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SMA_Lab -9 (Cascading behavior in networks)

In [19]:
```
%matplotlib inline
import networkx as nx
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib as mpl
import numpy as np
import warnings
warnings.filterwarnings('ignore')
from collections import Counter
import sys
import os
from __future__ import division
plt.rcParams["figure.figsize"] = (20,10)
from itertools import chain
import tqdm as tqdm
from colorthief import ColorThief

warnings.filterwarnings('ignore')
from IPython.core.display import display, HTML
display(HTML("<style>.container { width:80% !important; }</style>"))
```

In [20]:
```
votes_data = pd.read_excel('ESC2018_GF.xlsx',sheet_name='Combined result')
print(votes_data.shape)
votes_data.head(5)
```

```
(26, 47)
```

Out[20]:

	Rank	Running order	Country	Total	Albania	Austria	Belarus	Belgium	Croatia	Cyprus	...	Hu
0	1	22	Israel	529	6	19	8	16	16	10	...	
1	2	25	Cyprus	436	20	1	15	11	8	0	...	
2	3	5	Austria	342	2	0	10	15	0	2	...	
3	4	11	Germany	340	14	16	0	7	3	3	...	
4	5	26	Italy	308	24	10	4	6	10	15	...	

5 rows × 47 columns

In [21]:
```
votes_data.tail(5)
```

Out[21]:

	Rank	Running order	Country	Total	Albania	Austria	Belarus	Belgium	Croatia	Cyprus	...	Hu
21	22	3	Slovenia	64	0	5	4	0	7	0	...	
22	23	2	Spain	61	0	0	0	1	0	7	...	
23	24	9	United Kingdom	48	3	0	0	0	2	0	...	
24	25	17	Finland	46	0	0	0	0	0	0	...	
25	26	8	Portugal	39	0	0	0	0	0	0	...	

5 rows × 47 columns

In [22]:
```
votes_melted = votes_data.melt(
    ['Rank','Running order','Country','Total'],
    var_name = 'Source Country',value_name='points')
votes_melted.head()
```

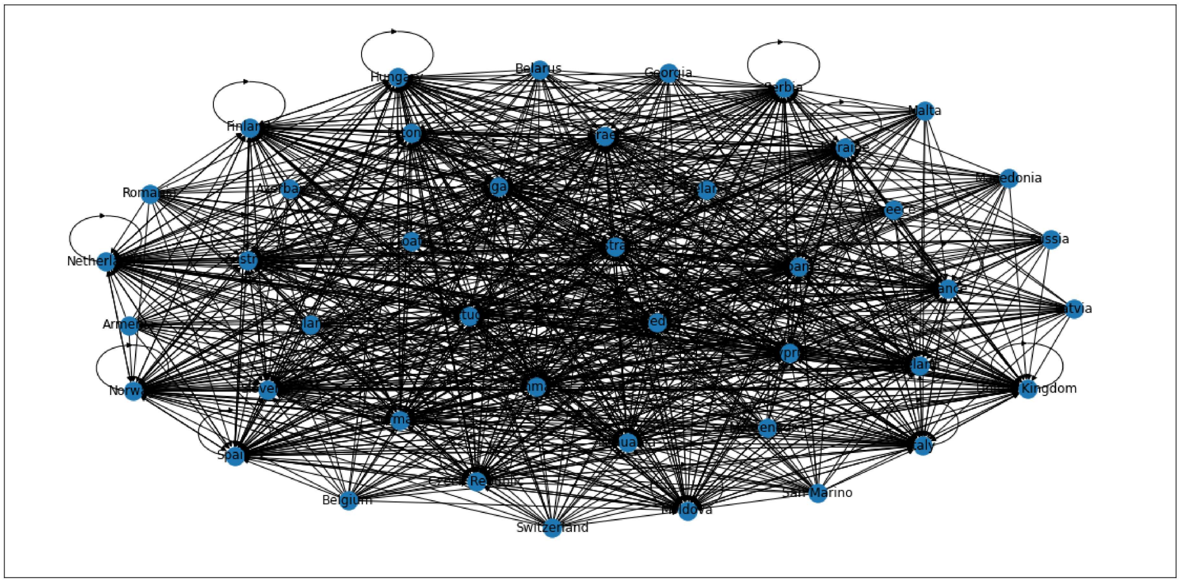
Out[22]:

