

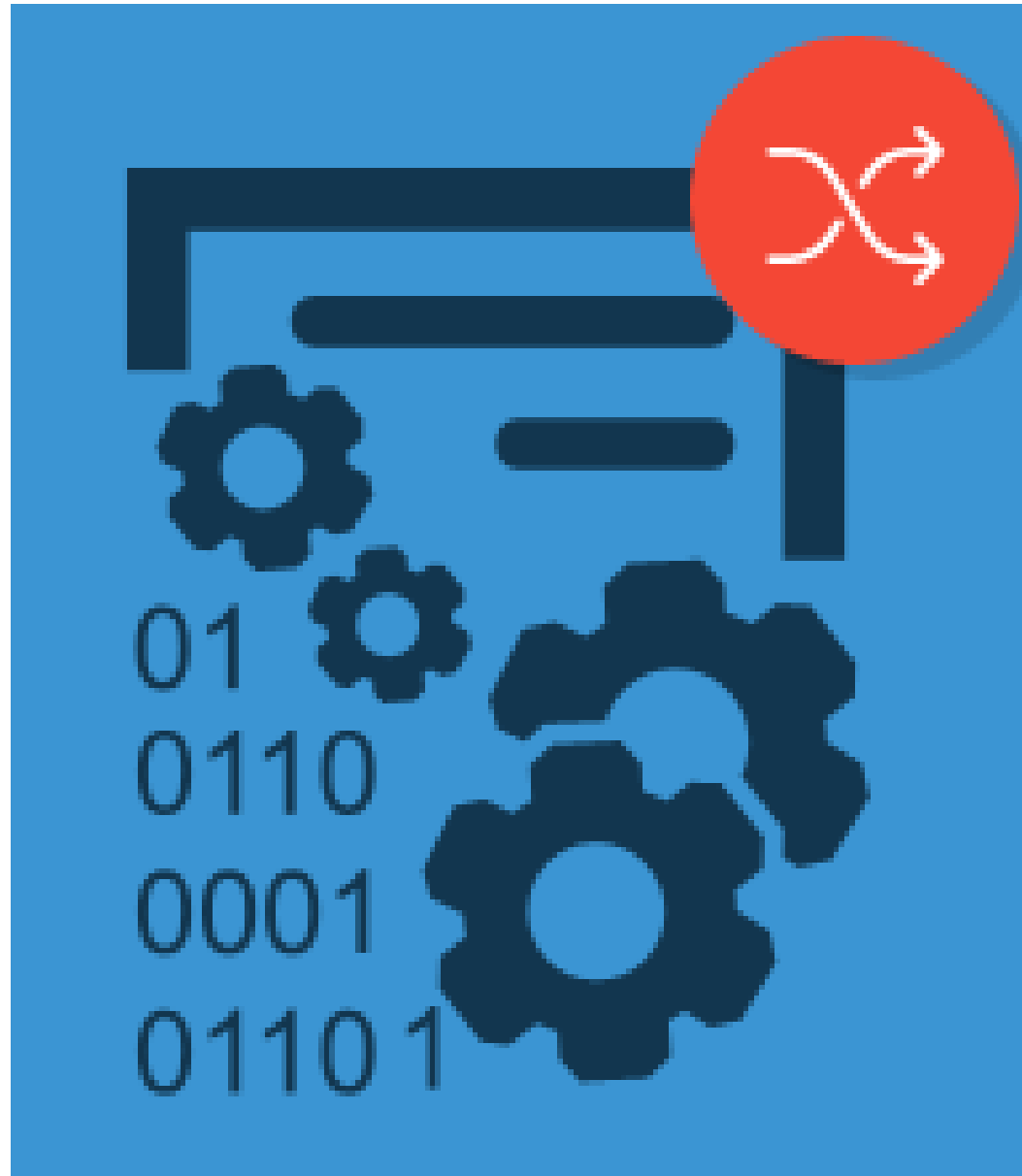
Feature Generation

FEATURE ENGINEERING WITH PYSPARK



John Hogue
Lead Data Scientist

Why generate new features?



