CoWrangler: Recommender System for Data-Wrangling Scripts

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Data wrangling is time consuming

emergency_call_description
REINDEER CT & DEAD END; NEW HANOVER; Station 332; 2015-12-10 @ 17:10:52
HAWS AVE; NORRISTOWN; Station STA27; 2015-12-10 @ 14:39:21
BLUEROUTE & RAMP I476 NB TO CHEMICAL RD; PLYMOUTH; ; 2015-12-10 @ 17:35:41

I want to split the values using semicolons. But how do I deal with **the third row**, which has fewer splits?

```
df[['address', 'township', 'station', 'timestamp']] = \
    df['desc'].str.split('; ', 3)
```

```
ValueError: Columns must be same length as key
```

My script worked after searching the web! Setting the expand parameter to True lets each missing split occupy a column.

```
df[['address', 'township', 'station', 'timestamp']] = \
    df['desc'].str.split('; ', 3, expand=True)
```

It took me **10 minutes** to wrangle just one column. There are 8 more!

How do I know if my script is working properly?

Is my data clean now?

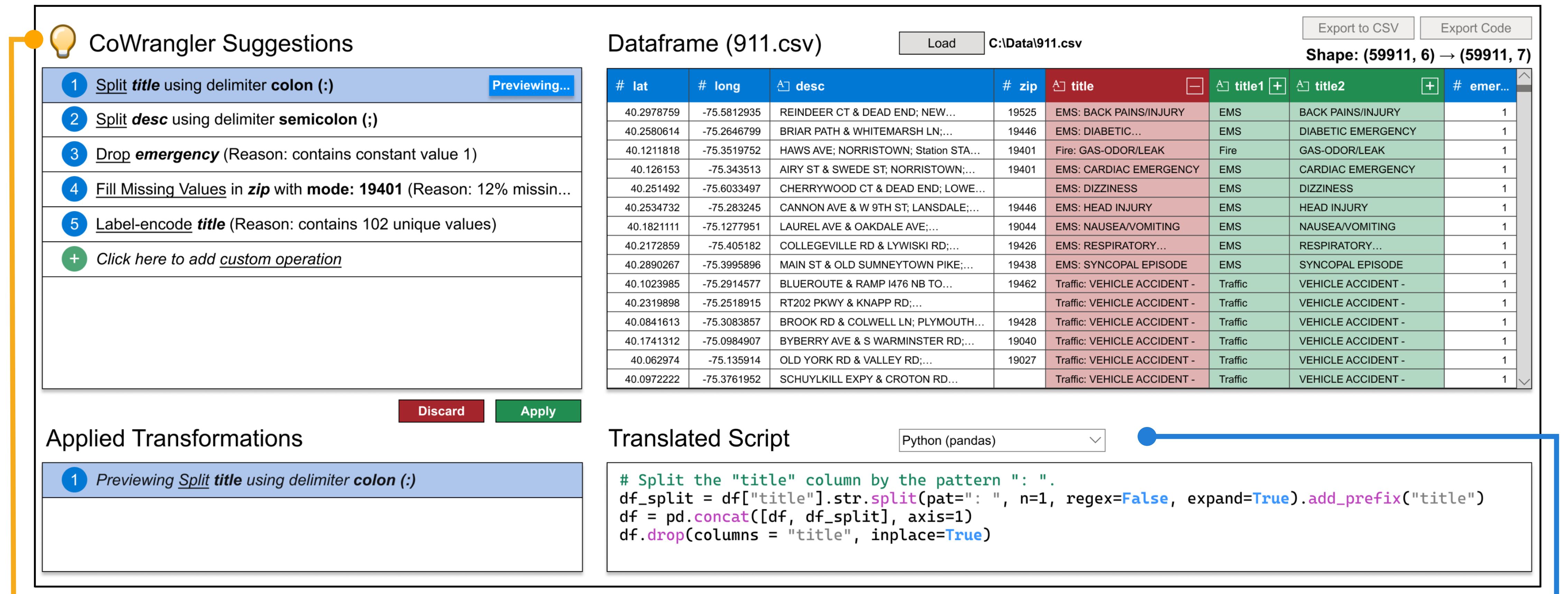
How will I navigate this API jungle? There are so many APIs and parameters!

How do I debug cryptic error messages like ValueError?

Automatic wrangling has several challenges

- How to **pick relevant** wrangling transformations from the **enormous space** of valid transformations?
- What **metric** to use to **rank** them?
- How to **translate** them to **human-readable** scripts?
- How to make the scripts **indistinguishable** from **human-authored** scripts?
- How to make sure the scripts are **performant**?

