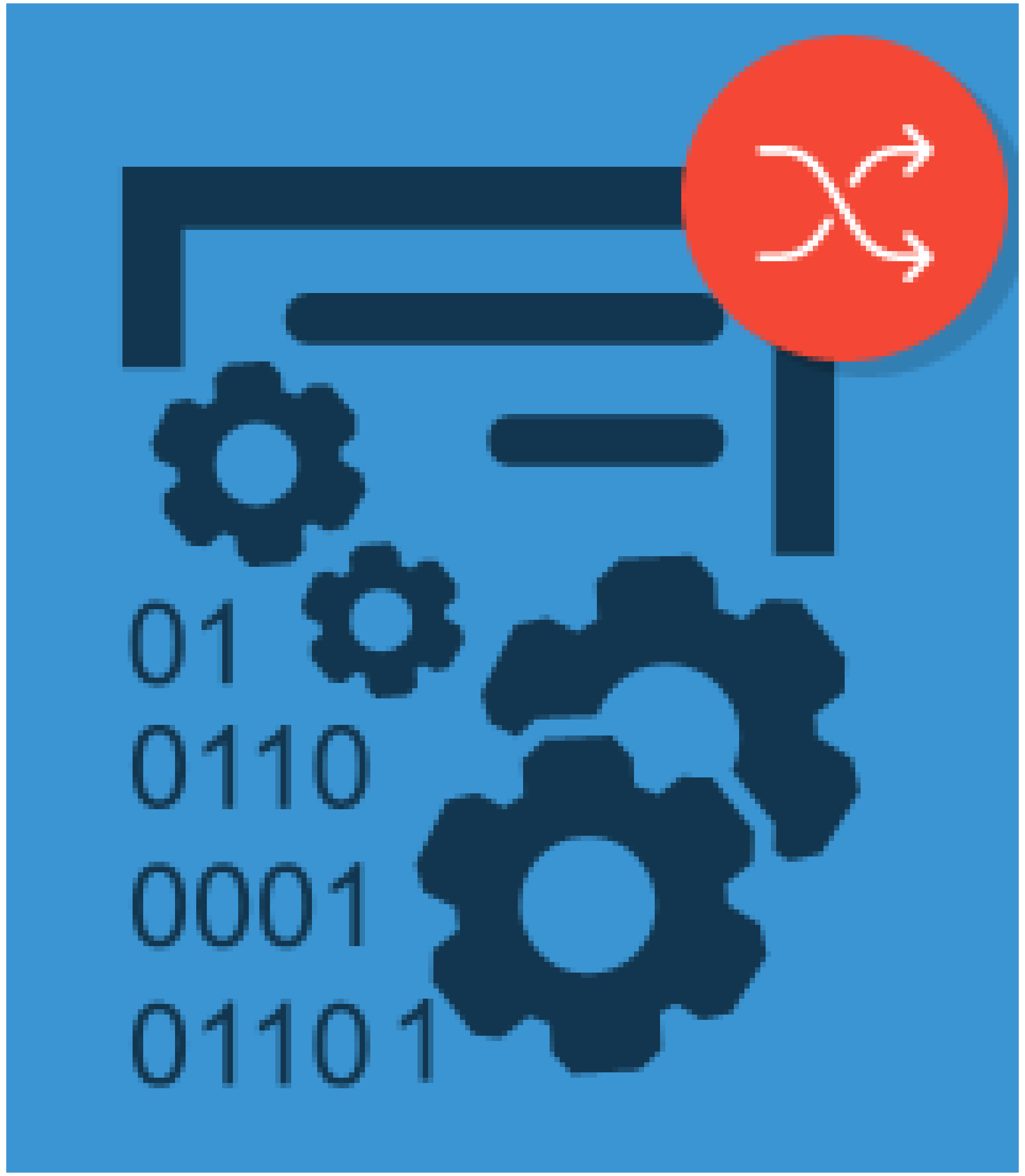
Feature Generation

FEATURE ENGINEERING WITH PYSPARK

John Hogue

Lead Data Scientist

Why generate new features?