	Rank	Running order	Country	Total	Source Country	points
0	1	22	Israel	529	Albania	6
1	2	25	Cyprus	436	Albania	20
2	3	5	Austria	342	Albania	2
3	4	11	Germany	340	Albania	14
4	5	26	Italy	308	Albania	24

In [23]:
```
G = nx.from_pandas_edgelist(votes_melted,
                            source='Source Country',
                            target='Country',
                            edge_attr='points',
                            create_using=nx.DiGraph())
print(nx.info(G))
```

```
DiGraph with 43 nodes and 1118 edges
```

In [24]:
```
nx.draw_networkx(G)
```



In [25]:
```
G.out_degree(weight='points')
```

Out[25]:
```
OutDegreeView({'Albania': 116, 'Israel': 116, 'Cyprus': 116, 'Austria': 116,
'Germany': 116, 'Italy': 116, 'Czech Republic': 116, 'Sweden': 116, 'Estoni
a': 116, 'Denmark': 116, 'Moldova': 116, 'Lithuania': 116, 'France': 116, 'Bu
lgaria': 116, 'Norway': 116, 'Ireland': 116, 'Ukraine': 116, 'Netherlands': 1
16, 'Serbia': 116, 'Australia': 116, 'Hungary': 116, 'Slovenia': 116, 'Spai
n': 116, 'United Kingdom': 116, 'Finland': 116, 'Portugal': 116, 'Belarus': 1
16, 'Belgium': 116, 'Croatia': 116, 'Macedonia': 116, 'Greece': 116, 'Icelan
d': 116, 'Latvia': 116, 'Malta': 116, 'Poland': 116, 'Romania': 116, 'Russi
a': 116, 'Switzerland': 116, 'Armenia': 116, 'Georgia': 116, 'Montenegro': 11
6, 'Azerbaijan': 116, 'San Marino': 116})
```

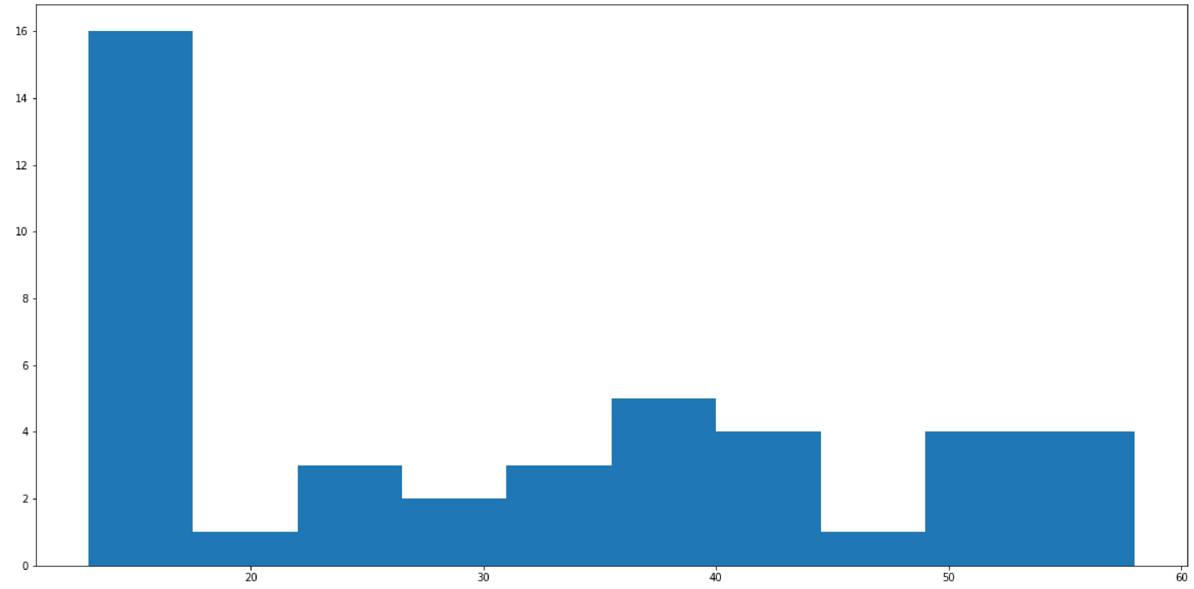
In [26]:
```
Gsub = G.edge_subgraph([(e[0],e[1]) for e in G.edges(data=True) if e[2]['point
```