CoWrangler recommends data-wrangling scripts



1. Split **title** using delimiter **colon (:)**
2. Split **desc** using delimiter **semicolon (;)**
3. Drop **emergency** (Reason: contains constant value 1)
4. Fill Missing Values in **zip** with **mode: 19401** (Reason: 12% missin...
5. Label-encode **title** (Reason: contains 102 unique values)

Click here to add custom operation

Applied Transformations: 1 *Previewing Split **title** using delimiter **colon (:)***

Shape: (59911, 6) → (59911, 7)

# lat	# long	desc	# zip	title	title1	title2	# emer...
40.2978759	-75.5812935	REINDEER CT & DEAD END; NEW…	19525	EMS: BACK PAINS/INJURY	EMS	BACK PAINS/INJURY	1
40.2580614	-75.2646799	BRIAR PATH & WHITEMARSH LN;…	19446	EMS: DIABETIC…	EMS	DIABETIC EMERGENCY	1
40.1211818	-75.3519752	HAWS AVE; NORRISTOWN; Station STA…	19401	Fire: GAS-ODOR/LEAK	Fire	GAS-ODOR/LEAK	1
40.126153	-75.343513	AIRY ST & SWEDE ST; NORRISTOWN;…	19401	EMS: CARDIAC EMERGENCY	EMS	CARDIAC EMERGENCY	1
40.251492	-75.6033497	CHERRYWOOD CT & DEAD END; LOWE…		EMS: DIZZINESS	EMS	DIZZINESS	1
40.2534732	-75.283245	CANNON AVE & W 9TH ST; LANSDALE;…	19446	EMS: HEAD INJURY	EMS	HEAD INJURY	1
40.1821111	-75.1277951	LAUREL AVE & OAKDALE AVE;…	19044	EMS: NAUSEA/VOMITING	EMS	NAUSEA/VOMITING	1
40.2172859	-75.405182	COLLEGEVILLE RD & LYWISKI RD;…	19426	EMS: RESPIRATORY…	EMS	RESPIRATORY…	1
40.2890267	-75.3995896	MAIN ST & OLD SUMNEYTOWN PIKE;…	19438	EMS: SYNCOPAL EPISODE	EMS	SYNCOPAL EPISODE	1
40.1023985	-75.2914577	BLUEROUTE & RAMP I476 NB TO…	19462	Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1
40.2319898	-75.2518915	RT202 PKWY & KNAPP RD;…		Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1
40.0841613	-75.3083857	BROOK RD & COLWELL LN; PLYMOUTH…	19428	Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1
40.1741312	-75.0984907	BYBERRY AVE & S WARMINSTER RD;…	19040	Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1
40.062974	-75.135914	OLD YORK RD & VALLEY RD;…	19027	Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1
40.0972222	-75.3761952	SCHUYLKILL EXPY & CROTON RD…		Traffic: VEHICLE ACCIDENT -	Traffic	VEHICLE ACCIDENT -	1

```
# Split the "title" column by the pattern ": ".
df_split = df["title"].str.split(pat=": ", n=1, regex=False, expand=True).add_prefix("title")
df = pd.concat([df, df_split], axis=1)
df.drop(columns = "title", inplace=True)
```

Wrangling suggestions with explanations

*Select a suggestions to view **translated script** and a preview of the **transformed data***

Translated scripts for suggestions

*CoWrangler generates **performant** scripts, with **comments** and **meaningful variable names***

CoWrangler enables human-in-the-loop wrangling

Data scientists can customize and interact with CoWrangler suggestions by

- **Editing the scripts** generated by CoWrangler
- Expressing **intent by example** [1]

timestamp	month
29-07-2011 5:10:52 PM	**07**
17-10-2016 5:29:21 PM	*10*
18-02-2014 2:39:21 PM	*02*
04-03-2012 4:47:36 PM	*03*
09-12-2010 4:56:52 PM	*12*
12-11-2015 3:39:04 PM	*11*