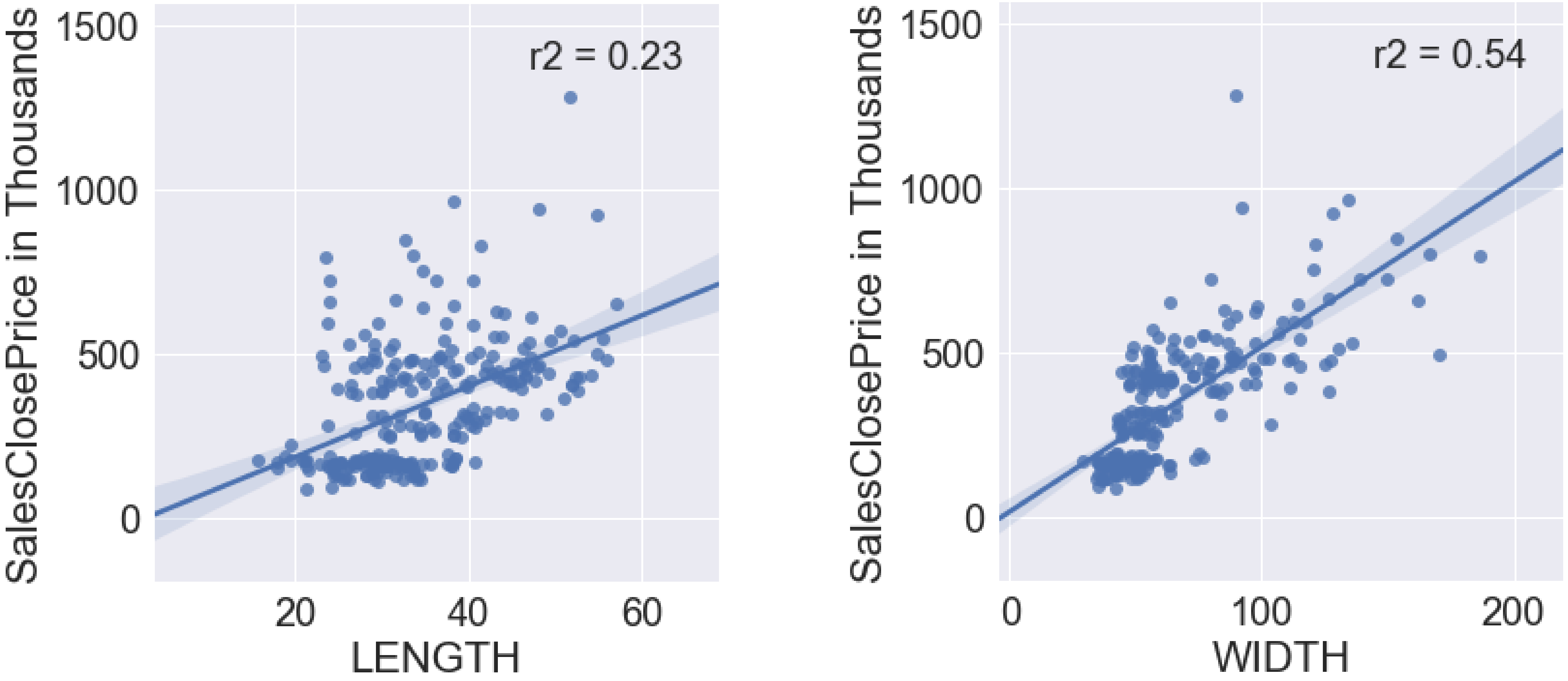
Multiplying

Summing

Differencing

Dividing

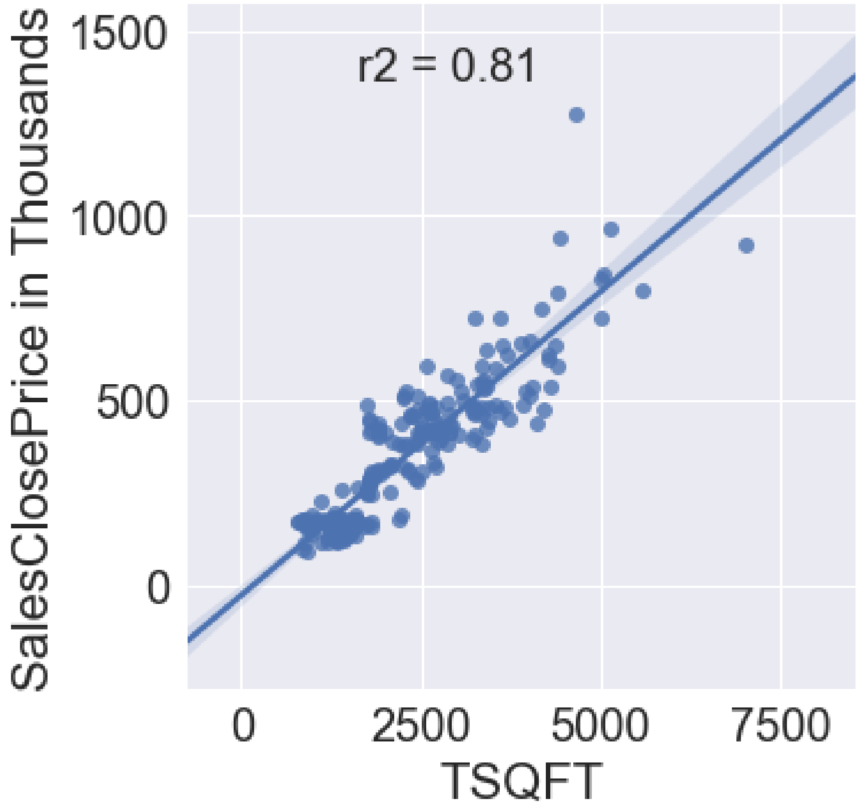
Why generate new features?



Combining Two Features

Multiplication

```
# Creating a new feature, area by multiplying
df = df.withColumn('TSQFT', (df['WIDTH'] * df['LENGTH']))
```



Other Ways to Combine Two Features

```
# Sum two columns
df = df.withColumn('TSQFT', (df['SQFTBELOWGROUND'] + df['SQFTABOVEGROUND']))
```

```
# Divide two columns
df = df.withColumn('PRICEPERTSQFT', (df['LISTPRICE'] / df['TSQFT']))
```

```
# Difference two columns
df = df.withColumn('DAYSONMARKET', datediff('OFFMARKETDATE', 'LISTDATE'))
```

What's the limit?

Automation of Features

- FeatureTools & TSFresh
- Explosion of Features
- Higher Order & Beyond?

Go forth and combine!