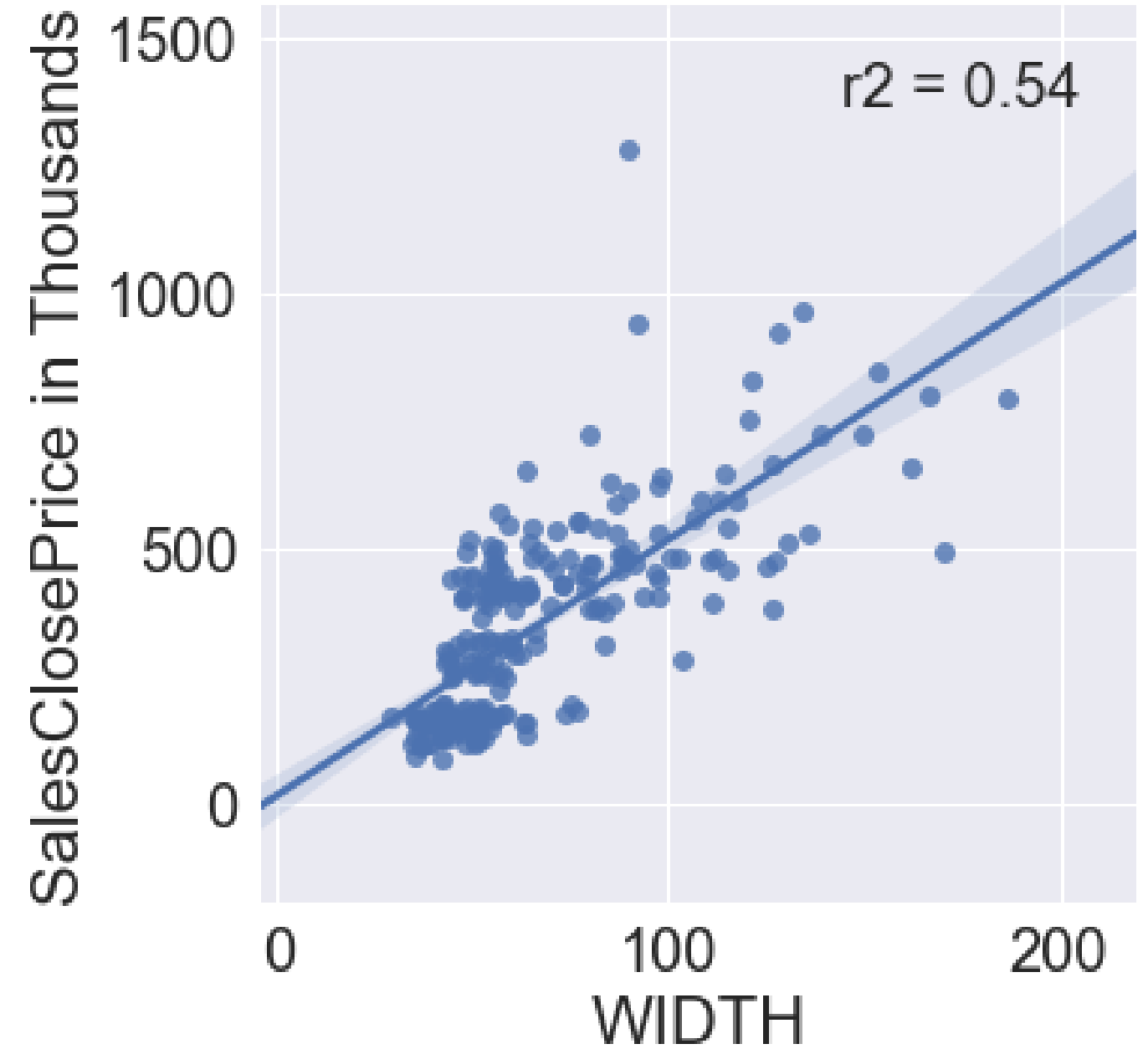
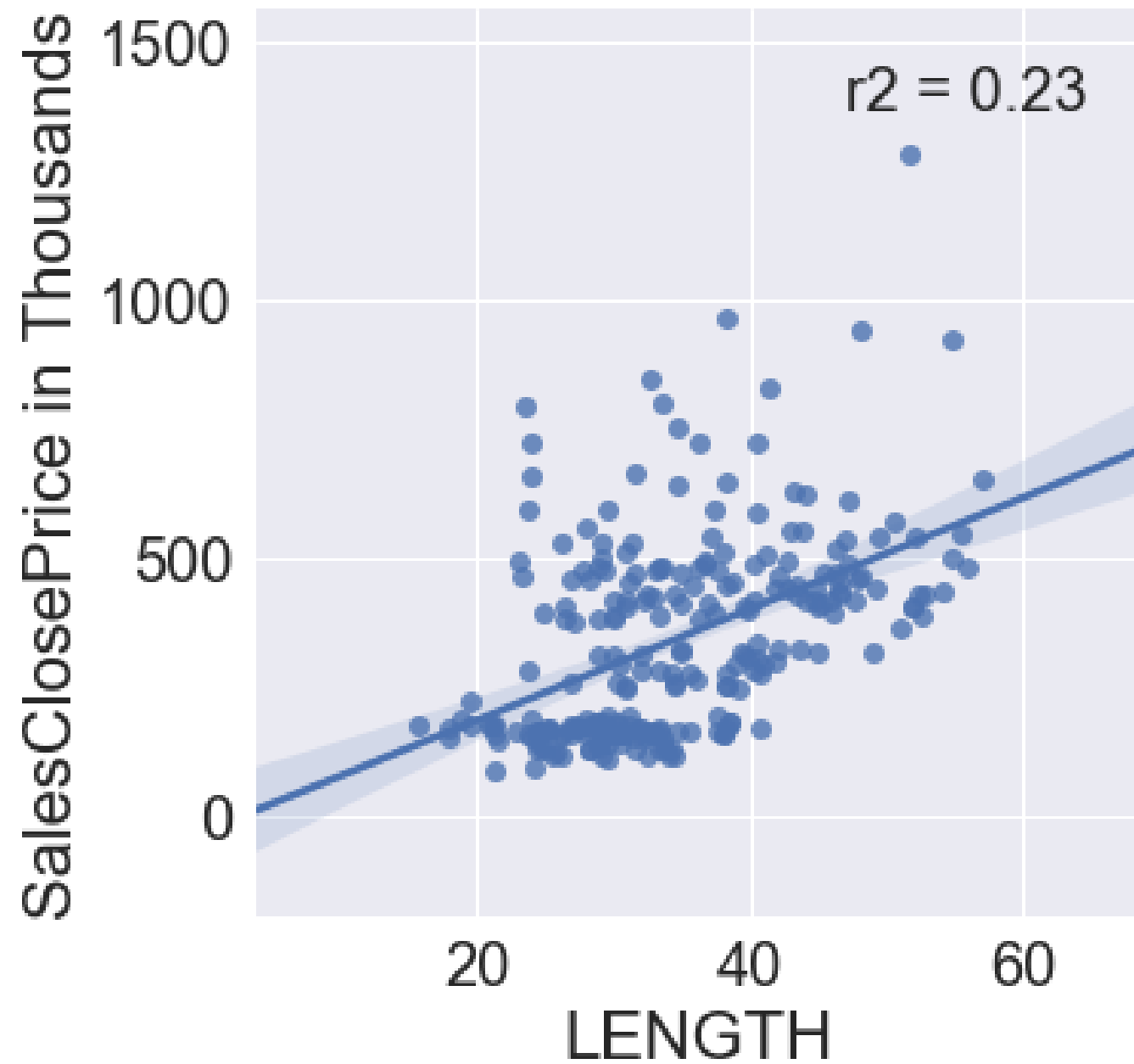
Multiplying

