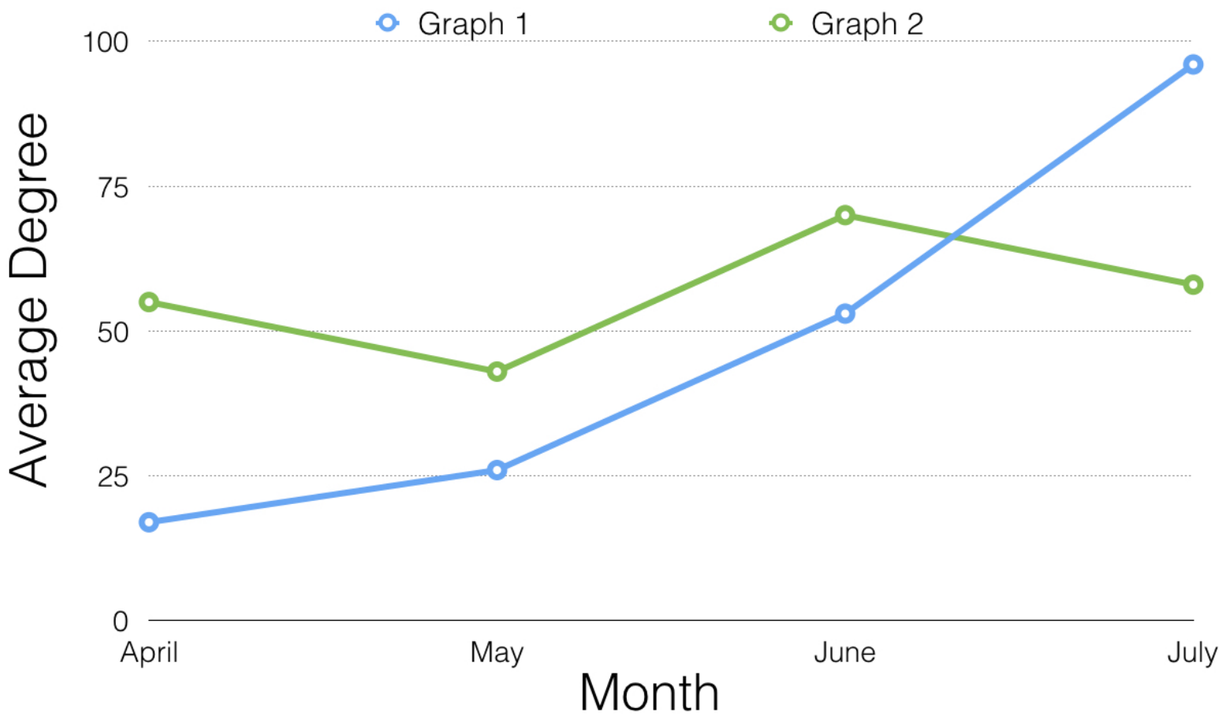
# Introduction to graph differences

NETWORK ANALYSIS IN PYTHON (PART 2)

**Eric Ma**

Data Carpentry instructor and author of nxviz package

# Time series analysis



# Time series analysis

- How some number changes as a function of time
  - Is there an upward or downward trend?
- Rate of change of things over a sliding window of time
- Examples:
  - Tracking weight over time
  - Tracking stock investment portfolio value over time

# Evolving graphs

- Graphs that change over time: communication networks
- Assumptions:
  - Edge changes over time; assume nodes stay constant
  - Both edges and nodes change over time

# Graph differences

- Graphs are comprised of:
  - A node set
  - An edge set
- If a node set doesn't change:
  - Changing only the edge set will result in a change in the graph

# Graph differences

- Analogy: set differences

```
set(c1, c2, c3).difference(set(c2, c3, c4)) = set(c1)

set(c2, c3, c4).difference(set(c1, c2, c3)) = set(c4)
```

  - In NetworkX: `.difference(G1, G2)` function
    - Assumes `G1` and `G2` have equal node sets

# Graph differences in Python

```
G1.edges()
```

```
[('cust1', 'cust2'), ('cust3', 'cust2')]
```

```
G2.edges()
```

```
[('cust1', 'cust3'), ('cust3', 'cust2')]
```

```
G2minusG1 = nx.difference(G2, G1)

G1minusG2 = nx.difference(G1, G2)
```