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Time Features

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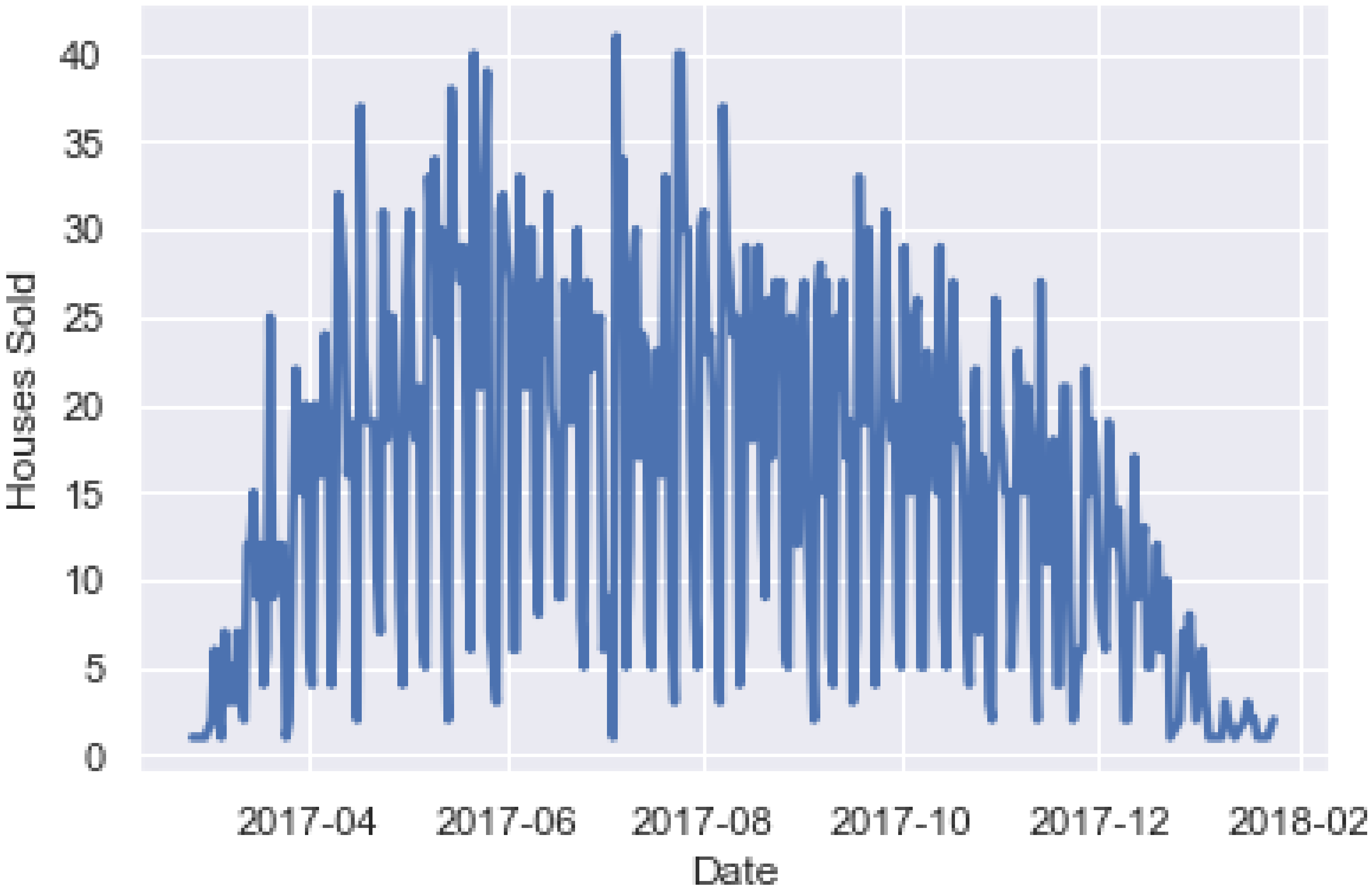
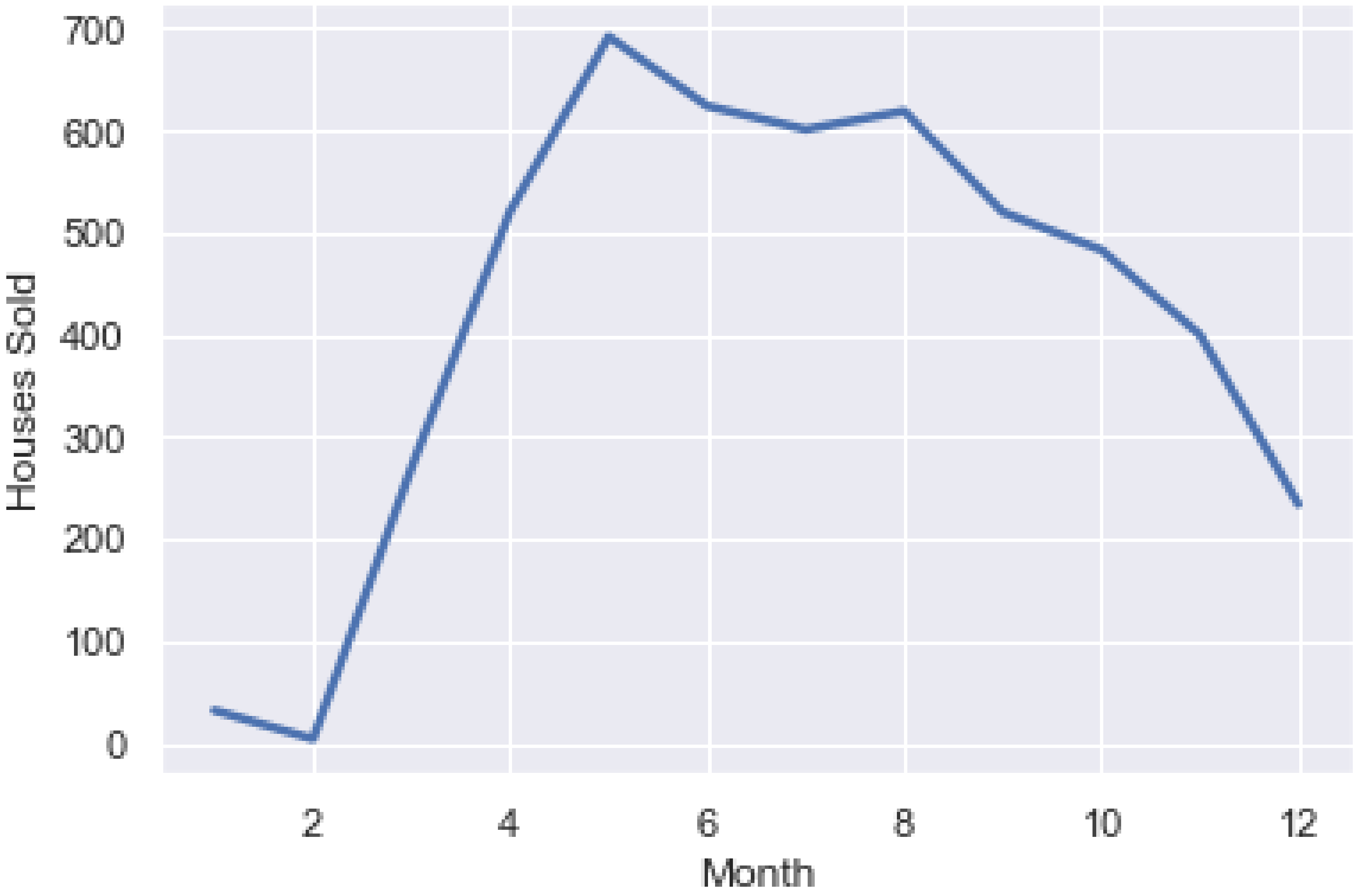
The Cyclical Nature of Things

