```python
"""!pip install numpy
!pip install networkx
!pip install matplotlib
!pip install pandas
!pip install tqdm
!pip install powerlaw"""

import matplotlib.pyplot as plt
import numpy as np
import datetime
import networkx as nx

from utils_graphs import *

datasets_folder = "datasets/"
graphs_folder = "graphs/"
measures_folder = "measures/"
plots_folder = "plots/"

# Horas críticas identificadas en el artículo de Beiró and Gandica et al.
HORA_CRITICA_NAT = "429624"
HORA_CRITICA_9N = "437037"
```

Análisis Exploratorio de Datos (EDA) y creación de grafos

```python
df_nat = read_data("nat", datasets_folder=datasets_folder)
df_9n = read_data("9n", datasets_folder=datasets_folder)
```

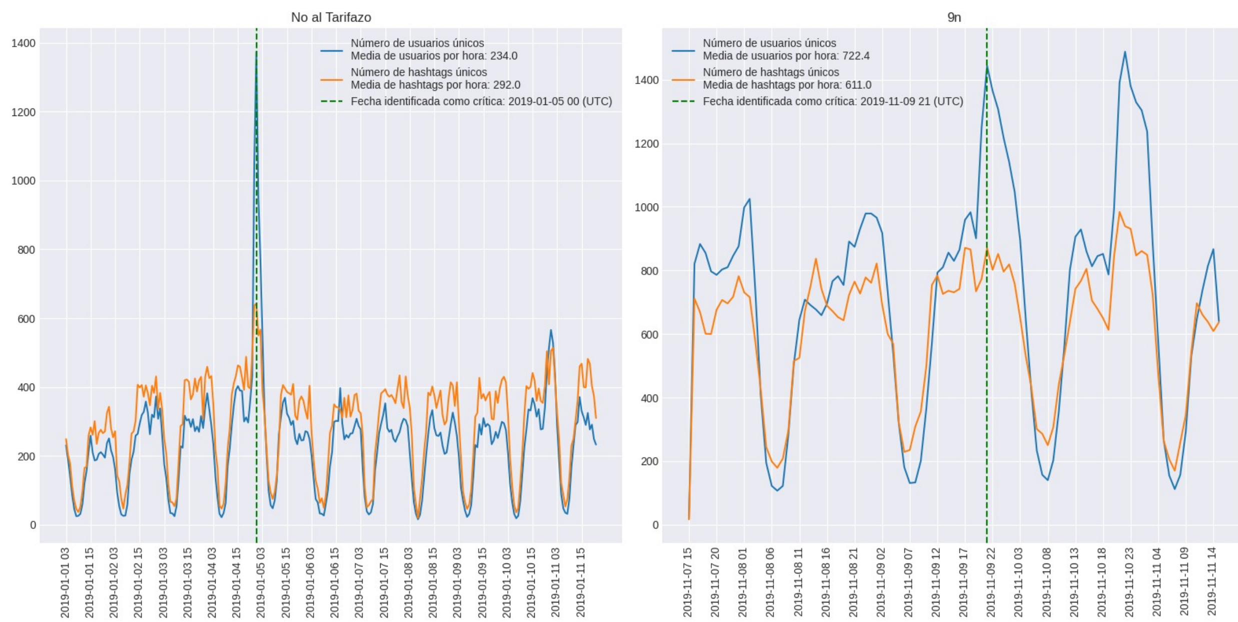
Número de usuarios y hashtags únicos por hora

```python
print("No al tarifazo: número de usuarios únicos:",
df_nat["user"].unique().shape[0], ", hashtags únicos:",
df_nat["hashtag"].unique().shape[0], ", horas únicas:",
df_nat["hour"].unique().shape[0], "en el conjunto de datos.\n")
print("9n: número de usuarios únicos:",
df_9n["user"].unique().shape[0], ", hashtags únicos:",
df_9n["hashtag"].unique().shape[0], ", horas únicas::",
df_9n["hour"].unique().shape[0], "en el conjunto de datos.")
```

```
No al tarifazo: número de usuarios únicos: 9670 , hashtags únicos:
23398 , horas únicas: 260 en el conjunto de datos.

9n: número de usuarios únicos: 8022 , hashtags únicos: 18717 , horas
únicas:: 97 en el conjunto de datos.
```

```
# Añado el numero de usuarios y hashtags únicos a sendos arrays

hour_nat = np.sort(df_nat["hour"].unique())
hour_9n = np.sort(df_9n["hour"].unique())

num_user_nat = []
num_hashtag_nat = []
for hour in hour_nat:
    df_hour_nat = df_nat[df_nat["hour"] == hour]
    num_user_nat.append(len(df_hour_nat["user"].unique()))
    num_hashtag_nat.append(len(df_hour_nat["hashtag"].unique()))

num_user_9n = []
num_hashtag_9n = []
for hour in np.sort(df_9n["hour"].unique()):
    df_hour_9n = df_9n[df_9n["hour"] == hour]
    num_user_9n.append(len(df_hour_9n["user"].unique()))
    num_hashtag_9n.append(len(df_hour_9n["hashtag"].unique()))

# Convierto la hora a formato año, mes, día, hora
hour_nat_dt = [datetime.datetime.fromtimestamp(int(hour)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H") for hour in
hour_nat]
hour_9n_dt = [datetime.datetime.fromtimestamp(int(hour)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H") for hour in hour_9n]

plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

ax1.set_title("No al Tarifazo")
ax1.plot(hour_nat_dt, num_user_nat, label="Número de usuarios únicos\
nMedia de usuarios por hora: " +str(round(np.mean(num_user_nat), 1)))
ax1.plot(hour_nat_dt, num_hashtag_nat, label="Número de hashtags
únicos\nMedia de hashtags por hora: "
+str(round(np.mean(num_hashtag_nat), 1)))
# Marcamos la hora marcada como crítica en Beiró & Gandica et al.
ax1.axvline(x=datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--", label="Fecha identificada como crítica: " +
str(datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H")) +' (UTC)')
ax1.set_xticks(hour_nat_dt[::12])
ax1.set_xticklabels(hour_nat_dt[::12])
ax1.tick_params(axis='x', rotation=90)
ax1.legend()

ax2.set_title("9n")
ax2.plot(hour_9n_dt, num_user_9n, label="Número de usuarios únicos\
```

```
nMedia de usuarios por hora: " +str(round(np.mean(num_user_9n), 1)))
ax2.plot(hour_9n_dt, num_hashtag_9n, label="Número de hashtags únicos\
nMedia de hashtags por hora: " +str(round(np.mean(num_hashtag_9n),
1)))
# Marcamos la hora marcada como crítica en Beiró & Gandica et al.
ax2.axvline(x=datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--", label="Fecha identificada como crítica: " +
str(datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H")) +' (UTC)')
ax2.set_xticks(hour_9n_dt[::5])
ax2.set_xticklabels(hour_9n_dt[::5])
ax2.tick_params(axis='x', rotation=90)
ax2.legend()

plt.tight_layout()
plt.savefig(plots_folder + "num_unique_users_hashtags.png")
plt.show()
```



Creación de redes por hora

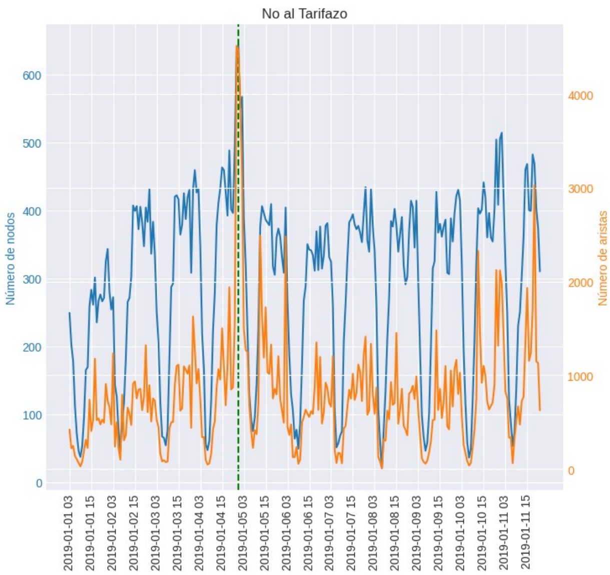
```
# Creamos grafos de la manifestación del 9n
manifestacion = "9n"

create_graphs("hashtag", "user", df_9n, manifestacion,
graphs_folder=graphs_folder)

create_graphs("user", "hashtag", df_9n, manifestacion,
graphs_folder=graphs_folder)
```

```
create_bipartite_graph(df_9n, manifestacion,
graphs_folder=graphs_folder)

# Creamos grafos de la manifestación del No al Tarifazo
manifestacion = "nat"

create_graphs("hashtag", "user", df_nat, manifestacion,
graphs_folder=graphs_folder)

create_graphs("user", "hashtag", df_nat, manifestacion,
graphs_folder=graphs_folder)

create_bipartite_graph(df_nat, manifestacion,
graphs_folder=graphs_folder)
```

Número de nodos y aristas en los grafos generados por hora

```
# Se leen los grafos creados para cada hora y se almacena el número de
nodos y de aristas de cada uno
num_edges_nat = []
num_nodes_nat = []
for hour in hour_nat:
    G = nx.read_gexf(graphs_folder + "nodes_hashtag/nat/" + str(hour)
+ '.gexf')
    num_edges_nat.append(G.number_of_edges())
    num_nodes_nat.append(G.number_of_nodes())

num_edges_9n = []
num_nodes_9n = []
for hour in hour_9n:
    G = nx.read_gexf(graphs_folder + "nodes_hashtag/9n/" + str(hour) +
'.gexf')
    num_edges_9n.append(G.number_of_edges())
    num_nodes_9n.append(G.number_of_nodes())

plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2)  = plt.subplots(1, 2, figsize=(15, 7))

ax1.plot(hour_nat_dt, num_nodes_nat, '#1f77b4', label="Número de
nodos\nMedia de nodos por hora: " +str(round(np.mean(num_nodes_nat),
1)))
ax1.set_ylabel('Número de nodos', color='#1f77b4')
ax1.tick_params(axis='y', labelcolor='#1f77b4')
# Marcamos la hora marcada como crítica en Beiró & Yérali et al.
ax1.axvline(x=datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--", label="Fecha identificada como crítica: " +
```

```
str(datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H")))

ax1b = ax1.twinx()
ax1b.plot(hour_nat_dt, num_edges_nat, '#ff7f0e', label="Número de
aristas \nMedia de aristas por hora: "
+str(round(np.mean(num_edges_nat), 1)))
ax1b.set_ylabel('Número de aristas', color='#ff7f0e')
ax1b.tick_params(axis='y', labelcolor='#ff7f0e')
ax1.set_title('No al Tarifazo')
ax1.set_xticks(hour_nat_dt[::12])
ax1.set_xticklabels(hour_nat_dt[::12])
ax1.tick_params(axis='x', rotation=90)

ax2.plot(hour_9n_dt, num_nodes_9n, '#1f77b4', label="Número de nodos\
nMedia de nodos por hora: " +str(round(np.mean(num_nodes_9n), 1)))
ax2.set_ylabel('Número de nodos', color='#1f77b4')
ax2.tick_params(axis='y', labelcolor='#1f77b4')
# Marcamos la hora marcada como crítica en Beiró & Yérali et al.
ax2.axvline(x=datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--", label="Fecha identificada como crítica: " +
str(datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H")))

ax2b = ax2.twinx()
ax2b.plot(hour_9n_dt, num_edges_9n, '#ff7f0e', label="Número de
aristas\nMedia de aristas por hora: "
+str(round(np.mean(num_edges_9n), 1)))
ax2b.set_ylabel('Número de aristas', color='#ff7f0e')
ax2b.tick_params(axis='y', labelcolor='#ff7f0e')
ax2.set_title('9n')

ax2.set_xticks(hour_9n_dt[::5])
ax2.set_xticklabels(hour_9n_dt[::5])
ax2.tick_params(axis='x', rotation=90)

plt.tight_layout()
plt.savefig(plots_folder + "num_nodes_edges.png")
plt.show()
```



