Introduction to SNAP.PY*

Anunay Kulshrestha

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**Slides based on http://snap.stanford.edu/class/cs224w-2016/recitation/SnapRecitationSlides.pdf*

Before we begin

- These slides are available at

  http://snap.stanford.edu/class/cs224w-2017/recitation/SNAP.PY_Recitation.pdf

- All examples used in these slides are available at

  http://snap.stanford.edu/class/cs224w-2017/recitation/examples.zip

What is SNAP?

- **S**tanford **N**etwork **A**nalysis **P**latform (SNAP) is a general purpose, high-performance system for analysis and manipulation of large networks.
    - http://snap.stanford.edu
    - Scales to massive networks with hundreds of millions of nodes and billions of edges
- **SNAP** Software: SNAP.PY for Python, SNAP C++
- **SNAP** Datasets: Over 70 datasets, available at http://snap.stanford.edu/data.

SNAP.PY Resources

- **Prebuilt packages** available for Mac OS X, Windows, Linux
  - http://snap.stanford.edu/snappy/index.html
- **Documentation** (including Tutorial & Reference Manual)
  - http://snap.stanford.edu/snappy/doc/index.html
- **User mailing list**
  - http://groups.google.com/group/snap-discuss

SNAP.PY Resources

- **Developer resources** (including Benchmarking tools)
  - https://github.com/snap-stanford/snap-python

SNAP Network Datasets

- Collection of over 70 network datasets
    - http://snap.stanford.edu/data

Installing SNAP.PY

- **Requires** Python 2.7
    - http://www.python.org/
- **Download** the SNAP.PY for your platform
    - http://snap.stanford.edu/snappy
- **Follow** instructions
    - http://snap.stanford.edu/snappy/index.html
    - `(sudo) python setup.py install`

Installing SNAP.PY

- **Problems?** Refer to our troubleshooting guide
  - https://docs.google.com/document/d/1iuFKw0mS5GsrVj7T7opXDY-qE8fbtd6HTJBZhDYeE3Q/edit
  - Post or look at existing posts on Piazza.

Using SNAP.PY

- The most important step

  -
    ```
    $ python
    >>> import snap
    ```

SNAP.PY Tutorial

- **Available** on the website
  - http://snap.stanford.edu/snappy/doc/tutorial/index-tut.html
- **Today, we will cover**
  - Basic SNAP.PY data types
  - Vectors, hash tables and pairs
  - Basic graph types
  - Graph creation
  - Adding and traversing nodes/edges
  - Useful functions for HW0

Basic Types & Vector Types

- **Basic Types** in SNAP are `TInt`, `TFlt`, and `TStr`
    - Correspond to Python types **`int`**, **`float`** and **`str`**
- **Vector Types**
    - *Naming convention*: `T<value_type>V`
    - *Examples*: `TIntV, TFltV, TStrV`
    - *Operations*:
        - **`Add(<value>)`**: Append a value at the end
        - **`Len()`**: Vector size
        - **`[<index>]`**: Get or set a value of an existing element
        - **`for i in V`**: Iteration over the vector

Vector Example

```
import snap

v = snap.TIntV()              # Create an empty vector

v.Add(1)                      # Add elements
v.Add(2)
v.Add(3)
v.Add(4)
v.Add(5)

print v.Len()                 # Print vector size

print v[3]                    # Get & Set elements
v[3] = 2*v[2]
print v[3]

for item in v:                # Iterate over elements
  print item

for i in range(0, v.Len()):
  print i, v[i]
```

Hash Table Types

- A set of **(key, value)** pairs
  - Keys must be of the same type
  - Values must be of the same type
  - However, value type can be different from the key type
  - *Naming convention*: `T<key_type><value_type>H`
  - *Examples*: `TIntStrH, TIntFltH, TStrIntH`
  - *Operations*:
    - **`[<key>]`**: Add a new value or get or set an existing value
    - **`Len()`**: Hash table size
    - **`for i in H`**: Iteration over keys

Hash Table Example

```
import snap

h = snap.TIntStrH()                 # Create an empty table

h[5] = 'apple'                      # Add elements
h[3] = 'tomato'
h[9] = 'orange'
h[6] = 'banana'
h[1] = 'apricot'

print h.Len()                       # Print table size

print 'h[3] = ', h[3]               # Get element value

h[3] = 'peach'                      # Set element value
print 'h[3] =', h[3]

for key in h:                       # Iterate over keys
  print key, h[key]
```

Pair Types

- A pair **(value1, value2)**
  - Type of value1 can be different from type of value2
  - *Naming convention*: `T<type1><type2>Pr`
  - *Examples*: `TIntStrPr, TIntFltPr, TStrIntPr`
  - *Operations*:
    - **`GetVal1`**: Get value1
    - **`GetVal2`**: Get value2

Pair Example

```
import snap

p = snap.TIntStrPr(1, 'one')       # Create a new pair

print p.GetVal1()                  # Get values
print p.GetVal2()
```

Basic Graph Classes

- Graphs
  - **TUNGraph**: undirected graph
  - **TNGraph**: directed graph
  - **TNEANet**: multigraph with attributes on nodes and edges

Graph (Creation) Example