# Let's practice!

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# Evolving graph statistics

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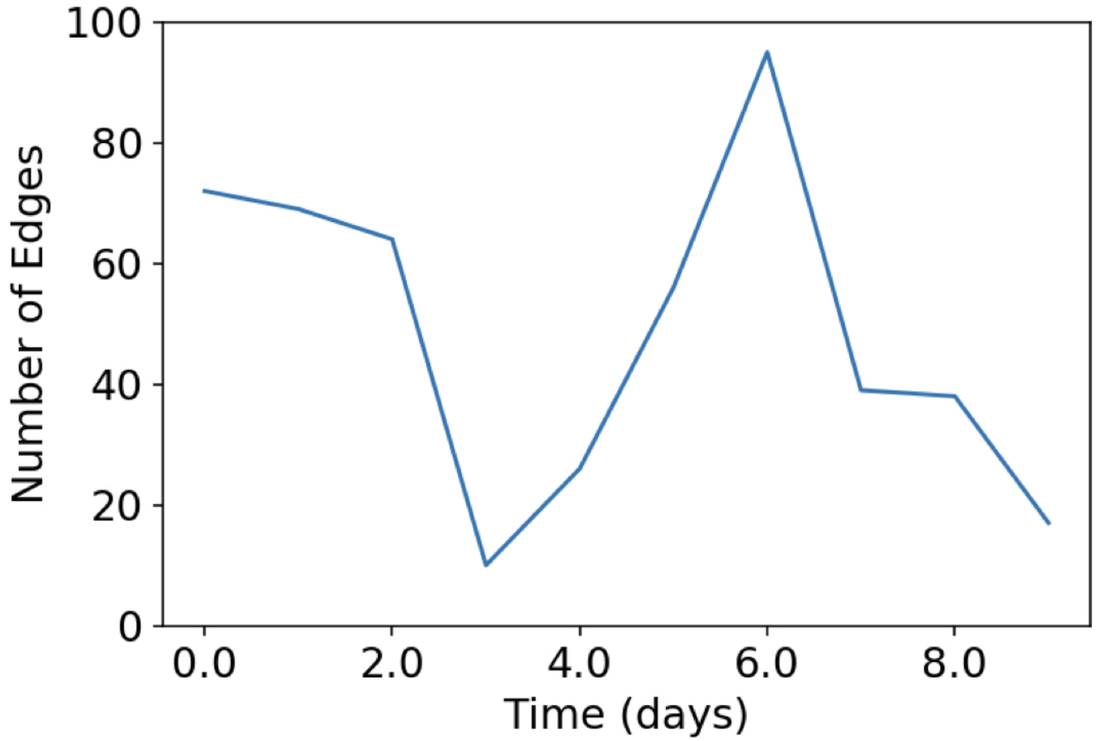
# Evolving graph statistics

- Graph summary statistics:
  - Number of nodes
  - Number of edges
  - Degree distribution
  - Centrality distributions

# Evolving graph statistics

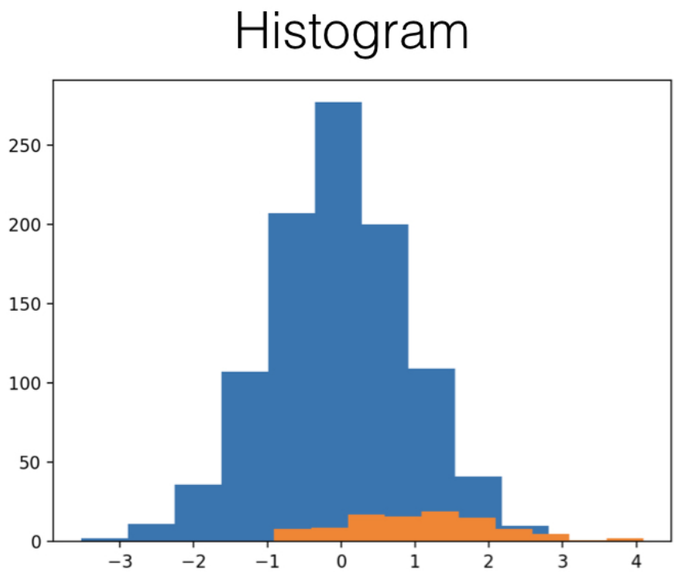


# Evolving graph statistics

- For simple metrics, use edgelist data
- For graph theoretic metrics, use graph object

