Stanford University

CS 329P : Practical Machine Learning (2021 Fall)

2.1 Data Cleaning

Qingqing Huang, Mu Li, Alex Smola

https://c.d2l.ai/stanford-cs329p

Exploratory data analysis

Check Notebook

Data Errors

- Data often have errors - the mismatch with ground truth (missing, erroneous or extreme values)
- Good ML models are robust to errors
  - DNN trained with SGD VS Decision trees
- Consequences:
  - The training may still converge, but slower
  - Accuracy degradation, could be hard to detect
  - Deploying these models may impact the quality of the new collected data
    - e.g. positive examples generated by poor recommendation / search results

Types of Data Errors

- Outliers: data values that significantly deviate from other observations
  - outliers VS under sampled rare events
- Rule violations: data values violate integrity constraints such as “Not Null” and “Must be unique” and “Non negative”
- Pattern violations: data values violate syntactic and semantic constraints such as formatting, misspelling

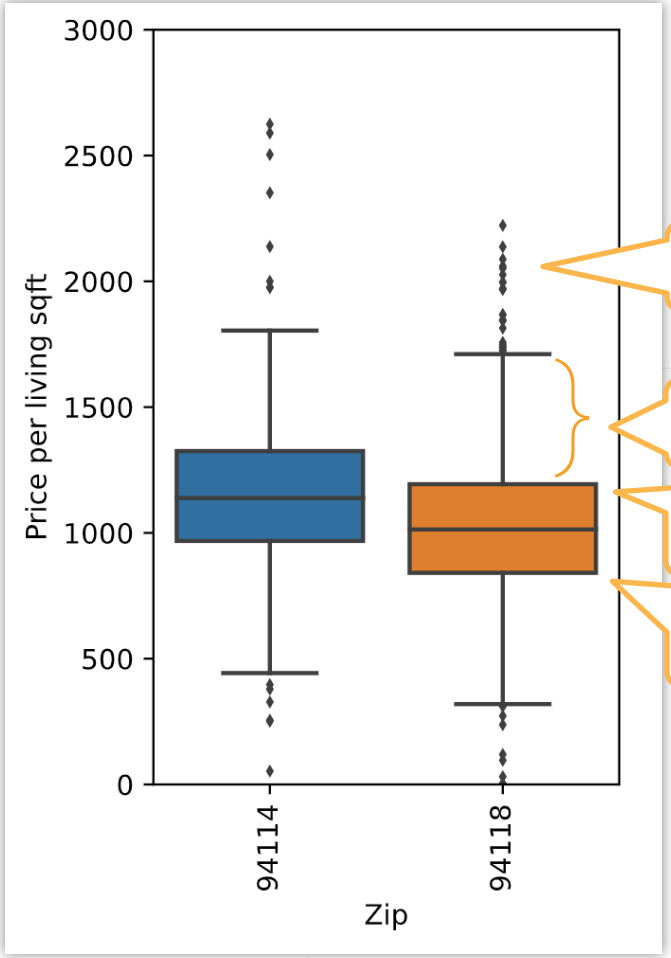
Outlier Detection

```
data['Type'].value_counts()[0:20]
```

executed in 19ms, finished 11:28:29 2021-09-15

SingleFamily	74318
Condo	18749
MultiFamily	6586
VacantLand	6199
Townhouse	5846
Unknown	5390
MobileManufactured	2588
Apartment	1416
Cooperative	161
Residential Lot	75
Single Family	69
Single Family Lot	56
Acreage	48
2 Story	39
3 Story	25
Hi-Rise (9+), Luxury	21
RESIDENTIAL	19
Condominium	19
Duplex	19
Mid-Rise (4-8)	17

Outliers



Rule-based Detection

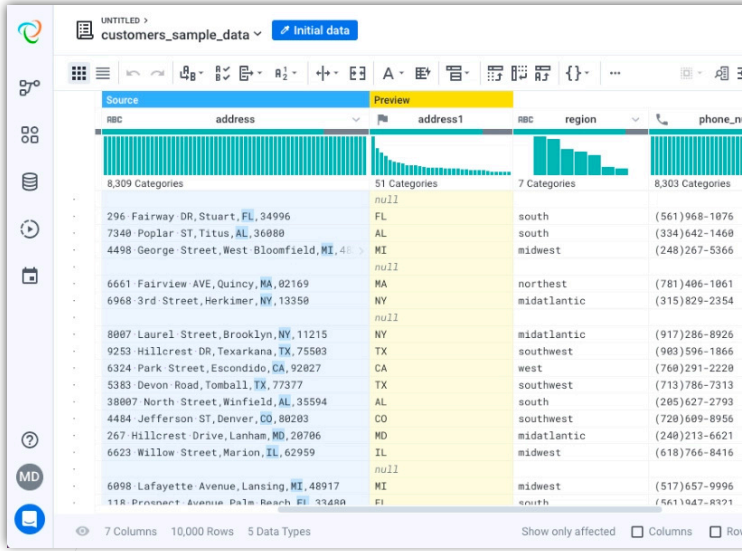
- Design rules to identify erroneous records
- Functional dependencies: $x \rightarrow y$ means a value x determines a unique value y
  - E.g. zip code → state, EIN → company name
- Denial constraints: specified with more flexible first-order logic
  - Phone number is not empty if vendor has an EIN
  - If two captures of the same animal indicated by the same tag number, then the first one must be marked as original

Pattern-based Detection

- Syntactic patterns
  - e.g. Map a column to the most prominent data type and identify values do not fit
  - eng, en, english -> English
- Semantic patterns
  - e.g. Add rules through knowledge graph
    - Values in column “Country” need have capitals, so a value “Stanford” is invalid

Summary

- Types of data errors: outliers, rule violations, pattern violations
- Multiple tools exist to help data cleaning
  - Graphic interface for interactive cleaning
  - Automatically detect and fix



Trifacta Wrangler