Coeficiente de anidamiento y modularidad por ventana horaria

```
# Manifestación: 9n
# Hashtags como nodos
hour_sort_9n_h, mod_sort_9n_h, nest_sort_9n_h =
get_clust_nest_coefficient("9n", "h", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)

# Usuarios como nodos
hour_sort_9n_u, mod_sort_9n_u, nest_sort_9n_u =
get_clust_nest_coefficient("9n", "u", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)

# Redes bipartitas
hour_sort_9n_b, mod_sort_9n_b, nest_sort_9n_b =
get_clust_nest_coefficient("9n", "b", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)

# Manifestación: No al tarifazo
# Hashtags como nodos
hour_sort_nat_h, mod_sort_nat_h, nest_sort_nat_h =
get_clust_nest_coefficient("nat", "h", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)

# Usuarios como nodos
hour_sort_nat_u, mod_sort_nat_u, nest_sort_nat_u =
get_clust_nest_coefficient("nat", "u", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)

# Redes bipartitas
hour_sort_nat_b, mod_sort_nat_b, nest_sort_nat_b =
```

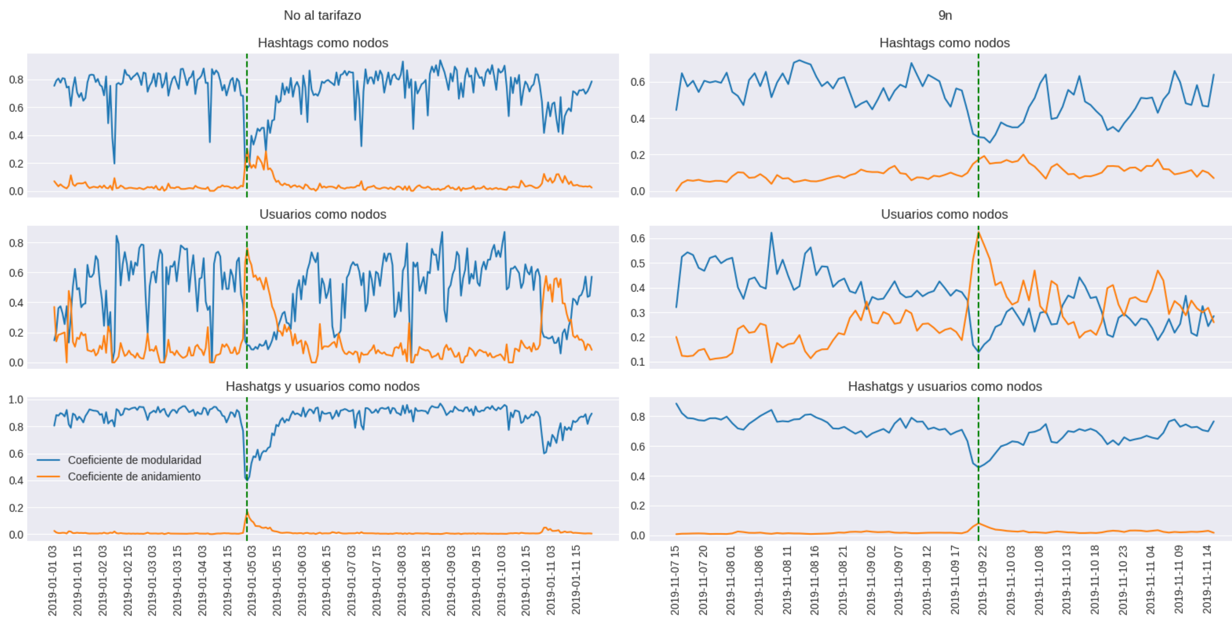
```
get_clust_nest_coefficient("nat", "b", measures_foler=measures_folder,
datasets_foler=datasets_folder, graphs_folder=graphs_folder)
```

```
Calculando el anidamiento y modularidad de 9n con criterio: h

100%|██████████| 97/97 [00:00<00:00, 222321.03it/s]

Calculando el anidamiento y modularidad de 9n con criterio: u


100%|██████████| 97/97 [00:00<00:00, 541741.00it/s]

Calculando el anidamiento y modularidad de 9n con criterio: b

100%|██████████| 97/97 [00:00<00:00, 293117.79it/s]

Calculando el anidamiento y modularidad de nat con criterio: h

100%|██████████| 260/260 [00:00<00:00, 1100422.85it/s]

Calculando el anidamiento y modularidad de nat con criterio: u

100%|██████████| 260/260 [00:00<00:00, 428663.14it/s]

Calculando el anidamiento y modularidad de nat con criterio: b

100%|██████████| 260/260 [00:00<00:00, 695927.91it/s]
```

```
# Convertimos el formato horario para el gráfico
dt_sort_arr_nat=[]
for hour in hour_sort_nat_b:

dt_sort_arr_nat.append(datetime.datetime.fromtimestamp(int(hour)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"))

dt_sort_arr_9n=[]
for hour in hour_sort_9n_b:

dt_sort_arr_9n.append(datetime.datetime.fromtimestamp(int(hour)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"))

plt.style.use('seaborn-v0_8-darkgrid')

fig, axs = plt.subplots(3, 2)
fig.set_size_inches(16,8)

# No al Tarifazo
# Hashtags como nodos

axs[0, 0].plot(dt_sort_arr_nat, mod_sort_nat_h)
axs[0, 0].plot(dt_sort_arr_nat, nest_sort_nat_h)
axs[0, 0].axvline(x=datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
```

```
ls="--")
axs[0, 0].get_xaxis().set_visible(False)
axs[0, 0].set_title("No al tarifazo\n\nHashtags como nodos")

# Usuarios como nodos
axs[1, 0].plot(dt_sort_arr_nat, mod_sort_nat_u)
axs[1, 0].plot(dt_sort_arr_nat, nest_sort_nat_u)
axs[1, 0].axvline(x=datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--")
axs[1, 0].get_xaxis().set_visible(False)
axs[1, 0].set_title("Usuarios como nodos")

# Redes bipartitas
axs[2, 0].plot(dt_sort_arr_nat, mod_sort_nat_b, label = "Coeficiente
de modularidad")
axs[2, 0].plot(dt_sort_arr_nat, nest_sort_nat_b, label = "Coeficiente
de anidamiento")
axs[2, 0].axvline(x=datetime.datetime.fromtimestamp(int(429624)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--")
axs[2, 0].set_xticks(dt_sort_arr_nat[::12])
axs[2, 0].set_xticklabels(dt_sort_arr_nat[::12])
axs[2, 0].tick_params(axis='x', rotation=90)
axs[2, 0].grid(axis='x', linestyle='')
axs[2, 0].legend()
axs[2, 0].set_title("Hashatgs y usuarios como nodos")

# 9n
# Hashtags como nodos

axs[0, 1].plot(dt_sort_arr_9n, mod_sort_9n_h)
axs[0, 1].plot(dt_sort_arr_9n, nest_sort_9n_h)
axs[0, 1].axvline(x=datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--")
axs[0, 1].get_xaxis().set_visible(False)
axs[0, 1].set_title("9n\n\nHashtags como nodos")

# Usuarios como nodos
axs[1, 1].plot(dt_sort_arr_9n, mod_sort_9n_u)
axs[1, 1].plot(dt_sort_arr_9n, nest_sort_9n_u)
axs[1, 1].axvline(x=datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--")
axs[1, 1].get_xaxis().set_visible(False)
axs[1, 1].set_title("Usuarios como nodos")

# Redes bipartitas
axs[2, 1].plot(dt_sort_arr_9n, mod_sort_9n_b)
```

```
axs[2, 1].plot(dt_sort_arr_9n, nest_sort_9n_b)
axs[2, 1].axvline(x=datetime.datetime.fromtimestamp(int(437037)*3600,
tz=datetime.timezone.utc).strftime("%Y-%m-%d %H"), color="green",
ls="--")
axs[2, 1].set_xticks(dt_sort_arr_9n[::5])
axs[2, 1].set_xticklabels(dt_sort_arr_9n[::5])
axs[2, 1].grid(axis='x', linestyle='')
axs[2, 1].tick_params(axis='x', rotation=90)
axs[2, 1].set_title("Hashatgs y usuarios como nodos")

plt.tight_layout()
#fig.suptitle('Coeficientes de modularidad y de anidamiento para
diferentes formaciones de las redes de conectividad', y=1.05)
plt.savefig(plots_folder + "mod_nest.png")
plt.show()
```



Función de Distribución de Probabilidad (PDF) y Función de Distribución Cumulativa Complementaria (CCDF) de las horas críticas

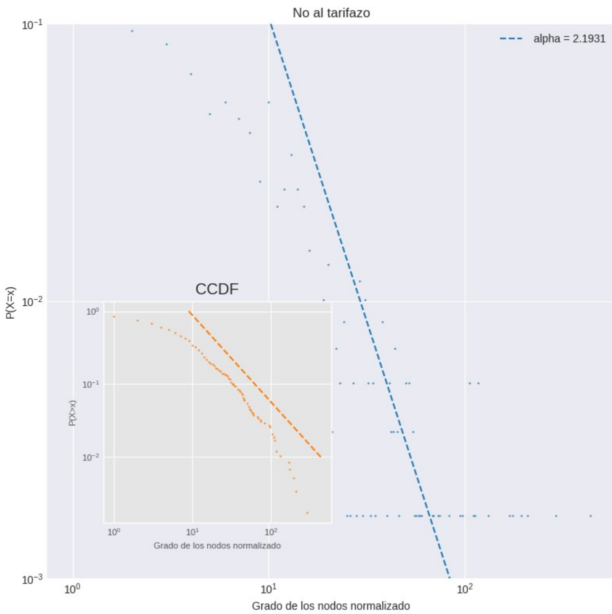
```
#No al tarifazo
plfit_nat, arr_pdf_points_nat, arr_ccdf_points_nat =
calc_degree_distribution(HORA_CRITICA_NAT, "nat/", mode="h",
graphs_folder=graphs_folder, measures_folder=measures_folder,
exp=True, read=False)

# 9n
plfit_9n, arr_pdf_points_9n, arr_ccdf_points_9n =
calc_degree_distribution(HORA_CRITICA_9N, "9n/", mode="h",
```