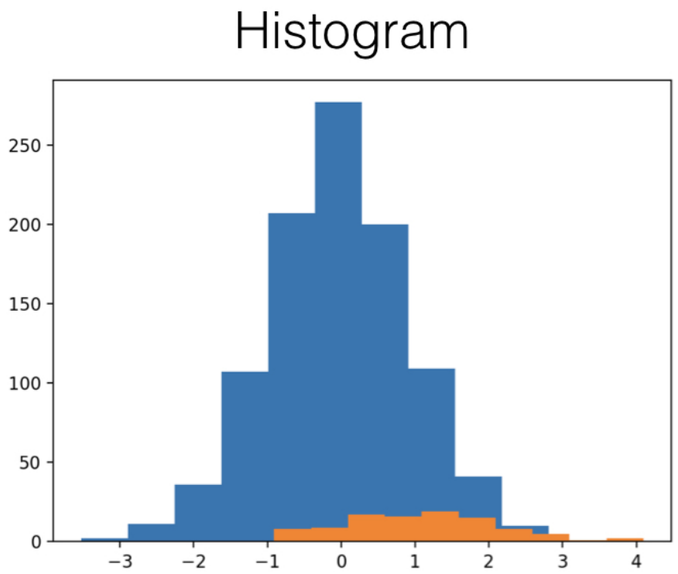
# Cumulative distribution

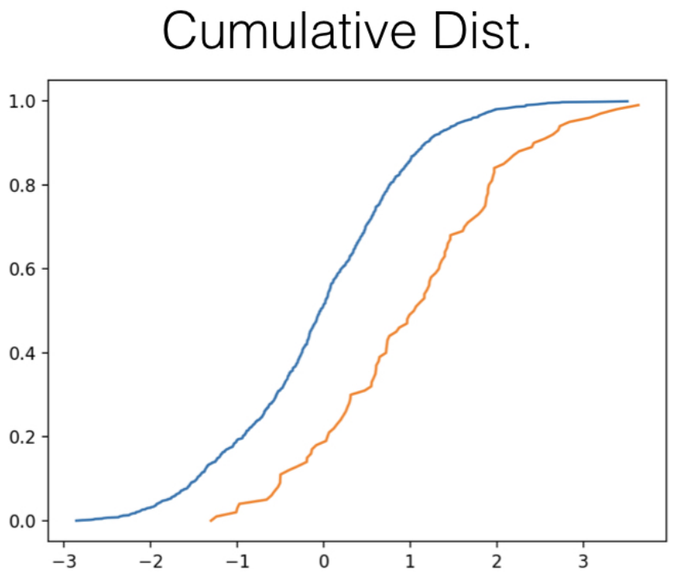
- Compact way of representing the distribution of values



# Cumulative distribution

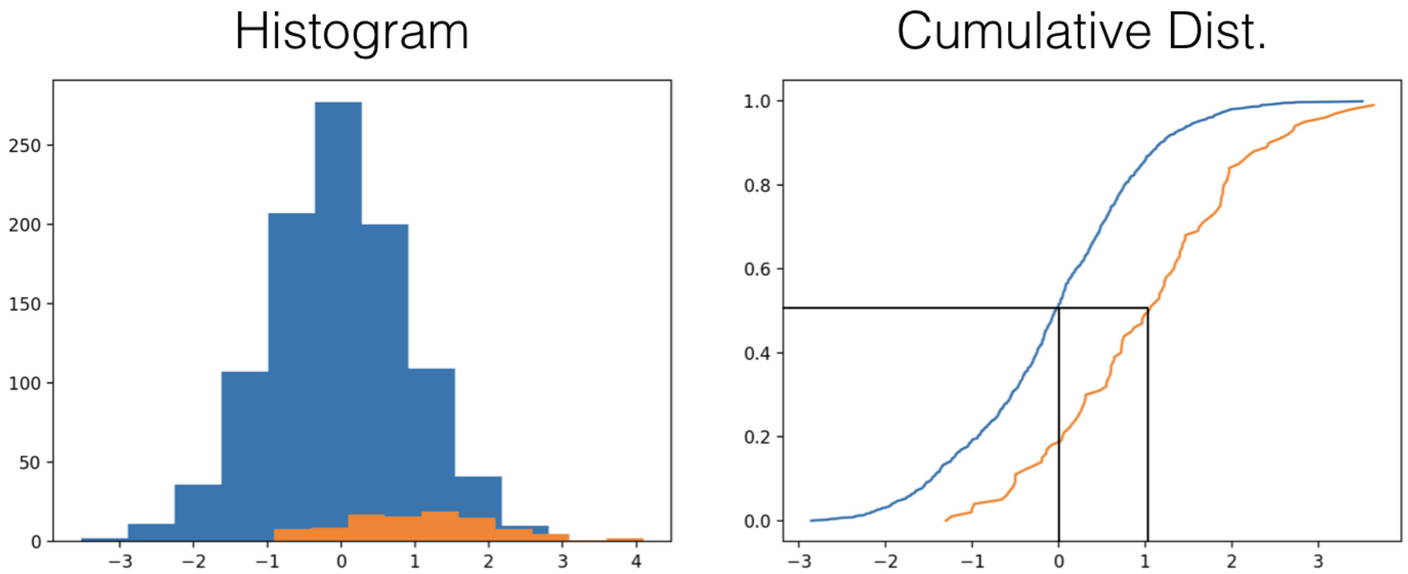
- Compact way of representing the distribution of values