Choosing the Right Level



Choosing the Right Level



Treating Date Fields as Dates...

```python
from pyspark.sql.functions import to_date

# Cast the data type to Date
df = df.withColumn('LISTDATE', to_date('LISTDATE'))
```

```python
# Inspect the field
df[['LISTDATE']].show(2)
```

```
+----------+
|  LISTDATE|
+----------+
|2017-07-14|
|2017-10-08|
+----------+
only showing top 2 rows
```

Time Components

```
from pyspark.sql.functions import year, month

# Create a new column of year number
df = df.withColumn('LIST_YEAR', year('LISTDATE'))
```

```
# Create a new column of month number
df = df.withColumn('LIST_MONTH', month('LISTDATE'))
```

```
from pyspark.sql.functions import dayofmonth, weekofyear

# Create new columns of the day number within the month
df = df.withColumn('LIST_DAYOFMONTH', dayofmonth('LISTDATE'))
```

```
# Create new columns of the week number within the year
df = df.withColumn('LIST_WEEKOFYEAR', weekofyear('LISTDATE'))
```

Basic Time Based Metrics

```
from pyspark.sql.functions import datediff

# Calculate difference between two date fields
df.withColumn('DAYSONMARKET', datediff('OFFMARKETDATE', 'LISTDATE'))
```

Lagging Features

`window()`

Returns a record based off a group of records

`lag(col, count=1)`

Returns the value that is offset by rows before the current row

Lagging Features, the PySpark Way

```
from pyspark.sql.functions import lag
from pyspark.sql.window import Window
# Create Window
w = Window().orderBy(m_df['DATE'])
# Create lagged column
m_df = m_df.withColumn('MORTGAGE-1wk', lag('MORTGAGE', count=1).over(w))
# Inspect results
m_df.show(3)
```

```
+----------+------------+----------------+
|      DATE|    MORTGAGE|    MORTGAGE-1wk|
+----------+------------+----------------+
|2013-10-10|        4.23|            null|
|2013-10-17|        4.28|            4.23|
|2013-10-24|        4.13|            4.28|
+----------+------------+----------------+
only showing top 3 rows
```

It's TIME to practice!