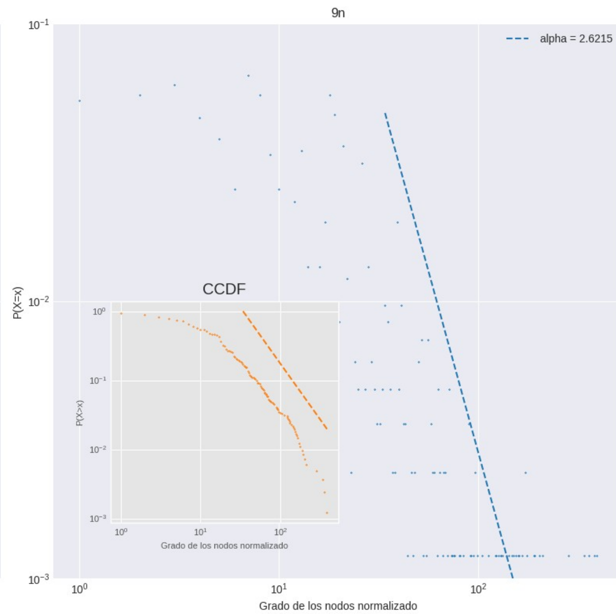
```
graphs_folder=graphs_folder, measures_folder=measures_folder,
exp=True)
```

```
100%|██████████| 1/1 [00:00<00:00, 60.85it/s]

Calculating best minimal value for power law fit
xmin progress: 98%

100%|██████████| 1/1 [00:00<00:00, 10866.07it/s]

Calculating best minimal value for power law fit
xmin progress: 99%
```

```
plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)
ax1.set_xscale('log')
ax1.set_yscale('log')

ax1.scatter(arr_pdf_points_nat[0][0], arr_pdf_points_nat[0][1],
marker="x", s=1, alpha=0.7)
plfit_nat.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_nat.alpha, 4)), ax=ax1, linestyle='--')
ax1.set_ylim(0.001, 0.1)

ax1.set_xlabel("Grado de los nodos normalizado")
ax1.set_ylabel("P(X=x)")
ax1.set_title("No al tarifazo")
ax1.legend()

with plt.style.context('ggplot'):
    ins_ax_nat = ax1.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_nat.set_xscale('log')
    ins_ax_nat.set_yscale('log')

    ins_ax_nat.scatter(arr_ccdf_points_nat[0][0],
arr_ccdf_points_nat[0][1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_nat.set_title("CCDF")
    ins_ax_nat.set_xlabel("Grado de los nodos normalizado",
fontsize=8)
    ins_ax_nat.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_nat.tick_params(labelsize=8)

    plfit_nat.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_nat.alpha, 5)), ax=ins_ax_nat, linestyle='--',
c='#ff7f0e')


ax2.set_xscale('log')
ax2.set_yscale('log')
```

```python
ax2.scatter(arr_pdf_points_9n[0][0], arr_pdf_points_9n[0][1],
marker="x", s=1, alpha=0.7)
plfit_9n.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_9n.alpha, 4)), ax=ax2, linestyle='--')
#plfit.plot_ccdf(label="powerlaw, alpha = " + str(round(plfit.alpha,
5)), color='red')
ax2.legend()
ax2.set_ylim(0.001, 0.1)

ax2.set_xlabel("Grado de los nodos normalizado")
ax2.set_ylabel("P(X=x)")
ax2.set_title("9n")

with plt.style.context('ggplot'):
    ins_ax_9n = ax2.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_9n.set_xscale('log')
    ins_ax_9n.set_yscale('log')

    ins_ax_9n.scatter(arr_ccdf_points_9n[0][0], arr_ccdf_points_9n[0]
[1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_9n.set_title("CCDF")
    ins_ax_9n.set_xlabel("Grado de los nodos normalizado", fontsize=8)
    ins_ax_9n.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_9n.tick_params(labelsize=8)

    plfit_9n.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_9n.alpha, 5)), ax=ins_ax_9n, linestyle='--',
c='#ff7f0e')
plt.tight_layout()
plt.savefig("plots/PDF_CCDF_nodes_hashtag.png")
plt.show()
```





AUTOSIMILITUD EN LAS REDES

Grado medio por Kt

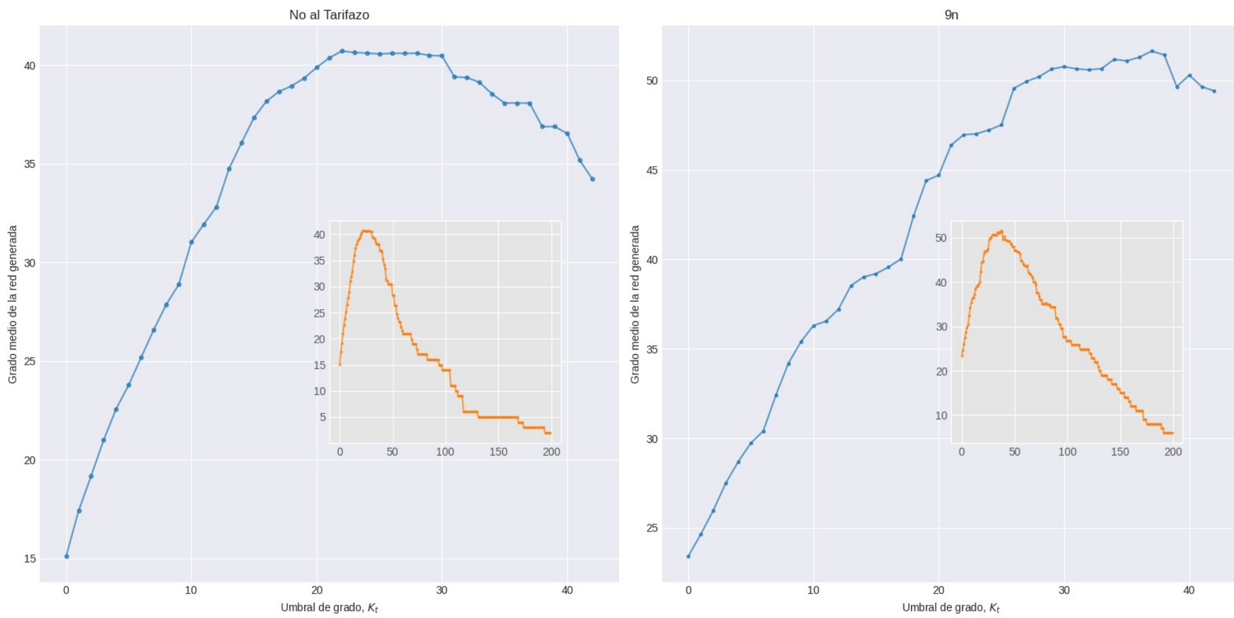
```
# MAX_UMBRAL es el máximo K_T que se va a usar para generar subgrafos
MAX_UMBRAL = 200

dict_hora_nat = {}
G_nat = nx.read_gexf(graphs_folder + "nodes_hashtag/nat/" +
HORA_CRITICA_NAT + '.gexf')
arr_medium_deg = []
for threshold in tqdm(range(MAX_UMBRAL)):
    threshold = float(threshold)
    if not threshold in dict_hora_nat.keys():
        # Se crea el subgrafo basandose en el threshold seleccionado
        F = thresh_normalization(G_nat,  threshold)
        if F == -1:
            # Caso de grafo vacío o grafo inconexo
            break
        dict_hora_nat[threshold] = calc_avg_degree(F)

dict_hora_9n = {}
G_9n = nx.read_gexf(graphs_folder + "nodes_hashtag/9n/" +
HORA_CRITICA_9N + '.gexf')
arr_medium_deg = []
for threshold in tqdm(range(MAX_UMBRAL)):
    threshold = float(threshold)
    if not threshold in dict_hora_9n.keys():
        # Se crea el subgrafo basándonos en el threshold seleccionado
```

```
        F = thresh_normalization(G_9n,  threshold)
        if F == -1:
            # Caso de grafo vacío o grafo inconexo
            break
        dict_hora_9n[threshold] = calc_avg_degree(F)
```

```
100%|██████████| 200/200 [00:00<00:00, 334.08it/s]
100%|██████████| 200/200 [00:01<00:00, 105.12it/s]
```

```
plt.style.use('seaborn-v0_8-darkgrid')

alpha=0.7

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

ax1.plot(list(dict_hora_nat.keys())[0:43],
list(dict_hora_nat.values())[0:43], alpha=0.7)
ax1.scatter(list(dict_hora_nat.keys())[0:43],
list(dict_hora_nat.values())[0:43], s=12, alpha=alpha)
ax1.set_title("No al Tarifazo")

with plt.style.context('ggplot'):
    ax1_inset = ax1.inset_axes([0.5, 0.25, 0.4, 0.4])
    #ax1_inset = inset_axes(ax1, width="40%", height="40%",
loc="center right")  # Dimensiones y ubicación del inset
    ax1_inset.plot(list(dict_hora_nat.keys()),
list(dict_hora_nat.values()), alpha=0.7, c='#ff7f0e')
    ax1_inset.scatter(list(dict_hora_nat.keys()),
list(dict_hora_nat.values()), s=4, alpha=alpha, c='#ff7f0e')

ax2.plot(list(dict_hora_9n.keys())[0:43], list(dict_hora_9n.values())
[0:43], alpha=alpha)
ax2.scatter(list(dict_hora_9n.keys())[0:43],
list(dict_hora_9n.values())[0:43], s=7, alpha=alpha)
ax2.set_title("9n")

with plt.style.context('ggplot'):
    ax2_inset = ax2.inset_axes([0.5, 0.25, 0.4, 0.4])
    #ax2_inset = inset_axes(ax2, width="40%", height="40%",
loc="center right")  # Dimensiones y ubicación del inset
    ax2_inset.plot(list(dict_hora_9n.keys()),
list(dict_hora_9n.values()), alpha=alpha, c='#ff7f0e')
    ax2_inset.scatter(list(dict_hora_9n.keys()),
list(dict_hora_9n.values()), s=4, alpha=alpha, c='#ff7f0e')
    ax2_inset.get_xaxis().set_visible(True)

ax1.set_ylabel("Grado medio de la red generada")
ax1.set_xlabel("Umbral de grado, $K_t$")
ax2.set_ylabel("Grado medio de la red generada")
```

```python
ax2.set_xlabel("Umbral de grado, $K_t$")

plt.tight_layout()
plt.savefig(plots_folder + "avg_deg.png")
plt.show()
```



Autosimilitud

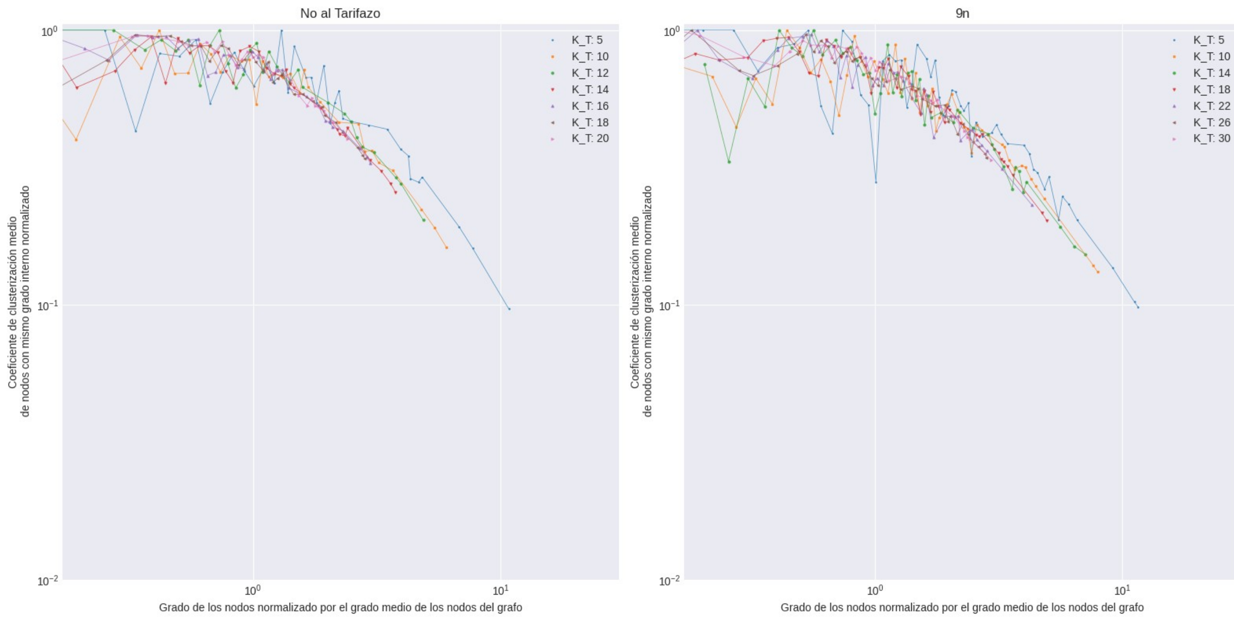
```python
# MAX_UMBRAL es el máximo K_T que vamos a usar para generar subgrafos
MAX_UMBRAL = 500

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
dict_thres_avg_clust_nat_h, dict_norm_int_deg_nat_h =
calc_self_sim(HORA_CRITICA_NAT, MAX_UMBRAL, "nat/")
dict_thres_avg_clust_9n_h, dict_norm_int_deg_9n_h =
calc_self_sim(HORA_CRITICA_9N, MAX_UMBRAL, "9n/")
```

```
 58%|█████▊    | 290/500 [00:02<00:01, 110.41it/s]
 76%|███████▌  | 379/500 [00:05<00:01, 71.38it/s]
```

```python
plt.style.use('seaborn-v0_8-darkgrid')

# Dado un diccionario con K_t como claves y como valores diccionarios
con internal degrees como clave y la media de coeficiente de
clusterización
# de los nodos que tienen dicho internal degree como valor, plotea el
scatter con la clave en eje X y los valores en eje Y
# Plotea tantos tipos como elementos haya en arr_index(esos indices en
concreto)
```

```
# Los valores de Kt que se van a representar
arr_kt_plot_nat = [5,10,12,14,16,18,20]
arr_kt_plot_9n = [5,10,14,18,22,26,30]

markers = get_all_markers()
alpha = 0.7

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)


for index, kt in enumerate(arr_kt_plot_nat):
    if kt in dict_norm_int_deg_nat_h.keys():
        points_x = list(dict_norm_int_deg_nat_h[kt].keys())[::2]
        points_y = list(dict_norm_int_deg_nat_h[kt].values())[::2]
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax1.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax1.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax1.set_xlabel("Grado de los nodos normalizado por el grado medio de
los nodos del grafo")
ax1.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)
ax1.set_xlim(0.17, 30)
ax1.legend()
ax1.set_title("No al Tarifazo")

for index, kt in enumerate(arr_kt_plot_9n):
    if kt in dict_norm_int_deg_9n_h.keys():
        points_x = list(dict_norm_int_deg_9n_h[kt].keys())[::2]
        points_y = list(dict_norm_int_deg_9n_h[kt].values())[::2]
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax2.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax2.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax2.set_xlabel("Grado de los nodos normalizado por el grado medio de
los nodos del grafo")
ax2.set_ylabel("Coeficiente de clusterización medio\n de nodos con
```