```
import snap

''' Graph (Creation) '''

G1 = snap.TNGraph.New()        # Create empty directed graph

G1.AddNode(1)                  # Important: Add nodes before adding edges
G1.AddNode(5)
G1.AddNode(12)

G1.AddEdge(1, 5)               # Add edges
G1.AddEdge(5, 1)
G1.AddEdge(5, 12)

G2 = snap.TUNGraph.New()       # Create empty undirected graph

N1 = snap.TNEANet.New()        # Create empty multigraph with attributes
```

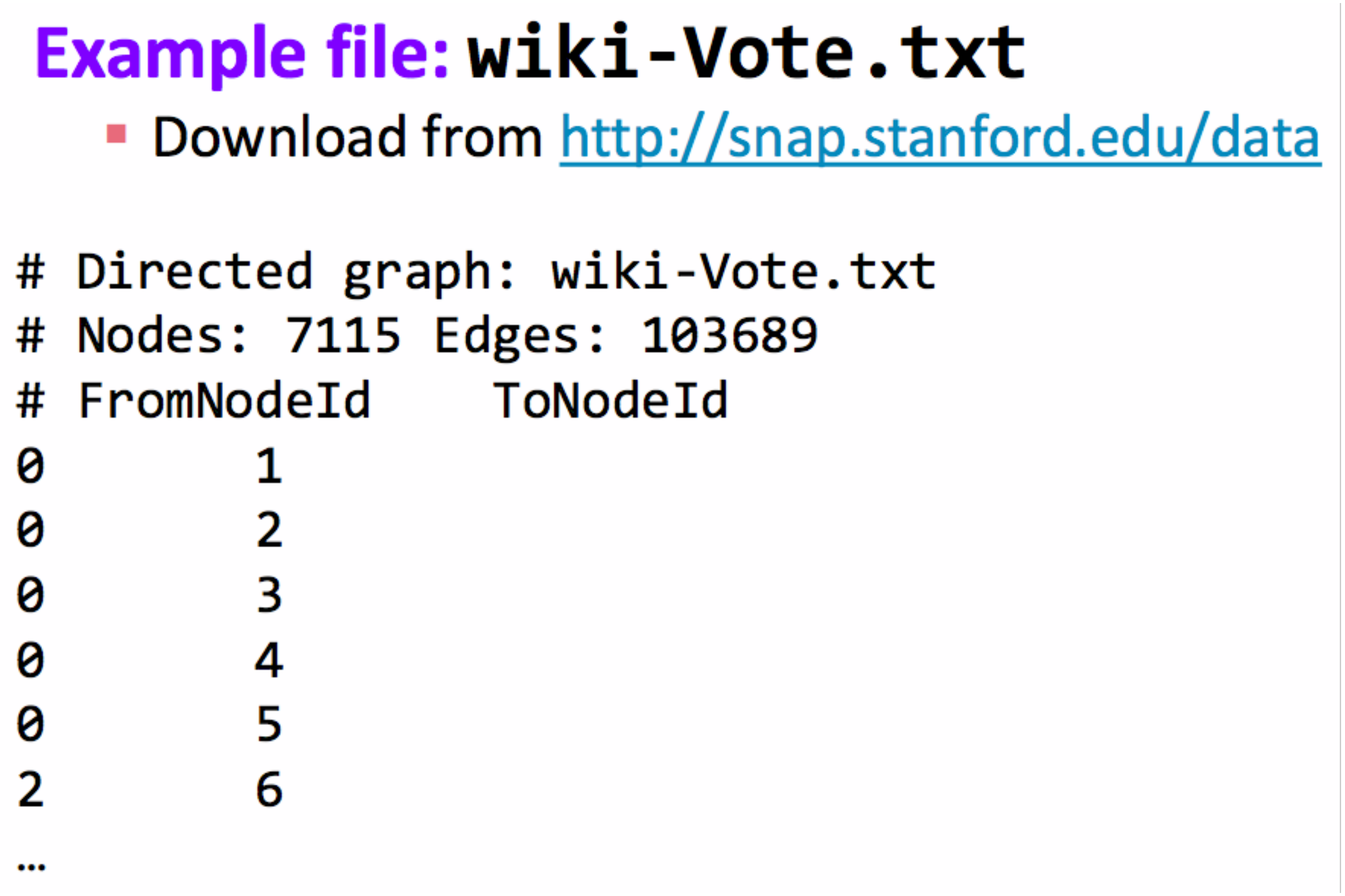
Graph (Traversal) Example

```
''' Graph (Traversal) '''

for NI in G1.Nodes():         # Node traversal
  print 'node id %d, out-degree %d, in-degree %d' % (NI.GetId(), NI.GetOutDeg(),
NI.GetInDeg())

for EI in G1.Edges():         # Edge traversal
  print '(%d, %d)' % (EI.GetSrcNId(), EI.GetDstNId())

for NI in G1.Nodes():         # Edge traversal by node
  for DstNId in NI.GetOutEdges():
    print '(%d, %d)' % (NI.GetId(), DstNId)
```

Graph (Saving & Loading) Example