FEATURE ENGINEERING WITH PYSPARK

Extracting Features

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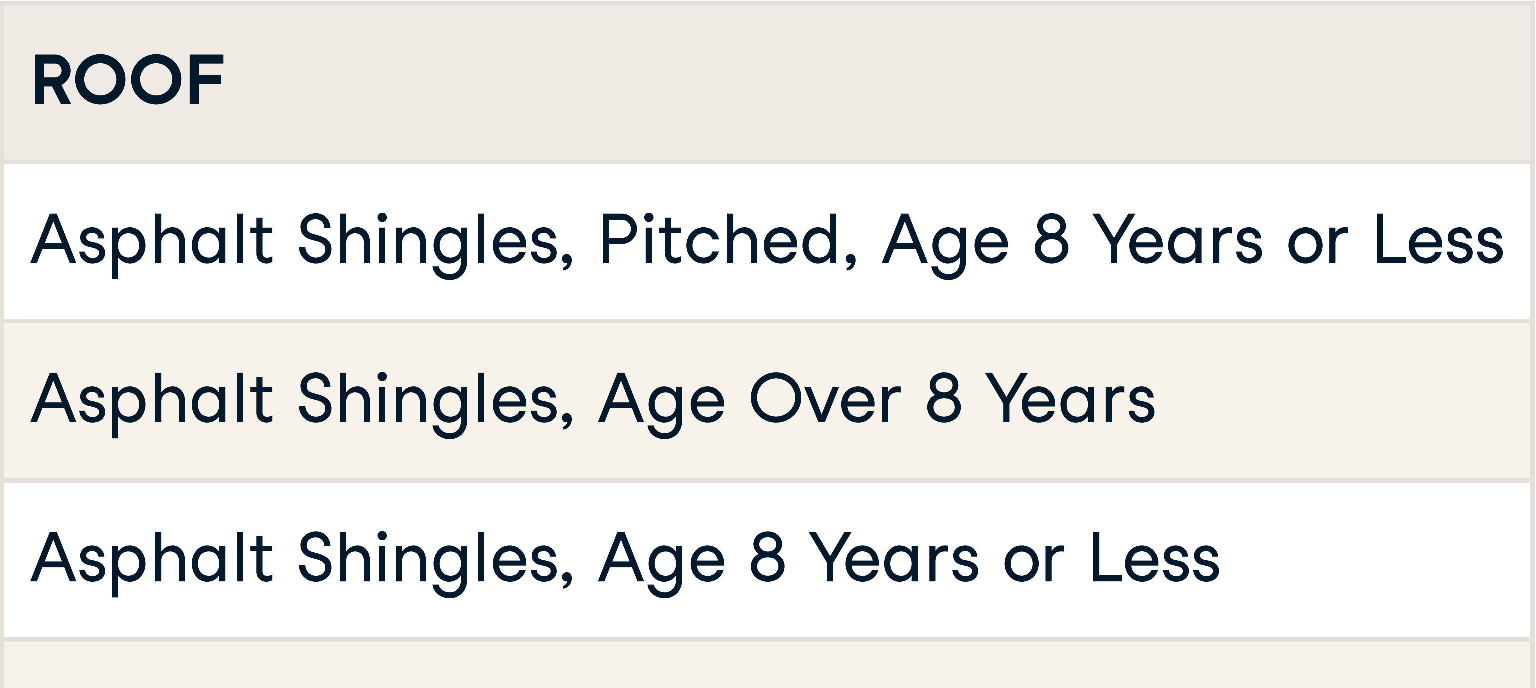
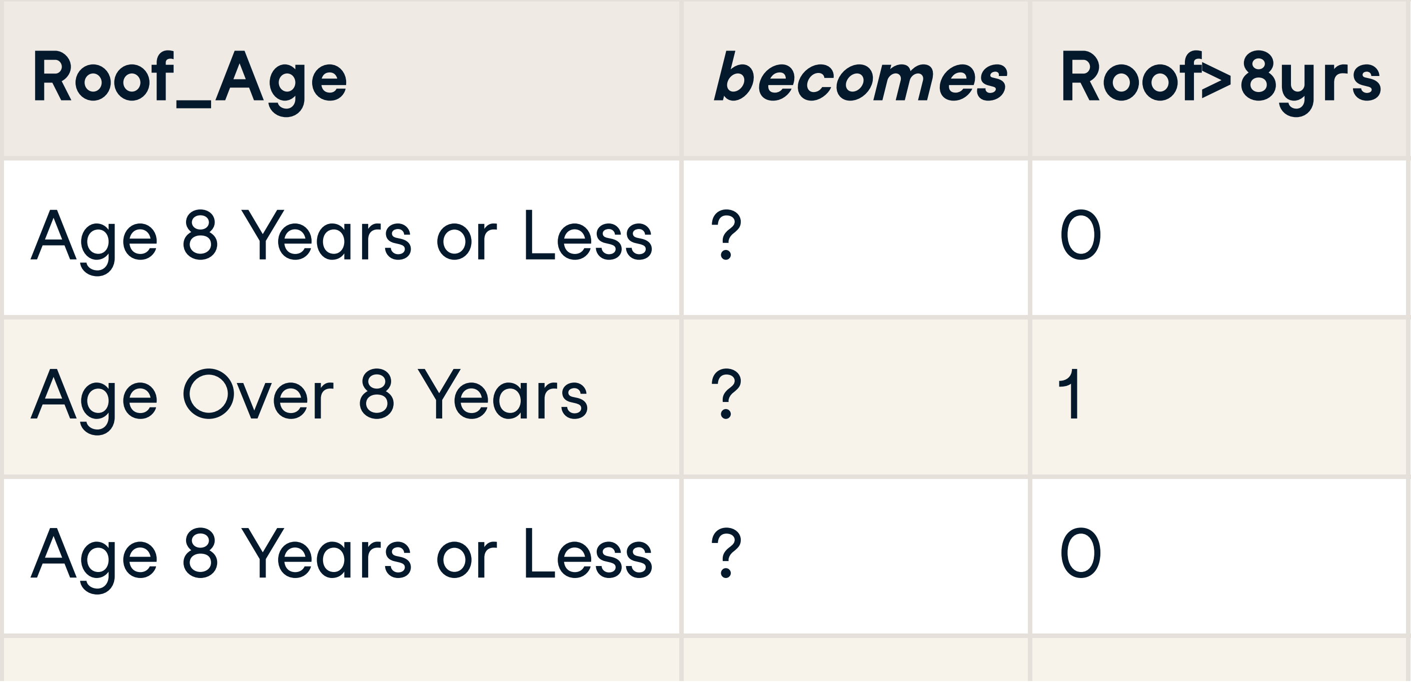
Lead Data Scientist, General Mills