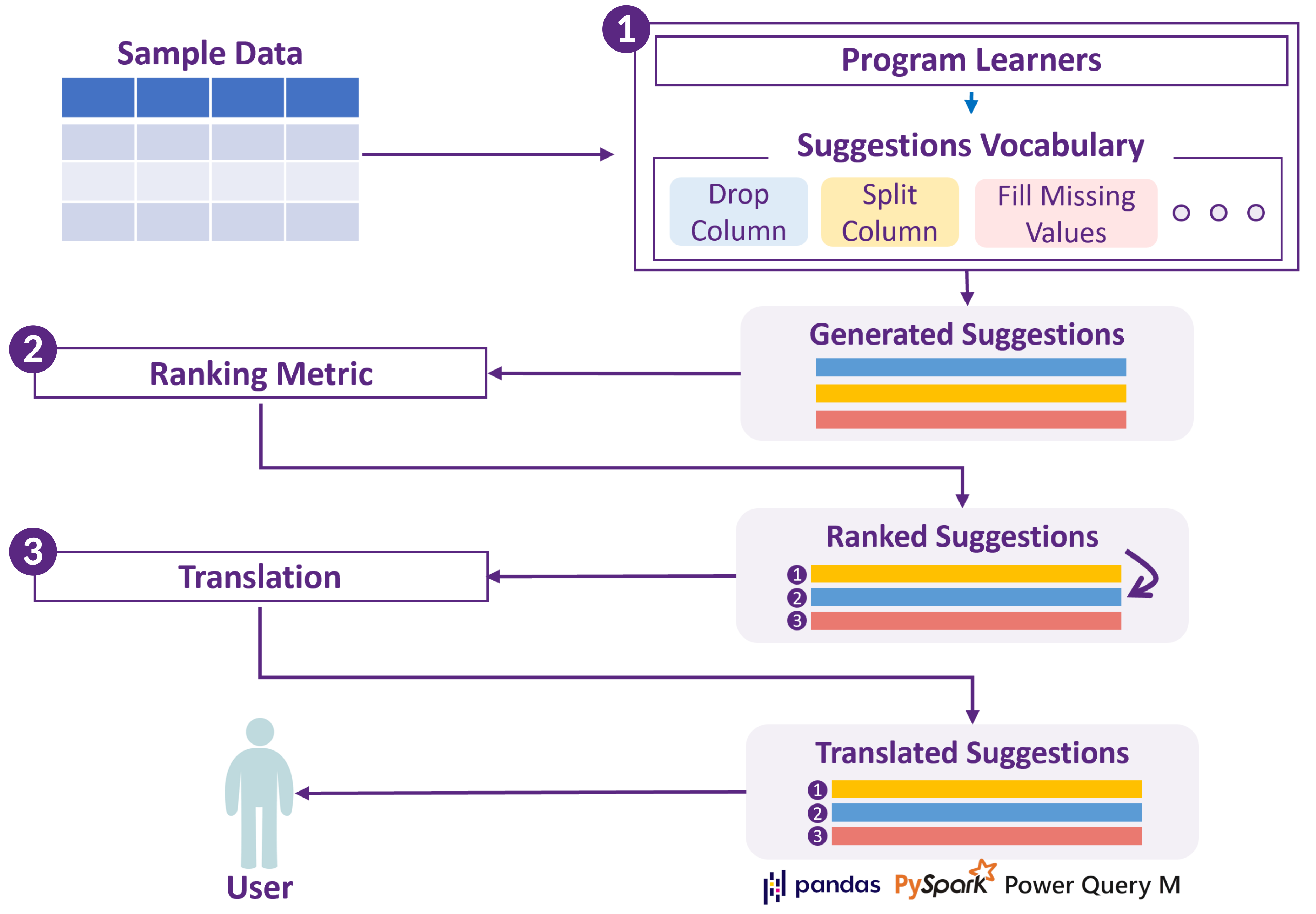
User provides an **example** to extract month

CoWrangler **extrapolates** values for all rows

```
# Derive column "month" from column: "timestamp"
from datetime import datetime

# Transform "timestamp" as per the following examples:
# 29-07-2011 5:10:52 PM -> 07
df.insert(6, "month", df.apply(lambda row : row["timestamp"].strftime("%m"), axis=1))
```

CoWrangler in a nutshell



1. **Predictive Synthesis** to learn & suggest **valid** transformations [2]
2. **Ranking** suggestions based on measurable **data quality improvements**
3. Smart **translation** to generate **performant** scripts, using vector APIs

CoWrangler achieves 53% accuracy

Benchmark: **2248 pandas operations** from **730 Kaggle notebooks**

- CoWrangler's vocabulary **supports 33%** operations
- Suggestions are **accurate in 53.4%** cases

References

[1] S Gulwani. Automating string processing in spreadsheets using input-output examples. POPL 2011
[2] M Raza and S Gulwani. Automated data extraction using predictive program synthesis. AAAI 2017