```
''' Graph (Saving & Loading) '''

# Save graph to text file
snap.SaveEdgeList(G1, 'test.txt', 'List of Edges')

# Load graph from text file
G3 = snap.LoadEdgeList(snap.PNGraph, 'test.txt', 0, 1)

# Save graph to binary
FOut = snap.TFOut('test.graph')
G1.Save(FOut)
FOut.Flush()

# Load graph from binary
FIn = snap.TFIn('test.graph')
G4 = snap.TNGraph.Load(FIn)
```

Loading Text Files



Example file: wiki-Vote.txt

- Download from http://snap.stanford.edu/data

```
# Directed graph: wiki-Vote.txt
# Nodes: 7115 Edges: 103689
# FromNodeId    ToNodeId
0       1
0       2
0       3
0       4
0       5
2       6
…
```

```
LoadEdgeList(PGraph, InFNm, SrcColId, DstColId, Separator)
G = snap.LoadEdgeList(snap.PNGraph, “wiki-Vote.txt”, 0, 1)
```

Useful Functions: `G.Nodes()` & `G.Edges()`

- Get a **generator** for all nodes in graph G
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=nodes()
- Get a **generator** for all edges in graph G
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=edges()
- Example

  -
    ```
    for node in G.Nodes()
    for edge in G.Edges()
    ```

Useful Functions: `G.GetNodes()` & `G.GetEdges()`

- Get the **total number** of nodes in G
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=getnodes
- Get the **total number** of edges in G
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=getedges
- Example

  -
    ```
    G = snap.LoadEdgeList(snap.PNGraph, "wiki-Vote.txt", 0, 1)
    print "G: Nodes %d, Edges %d" % (G.GetNodes(), G.GetEdges())
    ```

Useful Functions: `CntSelfEdges(G)` & `CntUniqDirEdges(G)`

- Get the **total number** of self edges in G
  - http://snap.stanford.edu/snappy/doc/reference/CntSelfEdges.html
  - Example

    -
      ```
      Count1 = snap.CntSelfEdges(G)
      print "Count of self edges is G is %d" % Count1
      ```

- Get the **total number** of unique directed edges in G
  - http://snap.stanford.edu/snappy/doc/reference/CntUniqDirEdges.html
  - Example

    -
      ```
      Count2 = snap.CntUniqDirEdges(G)
      print "Count of unique directed edges is %d" % Count2
      ```

Useful Functions: `CntUniqUndirEdges(G)`

- Get the **total number** of unique undirected edges in G
    - http://snap.stanford.edu/snappy/doc/reference/CntUniqUndirEdges.html
    - Example

        -
          ```
          Count3 = snap.CntUniqUndirEdges(G)
          print "Count of unique undirected edges is %d" % Count3
          ```

Useful Functions: `GetInDeg(G)` & `GetOutDeg()`

- Get the **in-degree** of a node *n*
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=getindeg
  - Example
    - `n.GetInDeg()`
- Get the **out-degree** of a node *n*
  - http://snap.stanford.edu/snappy/doc/reference/graphs.html?highlight=getoutdeg
  - Example
    - `n.GetOutDeg()`

Useful Functions: `GetWccs(G, C)` & `GetMxWcc(G)`

- Get all **weakly connected components** in G
    - http://snap.stanford.edu/snappy/doc/reference/GetWccs.html
    - Example

        -
          ```
          Components = snap.TCnComV()
          snap.GetWccs(G, Components)
          for CnCom in Components:
            print "Size of component: %d" % CnCom.Len()
          ```
- Get the **largest weakly connected component** in G
    - http://snap.stanford.edu/snappy/doc/reference/GetMxWcc.html
    - Example

        -
          ```
          MxWcc = snap.GetMxWcc(G)
          for EI in MxWcc.Edges():
            print "edge: (%d, %d)" % (EI.GetSrcNId(), EI.GetDstNId())
          ```

Useful Functions: `GetPageRank(G,P)` & `GetHits(G,H,A)`

- Get the **Pagerank score** of every node in G
    - http://snap.stanford.edu/snappy/doc/reference/GetPageRank.html
    - Example

        -
          ```
          PRankH = snap.TIntFltH()
          snap.GetPageRank(G, PRankH)
          sorted_PRankH = sorted(PRankH, key = lambda key: PRankH[key], reverse
          = True)
          ```

- Get the **Hubs & Authorities score** of every node in G
    - http://snap.stanford.edu/snappy/doc/reference/GetHits.html?highlight=gethits
    - Example

        -
          ```
          NIdHubH = snap.TIntFltH()
          NIdAuthH = snap.TIntFltH()
          snap.GetHits(G, NIdHubH, NIdAuthH)
          sortedByAuth = sorted(NIdAuthH, key = lambda key: NIdAuthH[key], reverse = True)
          sortedByHub = sorted(NIdHubH, key = lambda key: NIdHubH[key], reverse = True)
          ```

Thank you!