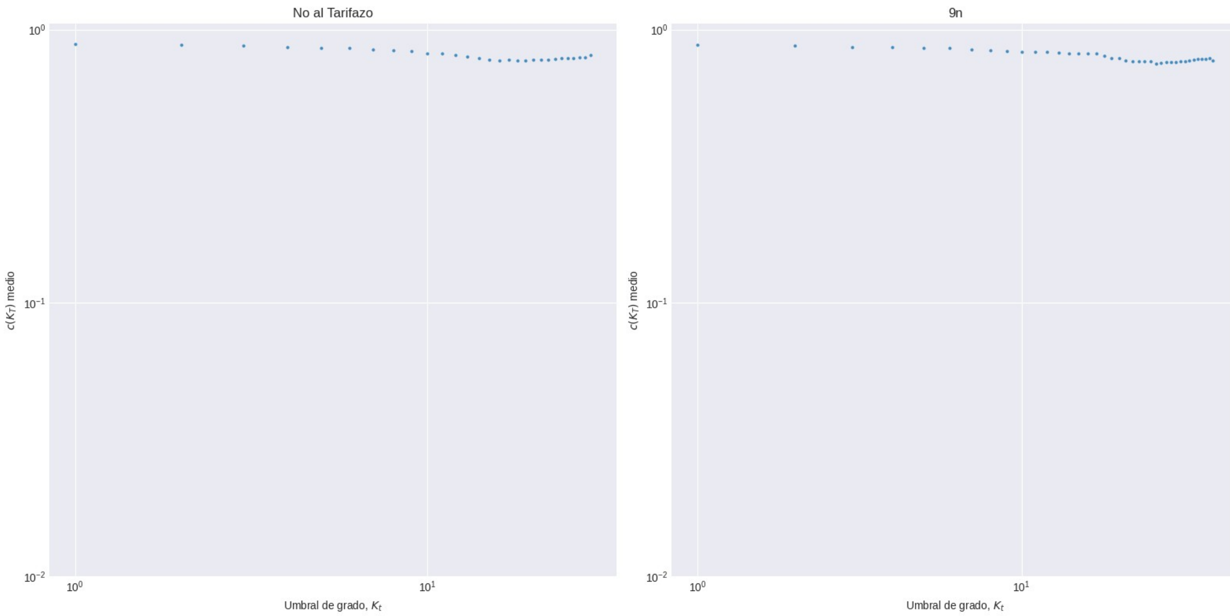
```
mismo grado interno normalizado")
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)
ax2.set_xlim(0.17, 30)
ax2.legend()
ax2.set_title("9n")

plt.tight_layout()
plt.savefig(plots_folder + "self_similarity.png")
plt.show()
```



Clustering promedio

```
plt.style.use('seaborn-v0_8-darkgrid')

# Máximos valores de Kt identificados para uqe no se observen errores
de tamaño finito
supreme_nat = 30
supreme_9n = 40

markers = get_all_markers()
alpha = 0.7

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)
```

```python
# Obtener las claves y los valores del diccionario
kt_nat = list(dict_thres_avg_clust_nat_h.keys())[:supreme_nat]
clust_nat = list(dict_thres_avg_clust_nat_h.values())[:supreme_nat]

ax1.scatter(kt_nat, clust_nat, s=4, alpha=alpha)

ax1.set_xlabel("Umbral de grado, $K_t$")
ax1.set_ylabel("$c(K_T)$ medio")
#ax1.legend(["max K_t posible: " + str(int(max(kt_nat)))])
ax1.set_title("No al Tarifazo")


ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)


# Obtener las claves y los valores del diccionario
kt_9n = list(dict_thres_avg_clust_9n_h.keys())[:supreme_9n]
clust_9n = list(dict_thres_avg_clust_9n_h.values())[:supreme_9n]

ax2.scatter(kt_9n, clust_9n, s=4, alpha=alpha)

ax2.set_xlabel("Umbral de grado, $K_t$")
ax2.set_ylabel("$c(K_T)$ medio")
#ax2.legend(["max K_t posible: " + str(int(max(kt_9n)))])
ax2.set_title("9n")


plt.tight_layout()
plt.savefig(plots_folder + "avg_clust_kt.png")
plt.show()
```

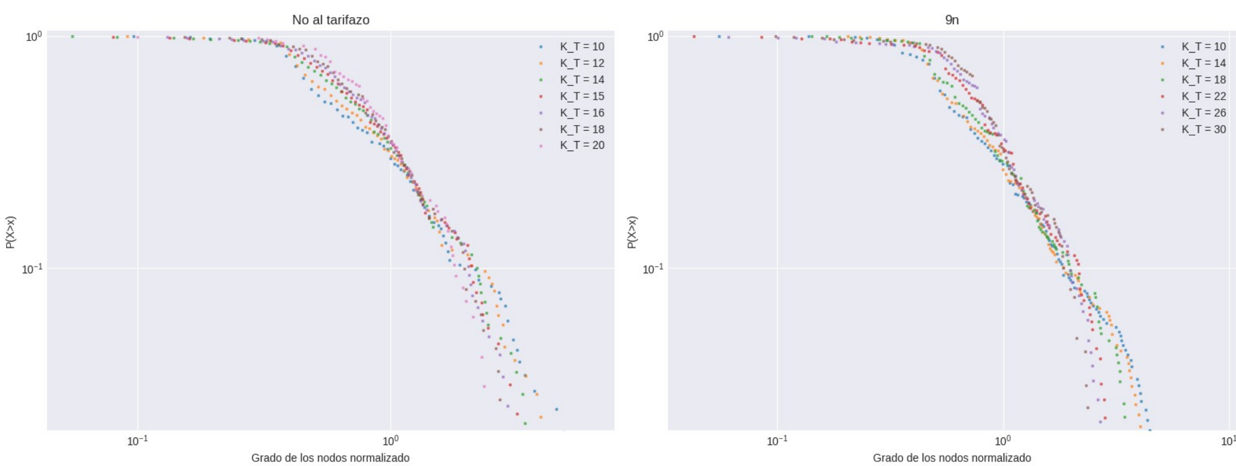



```
arr_kt_plot_nat = [10,12,14,15,16,18,20]
_, arr_deg_prob_nat, arr_deg_comp_cum_nat =
calc_degree_distribution("429624", "nat/", mode="h",
measures_folder=measures_folder, arr_kt=arr_kt_plot_nat, exp=False,
norm=True)
#calc_yerali(hora, graphs_folder, plots_folder, plfit=True,
normalize=False, show_comparative=False, only_ntamas=False)


arr_kt_plot_9n = [10,14,18,22,26,30]
_, arr_deg_prob_9n, arr_deg_comp_cum_9n =
calc_degree_distribution("437037",  "9n/", mode="h",
measures_folder=measures_folder, arr_kt=arr_kt_plot_9n, exp=False,
norm=True)
#calc_yerali(hora, graphs_folder, plots_folder, plfit=True,
normalize=False, show_comparative=False, only_ntamas=False)
```

```
100%|██████████| 7/7 [00:00<00:00, 24026.29it/s]
100%|██████████| 6/6 [00:00<00:00, 14580.43it/s]
```

```
plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,6)

dot_size=4
marker = "x"
alpha=0.7

for index, points in enumerate(arr_deg_comp_cum_nat):
    ax1.scatter(points[0], points[1], marker=marker, s=dot_size,
```

```
alpha=alpha, label="K_T = " + str(arr_kt_plot_nat[index]))
ax1.legend()
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.02, 1.05)
ax1.set_title("No al tarifazo")
ax1.set_xlabel("Grado de los nodos normalizado")
ax1.set_ylabel("P(X>x)")

for index, points in enumerate(arr_deg_comp_cum_9n):
    ax2.scatter(points[0], points[1], marker=marker, s=dot_size,
alpha=alpha, label="K_T = " + str(arr_kt_plot_9n[index]))
ax2.legend()
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.02, 1.05)
ax2.set_title("9n")
ax2.set_xlabel("Grado de los nodos normalizado")
ax2.set_ylabel("P(X>x)")

plt.tight_layout()
plt.savefig(plots_folder + "PDF_CCDF_Kts.png")
plt.show()
```



Resultados en otras ventanas temporales diferentes a la crítica

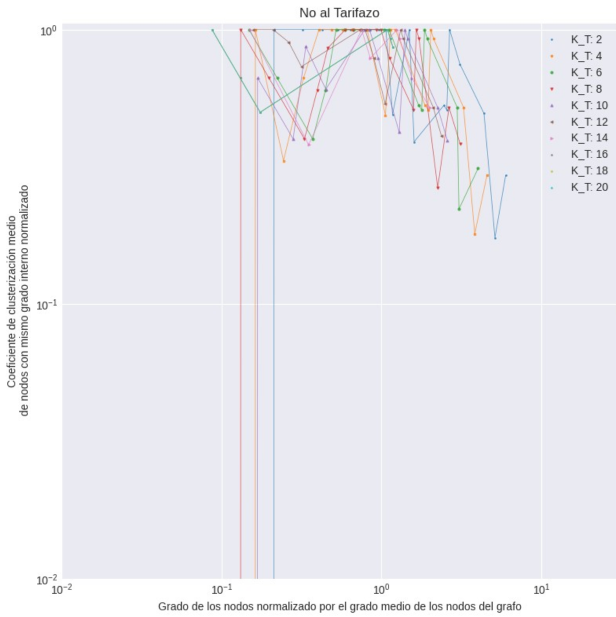
```
# MAX_UMBRAL es el máximo K_T que vamos a usar para generar subgrafos
MAX_UMBRAL = 500

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
```

