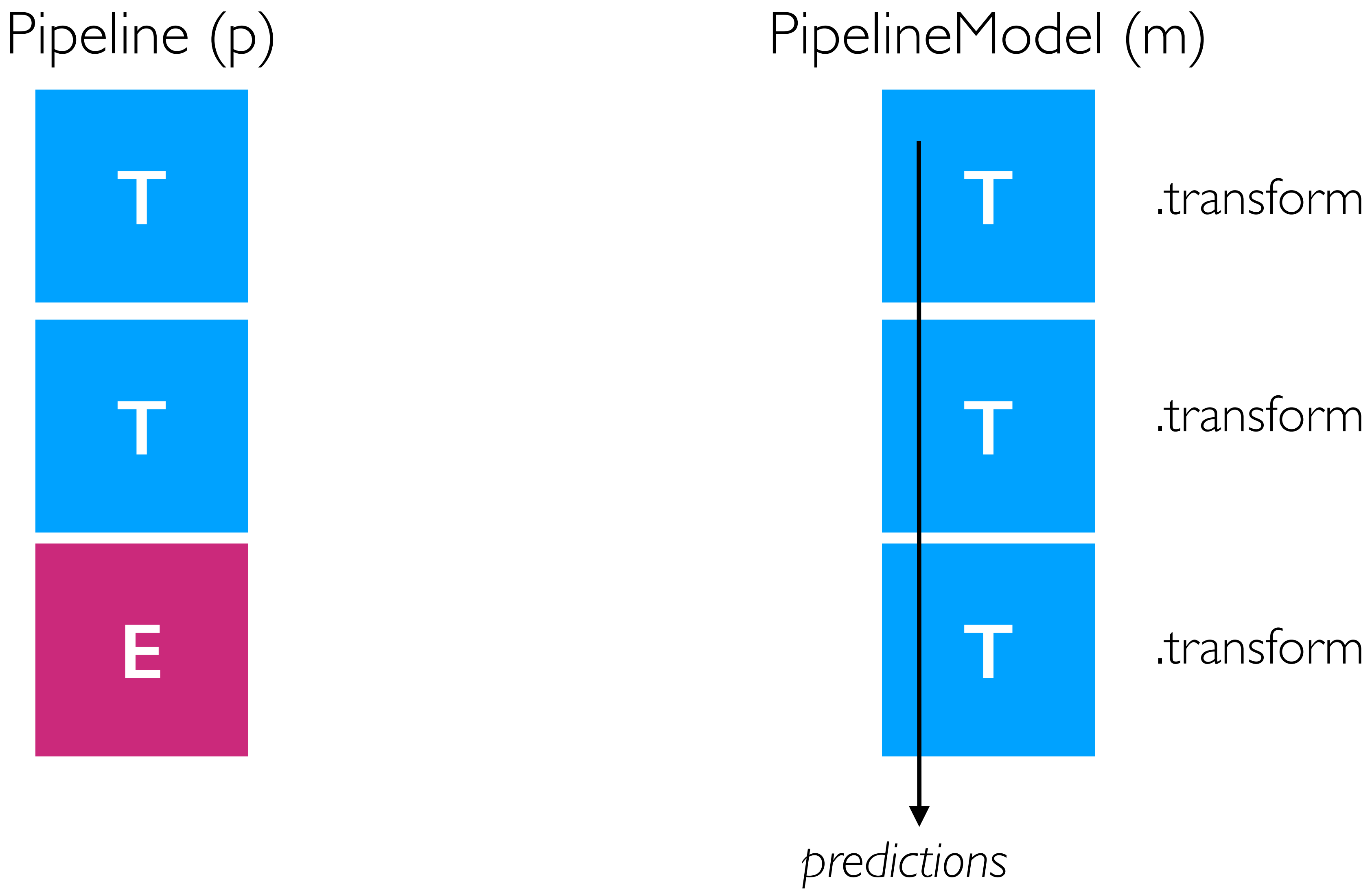

Pipeline (p)

PipelineModel (m)

.transform

.transform

.transform

predictions

m.transform(????)

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Spark mllib packages

- pyspark.mllib -- based on RDDs
- pyspark.ml -- based on DataFrames