Introduction to Biomedical Data Science and Health Informatics

Summary

Python for Data Science

Python for Data Science

- Arithmetic, logic, and string manipulation
  - +, -, *, /, **, and, or, not, ==, !=
  - items = some_string.split()
- Data types
  - Lists
  - Dictionaries
  - Sets
- Structure
  - def
  - if
  - for
- Vast library of functions available
  - import …
  - from … import …

Regular expressions

- import re
- Looks for patterns in text.

```
re.findall(r"([a-zA-Z]+) is ([0-9]+) years old", note)
```

```
[('John', '32'), ('Sarah', '29'), ('Sam', '2')]
```

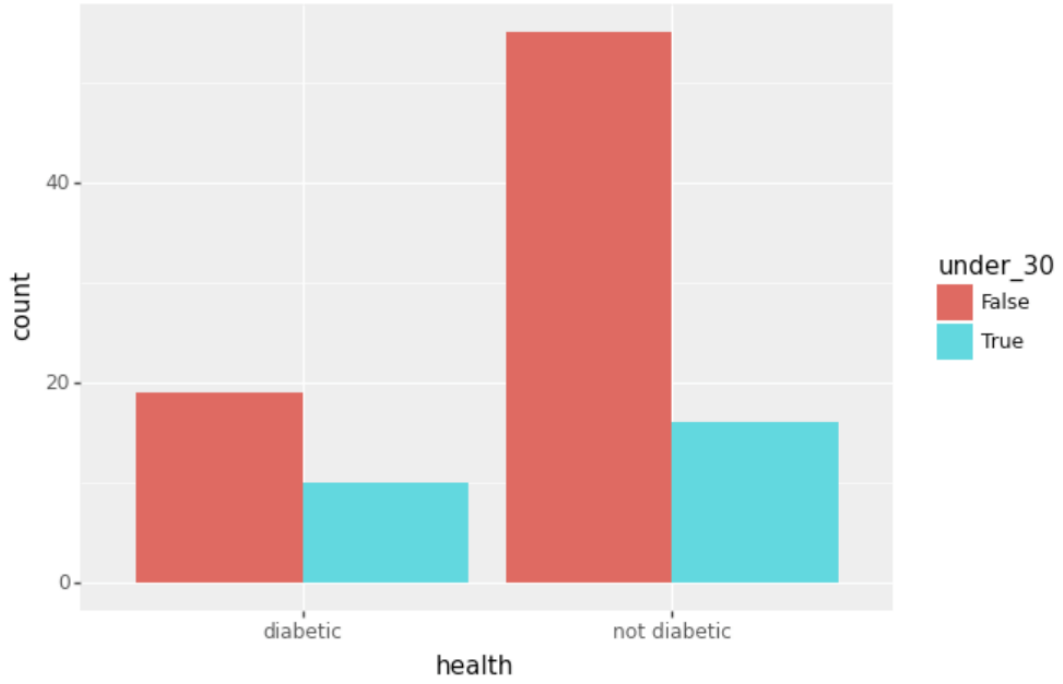
Data Frames

```
import pandas as pd

data = pd.read_csv('filename.csv')
age = data['age']

seniors = data[data['age'] >= 65]

has_alzheimers = data['conditions'].str.contains("Alzheimer's")
```

import plotnine as p9

```
(
    p9.ggplot(data, p9.aes(x='age', y='lifetime_bday_candles'))
    + p9.geom_line(color='red')
    + p9.geom_point()
    + p9.labs(y='lifetime birthday candle total', title='Candles by age')
)
```


```
patients['under_30'] = patients['ages'] < 30
(
    p9.ggplot(patients, p9.aes(x='health', fill='under_30'))
    + p9.geom_bar(position='dodge')
)
```



Relational Databases

Structured Query Language (SQL)

```
pd.read_sql('''
  SELECT thing1, thing2
  FROM table1_name
    INNER JOIN table2_name
      ON table1_name.column_name1 = table2_name.column_name2
  WHERE logical_constraint
  GROUP BY column_name
  ORDER BY column_name ASC/DESC
''', conn)
```

Data Cleaning and Visualization

Exploratory data analysis

- Always your first step.
- Focus on understanding the data not testing the hypothesis.