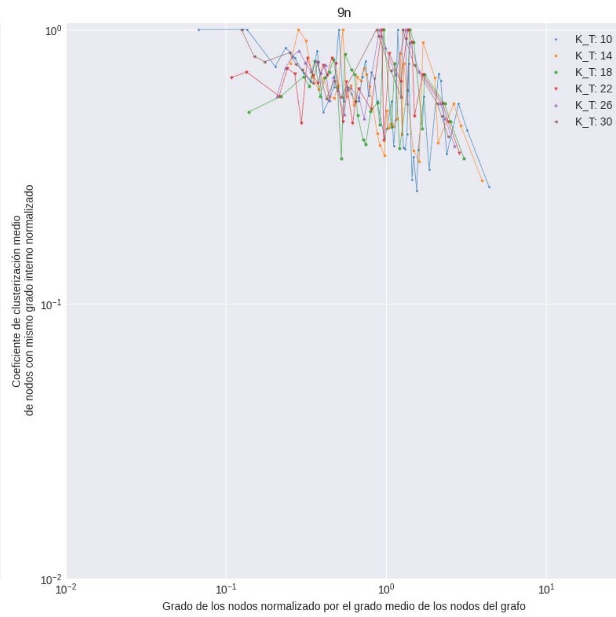
```
otra_hora_nat = "429600"

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
dict_thres_avg_clust_nat_h, dict_norm_int_deg_nat_h =
calc_self_sim(otra_hora_nat, MAX_UMBRAL, "nat/")

otra_hora_9n = "437002"
dict_thres_avg_clust_9n_h, dict_norm_int_deg_9n_h =
calc_self_sim(otra_hora_9n, MAX_UMBRAL, "9n/")
```

```
  0%|          | 0/500 [00:00<?, ?it/s]

 12%|█▏         | 59/500 [00:00<00:00, 487.83it/s]
 20%|██         | 99/500 [00:00<00:02, 164.24it/s]
```

```
alpha = 0.7

arr_kt_plot_nat = [2,4,6,8,10,12,14,16,18,20]
arr_kt_plot_9n = [10,14,18,22,26,30]

# Dado un diccionario con K_t como claves y como valores diccionarios
con internal degrees como clave y la media de coeficiente de
clusterización
# de los nodos que tienen dicho internal degree como valor, plotea el
scatter con la clave en eje X y los valores en eje Y
# Plotea tantos tipos como elementos haya en arr_index(esos indices en
concreto)


markers = get_all_markers()

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

plt.style.use('seaborn-v0_8-darkgrid')

for index, kt in enumerate(arr_kt_plot_nat):
    if kt in dict_norm_int_deg_nat_h.keys():
        points_x = list(dict_norm_int_deg_nat_h[kt].keys())
        points_y = list(dict_norm_int_deg_nat_h[kt].values())
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax1.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax1.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax1.set_xlabel("Grado de los nodos normalizado por el grado medio de
```

```
los nodos del grafo")
ax1.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)
ax1.set_xlim(0.01, 30)
ax1.legend()
ax1.set_title("No al Tarifazo")

for index, kt in enumerate(arr_kt_plot_9n):
    if kt in dict_norm_int_deg_9n_h.keys():
        points_x = list(dict_norm_int_deg_9n_h[kt].keys())
        points_y = list(dict_norm_int_deg_9n_h[kt].values())
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax2.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax2.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax2.set_xlabel("Grado de los nodos normalizado por el grado medio de
los nodos del grafo")
ax2.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)
ax2.set_xlim(0.01, 30)
ax2.legend()
ax2.set_title("9n")

plt.tight_layout()
plt.savefig(plots_folder + "self_similairty_others.png")
plt.show()
```





Uso de d-mercator

Los archivos de código relativos al uso de d-mercator se encuentran en la carpeta `d-mercator/` del presente repositorio.

Ajuste a ley de potencia de los grafos filtrados

```
# CREACIÓN DE LOS GRAFOS FILTRADOS

umbral_nat = 5
umbral_9n = 5
# No al tarifazo
G = nx.read_gexf(graphs_folder + "nodes_hashtag/nat/" +
HORA_CRITICA_NAT + ".gexf")
G = create_filtered_graph(G, umbral_nat)

# Componente gigante del grafo
Gcc = sorted(nx.connected_components(G), key=len, reverse=True)
G = G.subgraph(Gcc[0])

nx.write_gexf(G, graphs_folder + "filtered/" + str(umbral_nat) +
'/nat/' + HORA_CRITICA_NAT + ".gexf")

# 9n
G = nx.read_gexf(graphs_folder + "nodes_hashtag/9n/" + HORA_CRITICA_9N
+ ".gexf")

G = create_filtered_graph(G, umbral_9n)

# Componente gigante del grafo
Gcc = sorted(nx.connected_components(G), key=len, reverse=True)
```

```
G = G.subgraph(Gcc[0])

nx.write_gexf(G, graphs_folder + "filtered/" + str(umbral_9n) + '/9n/'
+ HORA_CRITICA_9N + ".gexf")
```

```
642 403
84 403
870 680
106 675
```

```
#No al tarifazo
plfit_nat, arr_pdf_points_nat, arr_ccdf_points_nat =
calc_degree_distribution(HORA_CRITICA_NAT, "nat/", mode="f",
graphs_folder=graphs_folder, measures_folder=measures_folder,
exp=True, thresh_filt=umbral_nat)

# 9n
plfit_9n, arr_pdf_points_9n, arr_ccdf_points_9n =
calc_degree_distribution(HORA_CRITICA_9N, "9n/", mode="f",
graphs_folder=graphs_folder, measures_folder=measures_folder,
exp=True, thresh_filt=umbral_9n)
```

```
100%|██████████| 1/1 [00:00<00:00, 16131.94it/s]



Calculating best minimal value for power law fit
xmin progress: 95%

100%|██████████| 1/1 [00:00<00:00, 13148.29it/s]

Calculating best minimal value for power law fit
xmin progress: 96%
```

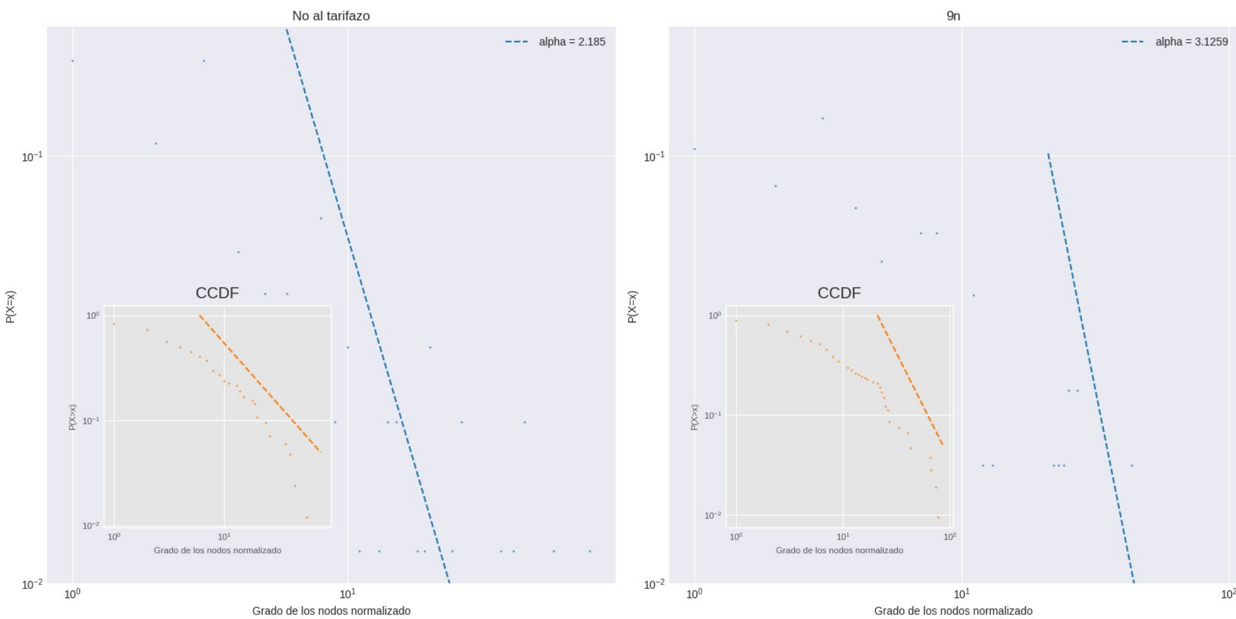
```
plfit_9n.D
```

```
np.float64(0.12685426675387346)
```

```
plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)
ax1.set_xscale('log')
ax1.set_yscale('log')

ax1.scatter(arr_pdf_points_nat[0][0], arr_pdf_points_nat[0][1],
marker="x", s=1, alpha=0.7)
plfit_nat.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_nat.alpha, 4)), ax=ax1, linestyle='--')
ax1.set_ylim(0.01, 0.2)
```

```
ax1.set_xlabel("Grado de los nodos normalizado")
ax1.set_ylabel("P(X=x)")
ax1.set_title("No al tarifazo")
ax1.legend()

with plt.style.context('ggplot'):
    ins_ax_nat = ax1.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_nat.set_xscale('log')
    ins_ax_nat.set_yscale('log')

    ins_ax_nat.scatter(arr_ccdf_points_nat[0][0],
arr_ccdf_points_nat[0][1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_nat.set_title("CCDF")
    ins_ax_nat.set_xlabel("Grado de los nodos normalizado",
fontsize=8)
    ins_ax_nat.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_nat.tick_params(labelsize=8)

    plfit_nat.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_nat.alpha, 5)), ax=ins_ax_nat, linestyle='--',
c='#ff7f0e')

ax2.set_xscale('log')
ax2.set_yscale('log')

ax2.scatter(arr_pdf_points_9n[0][0], arr_pdf_points_9n[0][1],
marker="x", s=1, alpha=0.7)
plfit_9n.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_9n.alpha, 4)), ax=ax2, linestyle='--')
#plfit.plot_ccdf(label="powerlaw, alpha = " + str(round(plfit.alpha,
5)), color='red')
ax2.legend()
ax2.set_ylim(0.01, 0.2)

ax2.set_xlabel("Grado de los nodos normalizado")
ax2.set_ylabel("P(X=x)")
ax2.set_title("9n")

with plt.style.context('ggplot'):
    ins_ax_9n = ax2.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_9n.set_xscale('log')
    ins_ax_9n.set_yscale('log')

    ins_ax_9n.scatter(arr_ccdf_points_9n[0][0], arr_ccdf_points_9n[0]
[1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_9n.set_title("CCDF")
    ins_ax_9n.set_xlabel("Grado de los nodos normalizado", fontsize=8)
    ins_ax_9n.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_9n.tick_params(labelsize=8)
```

```
    plfit_9n.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_9n.alpha, 5)), ax=ins_ax_9n, linestyle='--',
c='#ff7f0e')
plt.tight_layout()
plt.savefig("plots/PDF_CCDF_filtered.png")
plt.show()
```