In [28]:
```
print(nx.info(Gsub))
```

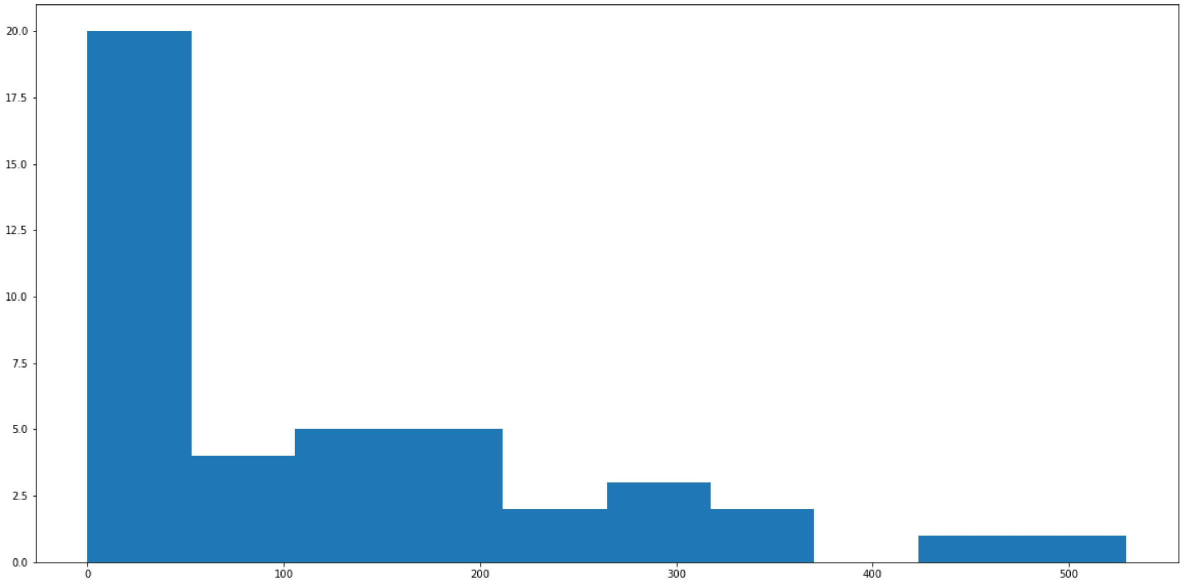
```
DiGraph with 43 nodes and 650 edges
```

```
In [29]: plt.hist(dict(Gsub.degree()).values())
```

```
Out[29]: (array([16.,  1.,  3.,  2.,  3.,  5.,  4.,  1.,  4.,  4.]),
          array([13. , 17.5, 22. , 26.5, 31. , 35.5, 40. , 44.5, 49. , 53.5, 58. ]),
          <BarContainer object of 10 artists>)
```



```
In [30]: h = plt.hist(dict(G.in_degree(weight='points')).values())
```



```
In [31]: deg_cen_points = dict(G.in_degree(weight='points'))
         {k:deg_cen_points[k] for k in deg_cen_points if deg_cen_points[k]==max(deg_cer
```

```
Out[31]: {'Israel': 529}
```

```
In [32]: page_rank = dict(nx.pagerank_numpy(G,weight='points'))
         {k:page_rank[k] for k in page_rank if page_rank[k]==max(page_rank.values())}
```

```
Out[32]: {'Israel': 0.09068710831987256}
```

In [33]:
```
between = dict(nx.betweenness_centrality(G,weight='points'))
{k:between[k] for k in between if between[k]==max(between.values())}
```

Out[33]:
```
{'Estonia': 46701.144689294066}
```

In [37]:
```
countries = pd.read_csv('countries.csv',index_col='Country',encoding='latin-1'
```

In [38]:
```
countries.head()
```

Out[38]:

	cc2	cc3	numeric	latitude	longitude
Country					
Afghanistan	AF	AFG	4	33.0000	65.0
Albania	AL	ALB	8	41.0000	20.0
Algeria	DZ	DZA	12	28.0000	3.0
American Samoa	AS	ASM	16	-14.3333	-170.0
Andorra	AD	AND	20	42.5000	1.6