Extracting Age with Text Match



ROOF
Asphalt Shingles, Pitched, Age 8 Years or Less
Asphalt Shingles, Age Over 8 Years
Asphalt Shingles, Age 8 Years or Less



Roof_Age	*becomes*	Roof>8yrs
Age 8 Years or Less	?	0
Age Over 8 Years	?	1
Age 8 Years or Less	?	0

Extracting Age with Text Match

```
from pyspark.sql.functions import when
# Create boolean filters
find_under_8 = df['ROOF'].like('%Age 8 Years or Less%')
find_over_8 = df['ROOF'].like('%Age Over 8 Years%')
# Apply filters using when() and otherwise()
df = df.withColumn('old_roof', (when(find_over_8, 1)
                                .when(find_under_8, 0)
                                .otherwise(None)))
# Inspect results
df[['ROOF', 'old_roof']].show(3, truncate=100)
```

```
+----------------------------------------------+--------+
|                                          ROOF|old_roof|
+----------------------------------------------+--------+
|                                          null|    null|
|Asphalt Shingles, Pitched, Age 8 Years or Less|       0|
|            Asphalt Shingles, Age Over 8 Years|       1|
+----------------------------------------------+--------+
only showing top 3 rows
```

Splitting Columns

ROOF	*becomes*	Roof_Material
Asphalt Shingles, Pitched, Age 8 Years or Less	?	Asphalt Shingles
Null	?	
Asphalt Shingles, Age Over 8 Years	?	Asphalt Shingles
Metal, Age 8 Years or Less	?	Metal
Tile, Age 8 Years or Less	?	Tile
Asphalt Shingles	?	Asphalt Shingles

Splitting Columns

```python
from pyspark.sql.functions import split
# Split the column on commas into a list
split_col = split(df['ROOF'], ',')
# Put the first value of the list into a new column
df = df.withColumn('Roof_Material', split_col.getItem(0))
# Inspect results
df[['ROOF', 'Roof_Material']].show(5, truncate=100)
```

```
+----------------------------------------------+----------------+
|                                          ROOF|   Roof_Material|
+----------------------------------------------+----------------+
|                                          null|            null|
|Asphalt Shingles, Pitched, Age 8 Years or Less|Asphalt Shingles|
|                                          null|            null|
|Asphalt Shingles, Pitched, Age 8 Years or Less|Asphalt Shingles|
|            Asphalt Shingles, Age Over 8 Years|Asphalt Shingles|
+----------------------------------------------+----------------+
only showing top 5 rows
```

Explode!