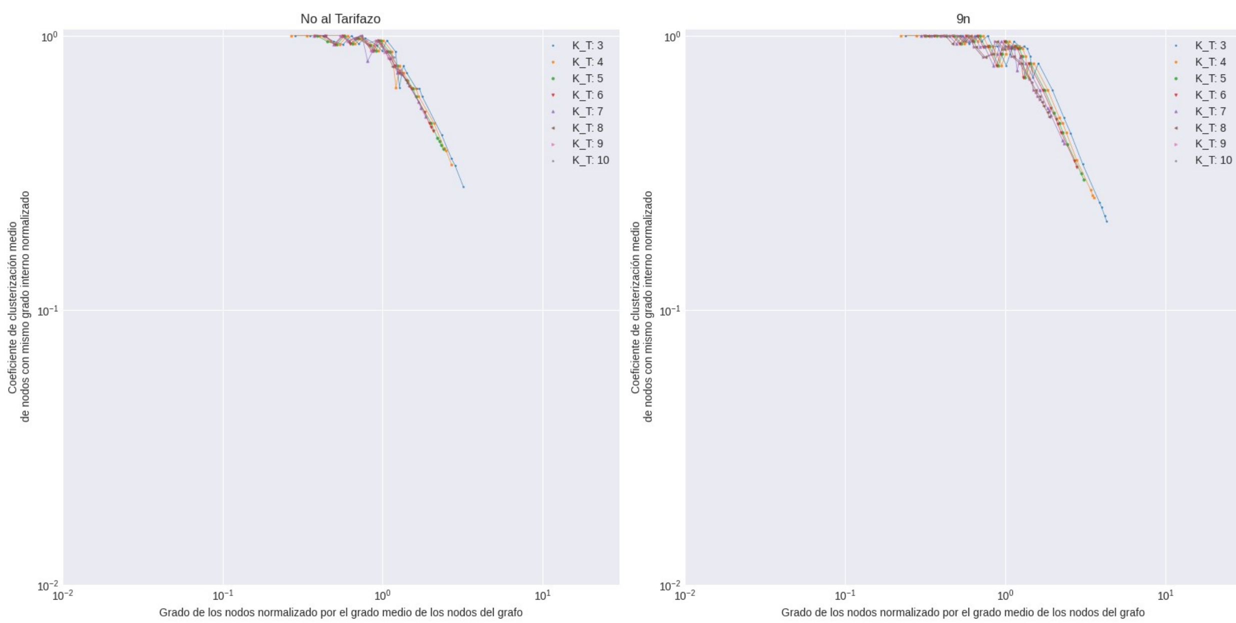


Autosimilitud de redes filtradas

```
# MAX_UMBRAL es el máximo K_T que vamos a usar para generar subgrafos
MAX_UMBRAL = 500

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
dict_thres_avg_clust_nat_h, dict_norm_int_deg_nat_h =
calc_self_sim(HORA_CRITICA_NAT, MAX_UMBRAL, "nat/", mode="f",
thresh_filter=umbral_nat)
dict_thres_avg_clust_9n_h, dict_norm_int_deg_9n_h =
calc_self_sim(HORA_CRITICA_9N, MAX_UMBRAL, "9n/", mode="f",
thresh_filter=umbral_9n)

  0%|          | 0/500 [00:00<?, ?it/s]

 11%|█         | 56/500 [00:00<00:02, 219.33it/s]
 16%|█▌        | 78/500 [00:00<00:01, 283.52it/s]

alpha = 0.7

arr_kt_plot_nat = [3,4,5,6,7,8,9,10]
```

```
arr_kt_plot_9n = [3,4,5,6,7,8,9,10]

# Dado un diccionario con K_t como claves y como valores diccionarios
con internal degrees como clave y la media de coeficiente de
clusterización
# de los nodos que tienen dicho internal degree como valor, plotea el
scatter con la clave en eje X y los valores en eje Y
# Plotea tantos tipos como elementos haya en arr_index(esos indices en
concreto)


markers = get_all_markers()

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

plt.style.use('seaborn-v0_8-darkgrid')

for index, kt in enumerate(arr_kt_plot_nat):
    if kt in dict_norm_int_deg_nat_h.keys():
        points_x = list(dict_norm_int_deg_nat_h[kt].keys())
        points_y = list(dict_norm_int_deg_nat_h[kt].values())
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax1.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax1.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax1.set_xlabel("Grado de los nodos normalizado por el grado medio de
los nodos del grafo")
ax1.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)
ax1.set_xlim(0.01, 30)
ax1.legend()
ax1.set_title("No al Tarifazo")

for index, kt in enumerate(arr_kt_plot_9n):
    if kt in dict_norm_int_deg_9n_h.keys():
        points_x = list(dict_norm_int_deg_9n_h[kt].keys())
        points_y = list(dict_norm_int_deg_9n_h[kt].values())
        # Se quita el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_h[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax2.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
```

```
        ax2.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax2.set_xlabel("Grado de los nodos normalizado por el grado medio de
los nodos del grafo")
ax2.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)
ax2.set_xlim(0.01, 30)
ax2.legend()
ax2.set_title("9n")

plt.tight_layout()
plt.savefig(plots_folder + "self_similairty_filtered.png")
plt.show()
```



Resultados en redes formadas con diferentes estrategias

Usuarios como nodos de los grafos

Ajuste a ley de potencia

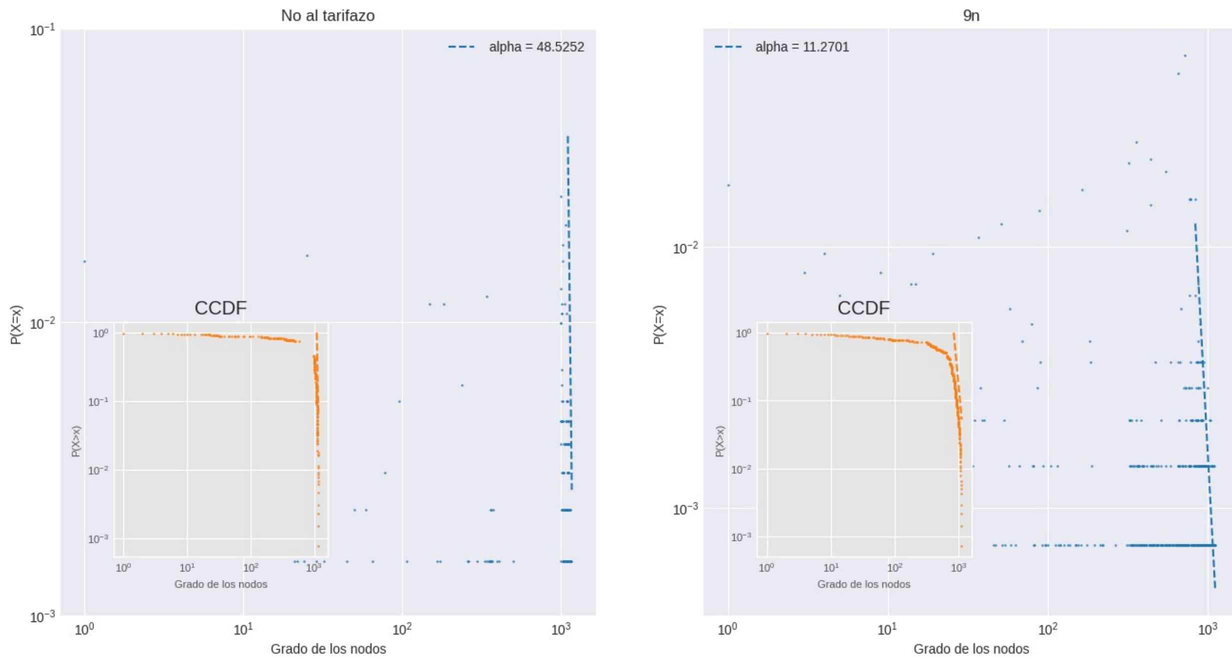
```
#No al tarifazo
plfit_nat, arr_pdf_points_nat, arr_ccdf_points_nat =
```

```python
calc_degree_distribution(HORA_CRITICA_NAT, "nat/", mode="u",
graphs_folder=graphs_folder, measures_folder=measures_folder, exp =
True, norm=False)

# 9n
plfit_9n, arr_pdf_points_9n, arr_ccdf_points_9n =
calc_degree_distribution(HORA_CRITICA_9N, "9n/", mode="u",
graphs_folder=graphs_folder, measures_folder=measures_folder, exp =
True, norm=False)
```

```
100%|██████████| 1/1 [00:00<00:00, 12446.01it/s]

Calculating best minimal value for power law fit
xmin progress: 99%

100%|██████████| 1/1 [00:00<00:00, 12018.06it/s]

Calculating best minimal value for power law fit
xmin progress: 99%
```

```python
plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)
ax1.set_xscale('log')
ax1.set_yscale('log')

ax1.scatter(arr_pdf_points_nat[0][0], arr_pdf_points_nat[0][1],
marker="x", s=1, alpha=0.7)
plfit_nat.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_nat.alpha, 4)), ax=ax1, linestyle='--')
ax1.set_ylim(0.001, 0.1)

ax1.set_xlabel("Grado de los nodos")
ax1.set_ylabel("P(X=x)")
ax1.set_title("No al tarifazo")
ax1.legend()

with plt.style.context('ggplot'):
    ins_ax_nat = ax1.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_nat.set_xscale('log')
    ins_ax_nat.set_yscale('log')

    ins_ax_nat.scatter(arr_ccdf_points_nat[0][0],
arr_ccdf_points_nat[0][1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_nat.set_title("CCDF")
    ins_ax_nat.set_xlabel("Grado de los nodos", fontsize=8)
    ins_ax_nat.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_nat.tick_params(labelsize=8)

    plfit_nat.power_law.plot_ccdf(label="powerlaw, alpha = " +
```

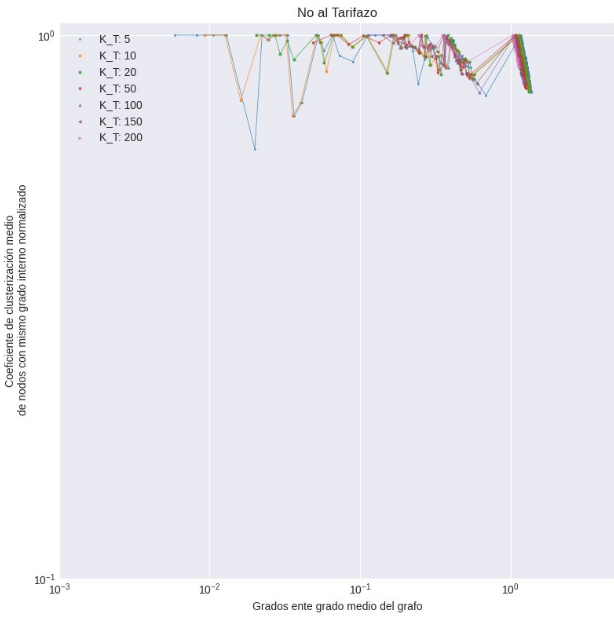
```
str(round(plfit_nat.alpha, 5)), ax=ins_ax_nat, linestyle='--',
c='#ff7f0e')

ax2.set_xscale('log')
ax2.set_yscale('log')

ax2.scatter(arr_pdf_points_9n[0][0], arr_pdf_points_9n[0][1],
marker="x", s=1, alpha=0.7)
plfit_9n.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_9n.alpha, 4)), ax=ax2, linestyle='--')
#plfit.plot_ccdf(label="powerlaw, alpha = " + str(round(plfit.alpha,
5)), color='red')
ax2.legend()

ax2.set_xlabel("Grado de los nodos")
ax2.set_ylabel("P(X=x)")
ax2.set_title("9n")

with plt.style.context('ggplot'):
    ins_ax_9n = ax2.inset_axes([0.1, 0.1, 0.4, 0.4])
    ins_ax_9n.set_xscale('log')
    ins_ax_9n.set_yscale('log')

    ins_ax_9n.scatter(arr_ccdf_points_9n[0][0], arr_ccdf_points_9n[0]
[1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_9n.set_title("CCDF")
    ins_ax_9n.set_xlabel("Grado de los nodos", fontsize=8)
    ins_ax_9n.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_9n.tick_params(labelsize=8)

    plfit_9n.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_9n.alpha, 5)), ax=ins_ax_9n, linestyle='--',
c='#ff7f0e')

plt.tight_layout
plt.savefig("plots/PDF_CCDF_nodes_user.png")
plt.show()
```