- Look at the data.
- Get summary data.
  - .describe()
  - .value_counts()
- Univariate and bivariate analyses.
  - Distribution, outliers.

Wickham's A layered grammar of graphics

- A plot consists of several components added together:
    - Data and aesthetic mappings (p9.ggplot, p9.aes)
    - Geometric objects (p9.geom_bar, p9.geom_line, p9.geom_point, …)
    - Scales (e.g. p9.scale_y_continuous(trans='log10'))
    - Facet specification (e.g. p9.facet_wrap('year'), p9.facet_grid('var1 ~ var2'))
    - Statistical transformations (e.g. stat='bin', stat='identity')
    - Coordinate system (e.g. p9.coord_flip(), p9.coord_fixed(ratio=1))

Data cleaning

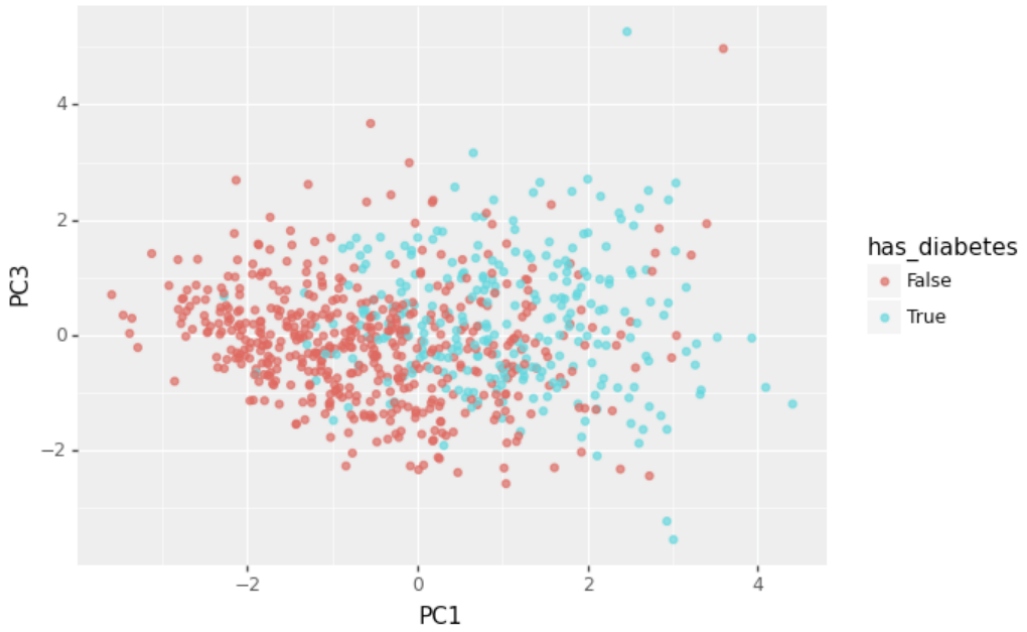
- Non-standardized data
- Inconveniently structured data
  - Tidy-ing data
  - Data with multiple factors
- Duplicate data
- Incorrect values
- Missing values

Machine Learning and Bioinformatics

Principal Component Analysis (PCA)

- Dimensionality reduction technique.
- Rotation of the dataset.

```
from sklearn import decomposition

pca = decomposition.PCA(n_components=4)
X_reduced = pd.DataFrame(
    pca.fit_transform(X),
    columns=['PC1', 'PC2', 'PC3', 'PC4']
)
```



sklearn

- Module for machine learning.
- Training, cross-validation, testing for several algorithms.
  - Logistic regression
  - Random forest
  - Neural networks
  - more

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import confusion_matrix

clf = RandomForestClassifier(
    n_estimators=some_number,
    max_depth=D,
    random_state=0)

sc = cross_val_score(clf, X_train, y_train, cv=10)

clf.fit(X_train, y_train)
y_predicted = clf.predict(X_test)

cm = confusion_matrix(y_predicted, y_test)
```

Natural Language Processing

nltk module

- Tokenization and normalization
- Stop word removal
- Part of speech tagging (POS)
- Named entity recognition (NER)
- Stemming and lemmatization