Summing

Differencing

Dividing

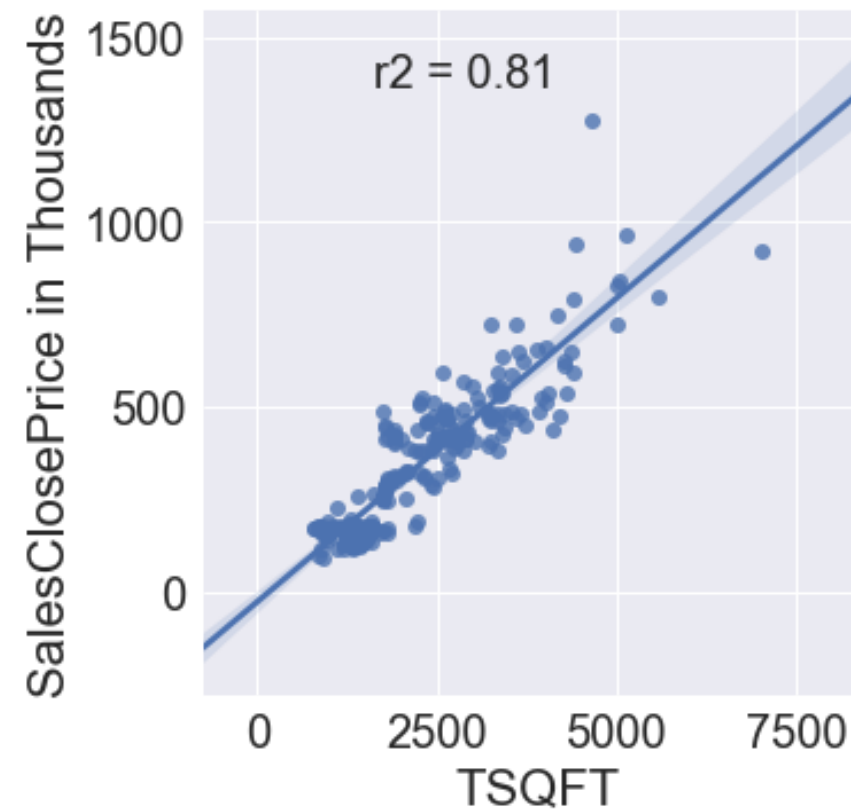
Why generate new features?