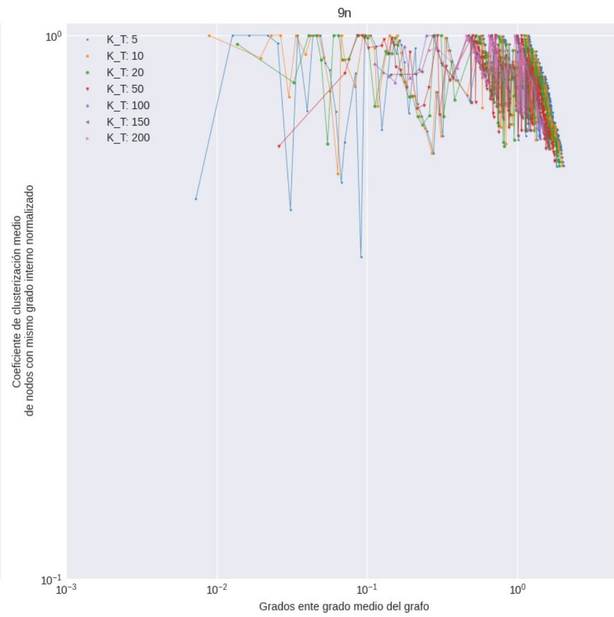


Autosimilitud

```
# MAX_UMBRAL es el máximo K_T que vamos a usar para generar subgrafos
MAX_UMBRAL = 250

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
dict_thres_avg_clust_nat_u, dict_norm_int_deg_nat_u =
calc_self_sim(HORA_CRITICA_NAT, MAX_UMBRAL, "nat/", mode='u')
dict_thres_avg_clust_9n_u, dict_norm_int_deg_9n_u =
calc_self_sim(HORA_CRITICA_9N, MAX_UMBRAL, "9n/", mode='u')

alpha = 0.7

arr_kt_plot_nat = [5,10,20,50,100,150,200,250,300,350]
arr_kt_plot_9n = [5,10,20,50,100,150,200,250,300,350]

# Dado un diccionario con K_t como claves y como valores diccionarios
con internal degrees como clave y la media de coeficiente de
clusterización
# de los nodos que tienen dicho internal degree como valor, plotea el
scatter con la clave en eje X y los valores en eje Y
# Plotea tantos tipos como elementos haya en arr_index(esos indices en
concreto)

markers = get_all_markers()

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)
```

```
plt.style.use('seaborn-v0_8-darkgrid')

for index, kt in enumerate(arr_kt_plot_nat):
    if kt in dict_norm_int_deg_nat_u.keys():
        points_x = list(dict_norm_int_deg_nat_u[kt].keys())[::2]
        points_y = list(dict_norm_int_deg_nat_u[kt].values())[::2]
        # Quitamos el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_u[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax1.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax1.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax1.set_xlabel("Grados ente grado medio del grafo")
ax1.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.1, 1.05)
ax1.set_xlim(0.001, 5)
ax1.legend()
ax1.set_title("No al Tarifazo")

for index, kt in enumerate(arr_kt_plot_9n):
    if kt in dict_norm_int_deg_9n_u.keys():
        points_x = list(dict_norm_int_deg_9n_u[kt].keys())[::2]
        points_y = list(dict_norm_int_deg_9n_u[kt].values())[::2]
        # Quitamos el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_u[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax2.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax2.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax2.set_xlabel("Grados ente grado medio del grafo")
ax2.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.1, 1.05)
ax2.set_xlim(0.001, 5)
ax2.legend()
ax2.set_title("9n")

plt.tight_layout()
plt.savefig(plots_folder + "self_similarity_nodes_user.png")
plt.show()
```

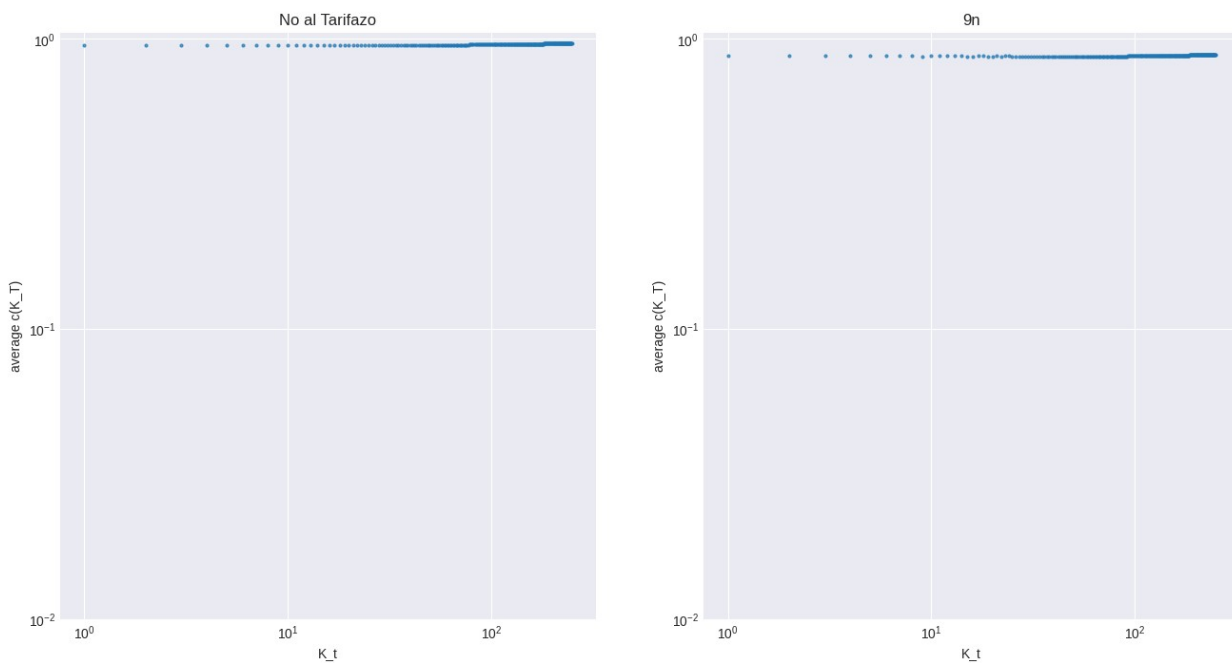




Clustering promedio

```
alpha = 0.7

arr_kt_plot_nat = [5,10,15,20,25,30,35,40]
arr_kt_plot_9n = [5,10,15,20,25,30,35,40]

markers = get_all_markers()

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

plt.styfig = plt.figure(figsize=(14,7))
plt.style.use('seaborn-v0_8-darkgrid')

ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)

# Obtener las claves y los valores del diccionario
kt_nat = list(dict_thres_avg_clust_nat_u.keys())[:MAX_UMBRAL]
clust_nat = list(dict_thres_avg_clust_nat_u.values())[:MAX_UMBRAL]

ax1.scatter(kt_nat, clust_nat, s=4, alpha=alpha)

ax1.set_xlabel("K_t")
ax1.set_ylabel("average c(K_T)")
#ax1.legend(["max K_t posible: " + str(int(max(kt_nat)))])
ax1.set_title("No al Tarifazo")


ax2.set_xscale('log')
```

```python
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)


# Obtener las claves y los valores del diccionario
kt_9n = list(dict_thres_avg_clust_9n_u.keys())[:MAX_UMBRAL]
clust_9n = list(dict_thres_avg_clust_9n_u.values())[:MAX_UMBRAL]

ax2.scatter(kt_9n, clust_9n, s=4, alpha=alpha)

ax2.set_xlabel("K_t")
ax2.set_ylabel("average c(K_T)")
#ax2.legend(["max K_t posible: " + str(int(max(kt_9n)))])
ax2.set_title("9n")


plt.tight_layout()
plt.savefig(plots_folder + "avg_clust_kt_nodes_user.png")
plt.show()
```




```
<Figure size 1400x700 with 0 Axes>
```

Redes bipartitas

Ajuste a ley de potencia

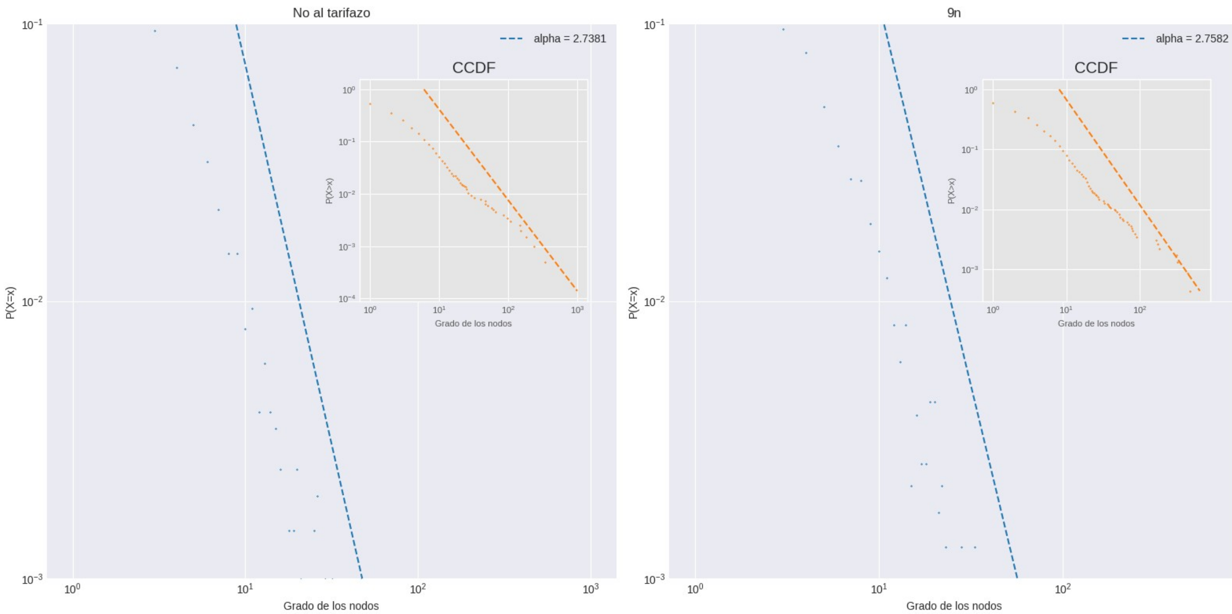
```python
#No al tarifazo
plfit_nat, arr_pdf_points_nat, arr_ccdf_points_nat =
calc_degree_distribution(HORA_CRITICA_NAT, "nat/", mode="b",
```

```
graphs_folder=graphs_folder, measures_folder=measures_folder, exp =
True, norm=False)

# 9n
plfit_9n, arr_pdf_points_9n, arr_ccdf_points_9n =
calc_degree_distribution(HORA_CRITICA_9N, "9n/", mode="b",
graphs_folder=graphs_folder, measures_folder=measures_folder, exp =
True, norm=False)
```

```
100%|██████████| 1/1 [00:00<00:00, 7133.17it/s]

Calculating best minimal value for power law fit
xmin progress: 97%

100%|██████████| 1/1 [00:00<00:00, 11983.73it/s]

Calculating best minimal value for power law fit
xmin progress: 98%
```

```
plt.style.use('seaborn-v0_8-darkgrid')

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)
ax1.set_xscale('log')
ax1.set_yscale('log')

ax1.scatter(arr_pdf_points_nat[0][0], arr_pdf_points_nat[0][1],
marker="x", s=1, alpha=0.7)
plfit_nat.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_nat.alpha, 4)), ax=ax1, linestyle='--')
ax1.set_ylim(0.001, 0.1)

ax1.set_xlabel("Grado de los nodos")
ax1.set_ylabel("P(X=x)")
ax1.set_title("No al tarifazo")
ax1.legend()

with plt.style.context('ggplot'):
    ins_ax_nat = ax1.inset_axes([0.55, 0.5, 0.4, 0.4])
    ins_ax_nat.set_xscale('log')
    ins_ax_nat.set_yscale('log')

    ins_ax_nat.scatter(arr_ccdf_points_nat[0][0],
arr_ccdf_points_nat[0][1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_nat.set_title("CCDF")
    ins_ax_nat.set_xlabel("Grado de los nodos", fontsize=8)
    ins_ax_nat.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_nat.tick_params(labelsize=8)
```

```python
    plfit_nat.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_nat.alpha, 5)), ax=ins_ax_nat, linestyle='--',
c='#ff7f0e')


ax2.set_xscale('log')
ax2.set_yscale('log')

ax2.scatter(arr_pdf_points_9n[0][0], arr_pdf_points_9n[0][1],
marker="x", s=1, alpha=0.7)
plfit_9n.power_law.plot_pdf(label=" alpha = " +
str(round(plfit_9n.alpha, 4)), ax=ax2, linestyle='--')
#plfit.plot_ccdf(label="powerlaw, alpha = " + str(round(plfit.alpha,
5)), color='red')
ax2.legend()
ax2.set_ylim(0.001, 0.1)

ax2.set_xlabel("Grado de los nodos")
ax2.set_ylabel("P(X=x)")
ax2.set_title("9n")

with plt.style.context('ggplot'):
    ins_ax_9n = ax2.inset_axes([0.55, 0.5, 0.4, 0.4])
    ins_ax_9n.set_xscale('log')
    ins_ax_9n.set_yscale('log')

    ins_ax_9n.scatter(arr_ccdf_points_9n[0][0], arr_ccdf_points_9n[0]
[1], marker="x", s=1, alpha=0.7, c='#ff7f0e')
    ins_ax_9n.set_title("CCDF")
    ins_ax_9n.set_xlabel("Grado de los nodos", fontsize=8)
    ins_ax_9n.set_ylabel("P(X>x)", fontsize=8)
    ins_ax_9n.tick_params(labelsize=8)

    plfit_9n.power_law.plot_ccdf(label="powerlaw, alpha = " +
str(round(plfit_9n.alpha, 5)), ax=ins_ax_9n, linestyle='--',
c='#ff7f0e')


plt.tight_layout()
plt.savefig("plots/PDF_CCDF_nodes_bipartite.png")
plt.show()
```