In [39]:
```
pos_geo = {  node:
           ( max(-10,min(countries.loc[node]['longitude'],55)), # fixing scale
             max(countries.loc[node]['latitude'],25)) #fixing scale
               for node in G.nodes() }
```

In [40]:
```
pos_geo = {}
for node in G.nodes():
    pos_geo[node] = (
                    max(-10,min(countries.loc[node]['longitude'],55)), # fixin
                    max(countries.loc[node]['latitude'],25) #fixing scale
    )
```

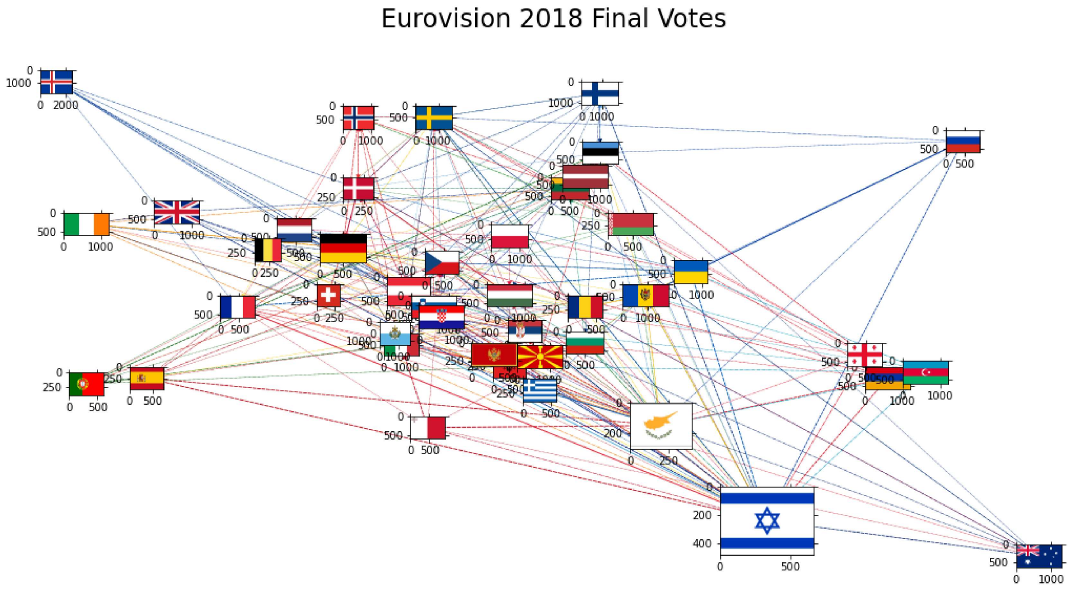
In [45]:
```
flags = {}
flag_color = {}
for node in tqdm.tqdm_notebook(G.nodes()):
    flags[node] = 'flags/'+(countries.loc[node]['cc3']).lower().replace(' ',''
    flag_color[node] =  ColorThief(flags[node]).get_color(quality=1)
```

```
  0%|          | 0/43 [00:00<?, ?it/s]
```

In [46]:
```
def RGB(red,green,blue):
    return '#%02x%02x%02x' % (red,green,blue)
```