Starting Record

NO	roof_list
2	[Asphalt Shingles, Pitched, Age 8 Years or Less]

Exploded Record

NO	ex_roof_list
2	Asphalt Shingles
2	Pitched
2	Age 8 Years or Less

Pivot!

Exploded Record

NO	ex_roof_list
2	Asphalt Shingles
2	Pitched
2	Age 8 Years or Less

Pivoted Record

NO	Age 8 Years or Less	Age Over 8 Years	Asphalt Shingles	Flat	Metal	Other	Pitched	...
2	0	1	1	0	0	0	1	...

Explode & Pivot!

```python
from pyspark.sql.functions import split, explode, lit, coalesce, first
```

```python
# Split the column on commas into a list
df = df.withColumn('roof_list', split(df['ROOF'], ', '))
```

```python
# Explode list into new records for each value
ex_df = df.withColumn('ex_roof_list', explode(df['roof_list']))
```

```python
# Create a dummy column of constant value
ex_df = ex_df.withColumn('constant_val', lit(1))
```

```python
# Pivot the values into boolean columns
piv_df = ex_df.groupBy('NO').pivot('ex_roof_list')\
  .agg(coalesce(first('constant_val')))
```

Let's wrangle some features!

FEATURE ENGINEERING WITH PYSPARK

Binarizing, Bucketing & Encoding

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Lead Data Scientist

Binarizing

FIREPLACES	*becomes*	Has_Fireplace
1	?	1
3	?	1
1	?	1
2	?	1
0	?	0

Binarizing

```
from pyspark.ml.feature import Binarizer
# Cast the data type to double
df = df.withColumn('FIREPLACES', df['FIREPLACES'].cast('double'))
# Create binarizing transformer
bin = Binarizer(threshold=0.0, inputCol='FIREPLACES', outputCol='FireplaceT')
# Apply the transformer
df = bin.transform(df)
# Inspect the results
df[['FIREPLACES','FireplaceT']].show(3)
```

```
+----------+-------------+
|FIREPLACES|   FireplaceT|
+----------+-------------+
|       0.0|          0.0|
|       1.0|          1.0|
|       2.0|          1.0|
+----------+-------------+
only showing top 3 rows
```

Bucketing

```python
from pyspark.ml.feature import Bucketizer
# Define how to split data
splits = [0, 1, 2, 3, 4, float('Inf')]
# Create bucketing transformer
buck = Bucketizer(splits=splits, inputCol='BATHSTOTAL', outputCol='baths')
# Apply transformer
df = buck.transform(df)
# Inspect results
df[['BATHSTOTAL', 'baths']].show(4)
```

```
+----------+-----------------+
|BATHSTOTAL|baths            |
+----------+-----------------+
|         2|              2.0|
|         3|              3.0|
|         1|              1.0|
|         5|              4.0|
+----------+-----------------+
only showing top 4 rows
```

One Hot Encoding

CITY	*becomes*	LELM	MAPW	OAKD	STP	WB
LELM - Lake Elmo	?	1	0	0	0	0
MAPW - Maplewood	?	0	1	0	0	0
OAKD - Oakdale	?	0	0	1	0	0
STP - Saint Paul	?	0	0	0	1	0
WB - Woodbury	?	0	0	0	0	1

One Hot Encoding the PySpark Way

```
from pyspark.ml.feature import OneHotEncoder, StringIndexer
```

```
# Create indexer transformer
stringIndexer = StringIndexer(inputCol='CITY', outputCol='City_Index')
```

```
# Fit transformer
model = stringIndexer.fit(df)
# Apply transformer
indexed = model.transform(df)
```

One Hot Encoding the PySpark Way

```
# Create encoder transformer
encoder = OneHotEncoder(inputCol='City_Index', outputCol='City_Vec)
```

```
# Apply the encoder transformer
encoded_df = encoder.transform(indexed)
```

```
# Inspect results
encoded_df[['City_Vec']].show(4)
```

```
+-------------+
|     City_Vec|
+-------------+
|    (4,[],[])|
|    (4,[],[])|
|(4,[2],[1.0])|
|(4,[2],[1.0])|
+-------------+
only showing top 4 rows
```

Get Transforming!

FEATURE ENGINEERING WITH PYSPARK