Autosimilitud

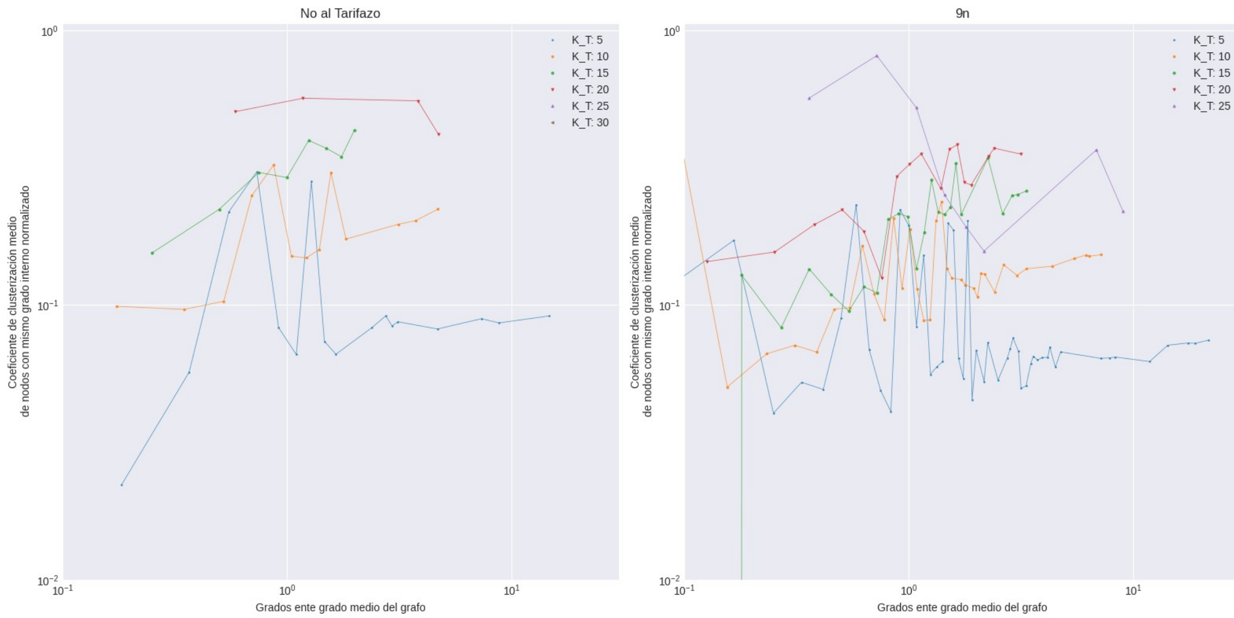
```
# MAX_UMBRAL es el máximo K_T que vamos a usar para generar subgrafos
MAX_UMBRAL = 250

# Seleccionamos el fichero correspondiente a la manifestación social
de la que queremos sacar la red y seleccionamos la hora que queremos
estudiar
dict_thres_avg_clust_nat_b, dict_norm_int_deg_nat_b =
calc_self_sim(HORA_CRITICA_NAT, MAX_UMBRAL, "nat/", mode='b')
dict_thres_avg_clust_9n_b, dict_norm_int_deg_9n_b =
calc_self_sim(HORA_CRITICA_9N, MAX_UMBRAL, "9n/", mode='b')
```

```
 13%|█▎        | 32/250 [00:00<00:00, 455.31it/s]
 16%|█▌        | 40/250 [00:00<00:00, 394.50it/s]
```

```
alpha = 0.7
arr_kt_plot_nat = [5,10,15,20,25,30,35,40]
arr_kt_plot_9n = [5,10,15,20,25]

# Dado un diccionario con K_t como claves y como valores diccionarios
con internal degrees como clave y la media de coeficiente de
clusterización
# de los nodos que tienen dicho internal degree como valor, plotea el
scatter con la clave en eje X y los valores en eje Y
# Plotea tantos tipos como elementos haya en arr_index(esos indices en
concreto)


markers = get_all_markers()

fig, (ax1, ax2) = plt.subplots(1, 2)
```

```
fig.set_size_inches(16,8)

plt.style.use('seaborn-v0_8-darkgrid')

for index, kt in enumerate(arr_kt_plot_nat):
    if kt in dict_norm_int_deg_nat_b.keys():
        points_x = list(dict_norm_int_deg_nat_b[kt].keys())[::2]
        points_y = list(dict_norm_int_deg_nat_b[kt].values())[::2]
        # Quitamos el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_b[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax1.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax1.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax1.set_xlabel("Grados ente grado medio del grafo")
ax1.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)
ax1.set_xlim(0.1, 30)
ax1.legend()
ax1.set_title("No al Tarifazo")

for index, kt in enumerate(arr_kt_plot_9n):
    if kt in dict_norm_int_deg_9n_b.keys():
        points_x = list(dict_norm_int_deg_9n_b[kt].keys())
        points_y = list(dict_norm_int_deg_9n_b[kt].values())
        # Quitamos el 0 para que la visualizacións se más clara
        if float(0) in dict_norm_int_deg_9n_b[kt].keys():
            points_x = points_x[1:]
            points_y = points_y[1:]
        ax2.plot(points_x, points_y, alpha=alpha, linewidth=0.6)
        ax2.scatter(points_x, points_y, alpha=alpha, s=4,
marker=markers[index], label=f'K_T: {kt}')

ax2.set_xlabel("Grados ente grado medio del grafo")
ax2.set_ylabel("Coeficiente de clusterización medio\n de nodos con
mismo grado interno normalizado")
ax2.set_xscale('log')
ax2.set_yscale('log')
ax2.set_ylim(0.01, 1.05)
ax2.set_xlim(0.1, 30)
ax2.legend()
ax2.set_title("9n")

plt.tight_layout()
```

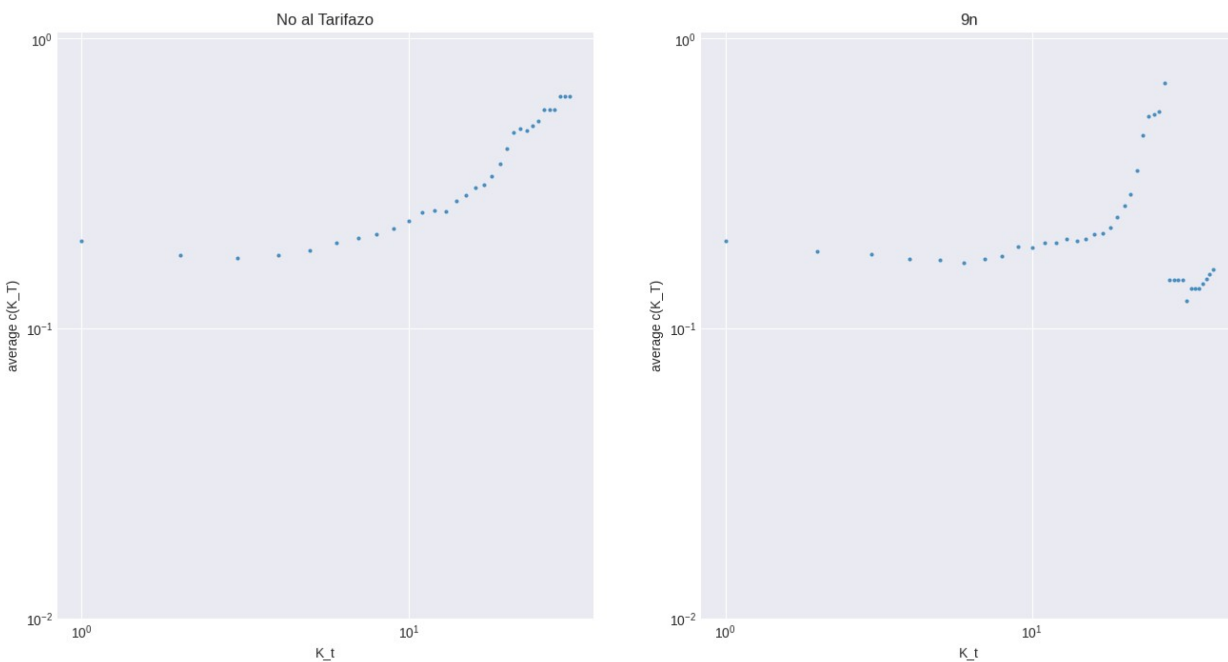
```
plt.savefig(plots_folder + "self_similarity_bipartite.png")
plt.show()
```



Clustering promedio

```
alpha = 0.7

fig, (ax1, ax2) = plt.subplots(1, 2)
fig.set_size_inches(16,8)

plt.styfig = plt.figure(figsize=(14,7))
plt.style.use('seaborn-v0_8-darkgrid')

ax1.set_xscale('log')
ax1.set_yscale('log')
ax1.set_ylim(0.01, 1.05)

# Obtener las claves y los valores del diccionario
kt_nat = list(dict_thres_avg_clust_nat_b.keys())[:MAX_UMBRAL]
clust_nat = list(dict_thres_avg_clust_nat_b.values())[:MAX_UMBRAL]

ax1.scatter(kt_nat, clust_nat, s=4, alpha=alpha)

ax1.set_xlabel("K_t")
ax1.set_ylabel("average c(K_T)")
#ax1.legend(["max K_t posible: " + str(int(max(kt_nat)))])
ax1.set_title("No al Tarifazo")


ax2.set_xscale('log')
ax2.set_yscale('log')
```

```
ax2.set_ylim(0.01, 1.05)


# Obtener las claves y los valores del diccionario
kt_9n = list(dict_thres_avg_clust_9n_b.keys())[:MAX_UMBRAL]
clust_9n = list(dict_thres_avg_clust_9n_b.values())[:MAX_UMBRAL]

ax2.scatter(kt_9n, clust_9n, s=4, alpha=alpha)

ax2.set_xlabel("K_t")
ax2.set_ylabel("average c(K_T)")
#ax2.legend(["max K_t posible: " + str(int(max(kt_9n)))])
ax2.set_title("9n")

plt.tight_layout()
plt.savefig(plots_folder + "avg_clust_kt_bipartite.png")
plt.show()
```




```
<Figure size 1400x700 with 0 Axes>
```