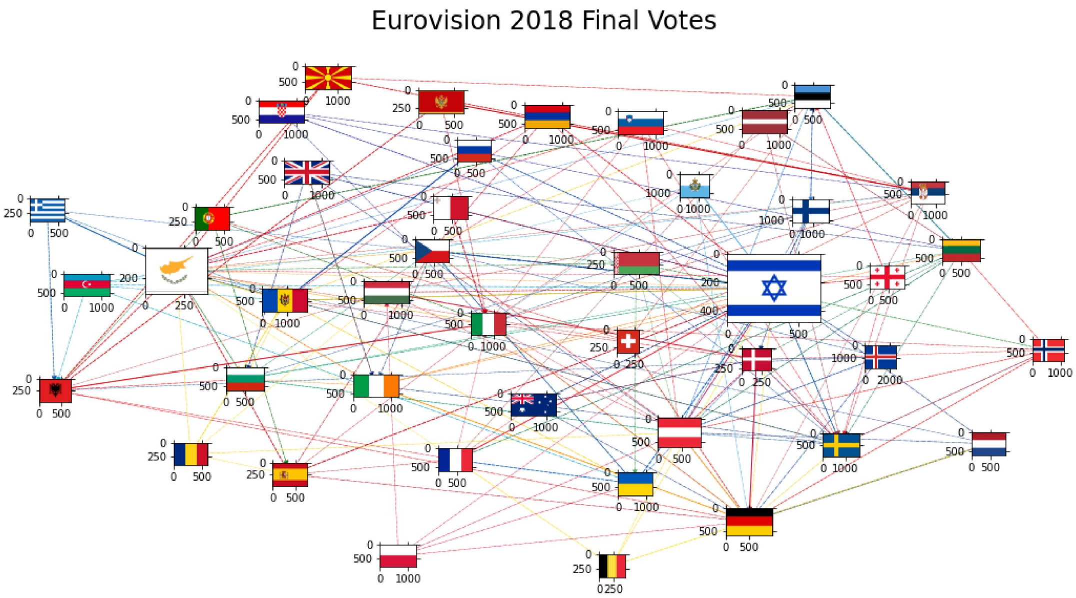
In [47]:

```
ax=plt.gca()
fig=plt.gcf()
plt.axis('off')
plt.title('Eurovision 2018 Final Votes',fontsize = 24)

trans = ax.transData.transform
trans2 = fig.transFigure.inverted().transform

tick_params = {'top':'off', 'bottom':'off', 'left':'off', 'right':'off',
              'labelleft':'off', 'labelbottom':'off'} #flag grid params

styles = ['dotted','dashdot','dashed','solid'] # line styles

pos = pos_geo

# draw edges
for e in G.edges(data=True):
    width = e[2]['points']/24 #normalize by max points
    style=styles[int(width*3)]
    if width>0.3: #filter small votes
        nx.draw_networkx_edges(G,pos,edgelist=[e],width=width, style=style, ec
        # in networkx versions >2.1 arrowheads can be adjusted

#draw nodes
for node in G.nodes():
    imsize = max((0.3*G.in_degree(node,weight='points')
                 /max(dict(G.in_degree(weight='points')).values()))**2,0.03)

    # size is proportional to the votes
    flag = mpl.image.imread(flags[node])

    (x,y) = pos[node]
    xx,yy = trans((x,y)) # figure coordinates
    xa,ya = trans2((xx,yy)) # axes coordinates

    country = plt.axes([xa-imsize/2.0,ya-imsize/2.0, imsize, imsize ])
    country.imshow(flag)
    country.set_aspect('equal')
    country.tick_params(**tick_params)

fig.savefig('images/eurovision2018_map.png')
```


Eurovision 2018 Final Votes

In [48]:

```
ax=plt.gca()
fig=plt.gcf()
plt.axis('off')
plt.title('Eurovision 2018 Final Votes',fontsize = 24)

pos = nx.layout.fruchterman_reingold_layout(G,k=1,weight = 'points',iterations

trans = ax.transData.transform
trans2 = fig.transFigure.inverted().transform


tick_params = {'top':'off', 'bottom':'off', 'left':'off', 'right':'off',
              'labelleft':'off', 'labelbottom':'off'} #flag grid params
styles = ['dotted','dashdot','dashed','solid'] # line styles



# draw edges
for e in G.edges(data=True):
    width = e[2]['points']/24 #normalize by max points
    style=styles[int(width*3)]
    if width>0.4: #filter small votes
        nx.draw_networkx_edges(G,pos,edgelist=[e],width=width,
                               style=style, edge_color = RGB(*flag_color[e[0]]
        # in networkx versions >2.1 arrowheads can be adjusted

#draw nodes
for node in G.nodes():
    imsize = max((0.3*G.in_degree(node,weight='points')/max(dict(G.in_degree(w
    # size is proportional to the votes
    flag = mpl.image.imread(flags[node])

    (x,y) = pos[node]
    xx,yy = trans((x,y)) # figure coordinates
    xa,ya = trans2((xx,yy)) # axes coordinates

    country = plt.axes([xa-imsize/2.0,ya-imsize/2.0, imsize, imsize ])
    country.imshow(flag)
    country.set_aspect('equal')
    country.tick_params(**tick_params)

fig.savefig('images/eurovision2018_spring.png')
```


Eurovision 2018 Final Votes