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 & TSMF
- Explosion of Features
- Higher Order & Beyond?



Go forth and combine!

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Time Features

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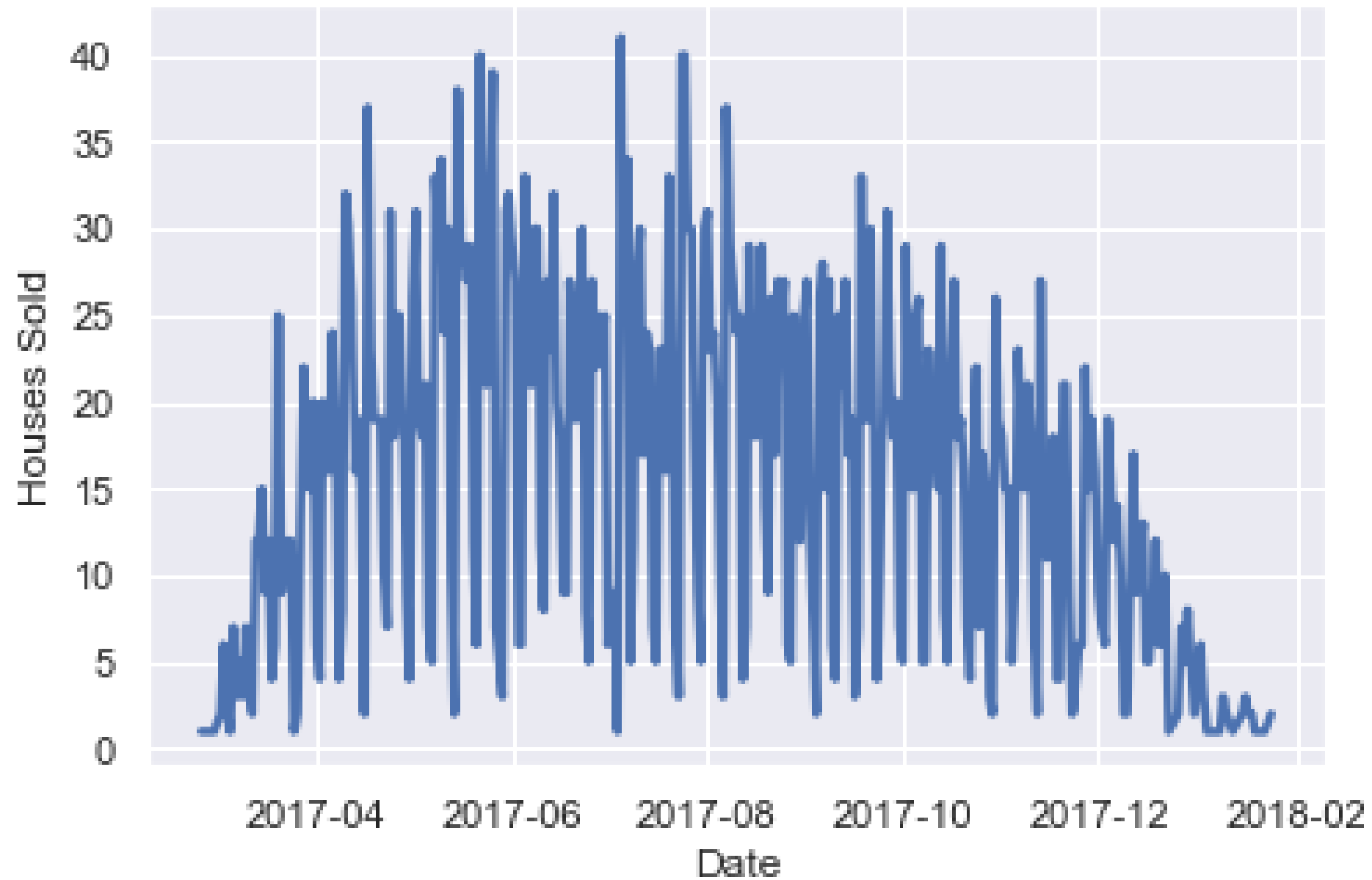
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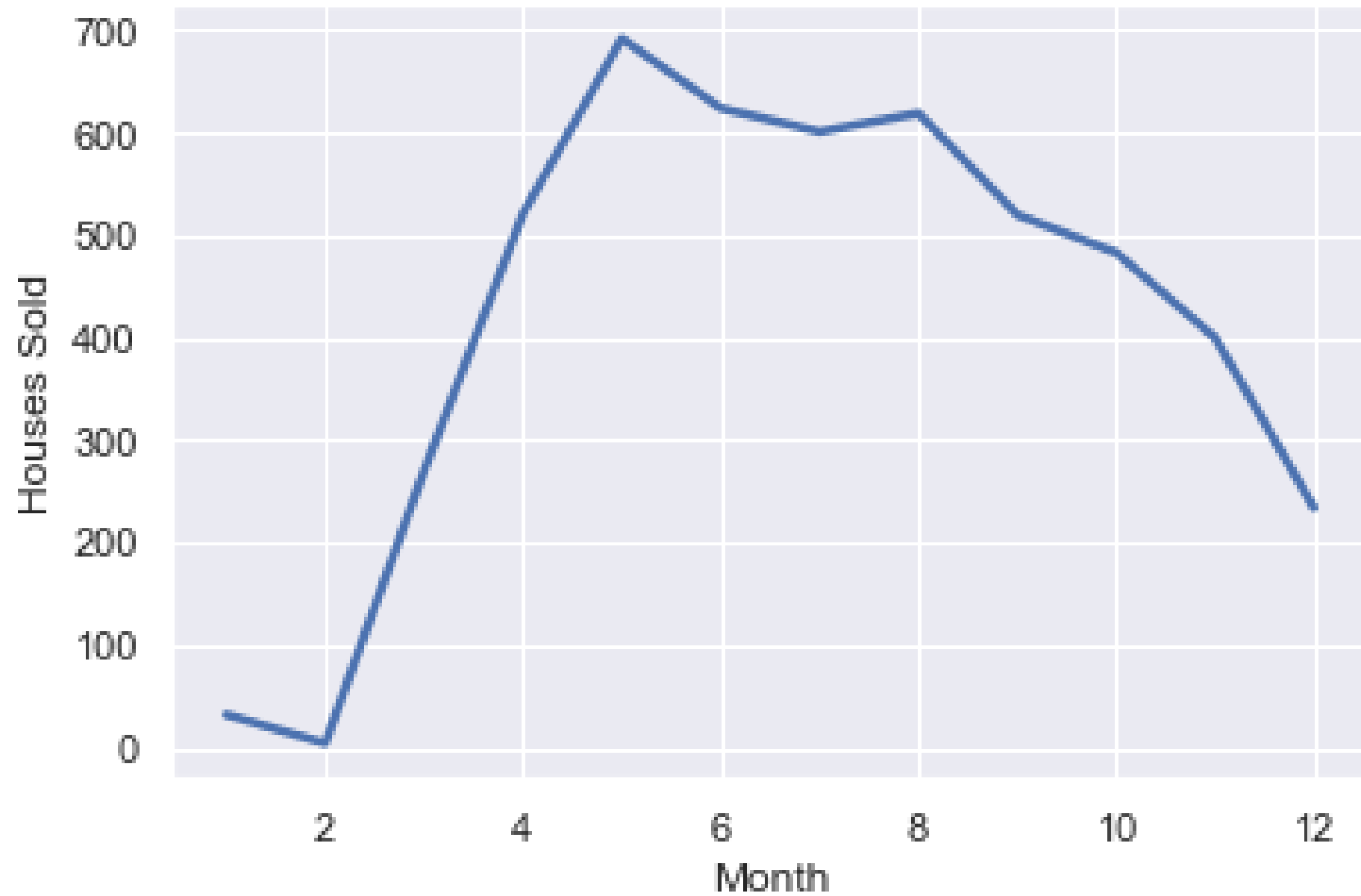
The Cyclical Nature of Things



Choosing the Right Level



Choosing the Right Level



Treating Date Fields as Dates...

```
from pyspark.sql.functions import to_date

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

```
# 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!

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Extracting Features

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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	<i>becomes</i>	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	<i>becomes</i>	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

```
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!

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

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

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

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

```
# 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

FEATURE ENGINEERING WITH PYSPARK



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Lead Data Scientist

Binarizing

FIREPLACES	<i>becomes</i>	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

```
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	<i>becomes</i>	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,[],[1])|
|(4,[],[1])|
|(4,[2],[1.0])|
|(4,[2],[1.0])|
+-----+
only showing top 4 rows
```

Get Transforming!

FEATURE ENGINEERING WITH PYSPARK