# Cumulative distribution

- Compact way of representing the distribution of values



# Let's practice!

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# Zooming in & zooming out: Overall graph summary

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# Graph exploration at scales

- Exploration at global and local scales
- Global: Centrality distributions
- Local: Connectivity and structures

# Zooming on nodes

- Isolate a given node or set of nodes
- Plot node statistic over time

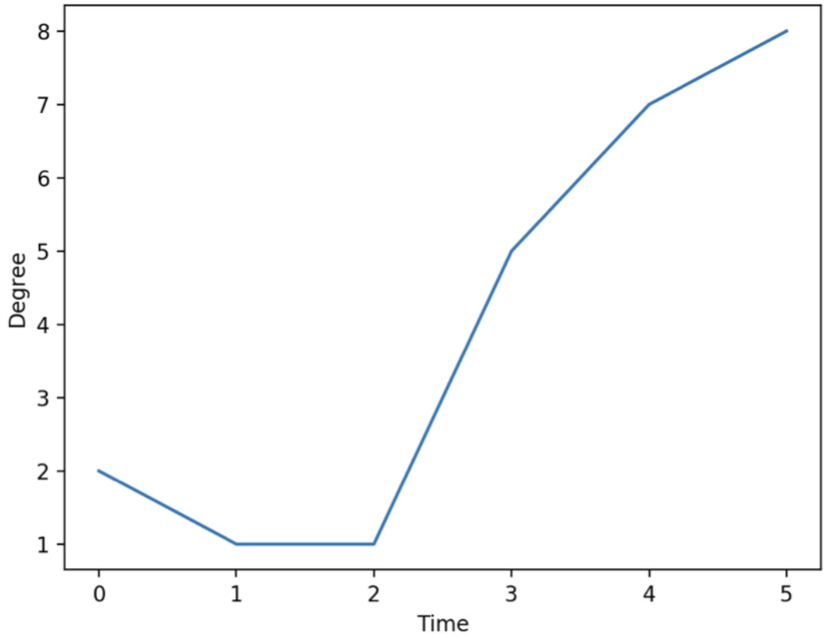
# Summarizing evolving node statistics

- Customer-product dataset
  - Investigate how purchasing patterns have changed over time
- `customer1` - node of interest

# Summarizing evolving node statistics

```
Gs = [....]

noi = 'customer1'

degs = []

for g in Gs:
    ...          # Get the degree of the node
    degs.append(len(g.neighbors(noi)))

plt.plot(degs)
plt.show()
```

# Summarizing evolving node statistics



# Default dictionaries

```
from collections import defaultdict
d = defaultdict(list)

d['heathrow'].append(0.31)
d['heathrow'].append(0.84)

d
```

```
defaultdict(list, {'heathrow': [0.31, 0.84]})
```

# Default dictionaries

```
d2 = dict()
d2['heathrow'].append(0.31)
```

```
KeyError                                  Traceback (most recent call last)
<ipython-input-19-291c74368a8f> in <module>()
--> 1 d2['heathrow'].append(0.31)
KeyError: 'heathrow'
```

# Let's practice!

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