Potential Cheater Analysis

Looking at another dataset for comparison, but potentially found a cheater.

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from stockfish import Stockfish
import chess
import chess.engine
import math
```

In [2]:
```
engine = chess.engine.SimpleEngine.popen_uci("C:/Users/meinzecp/Downloads/stockfish_14.1_win_x64_avx2/stockfish_14.1_win_x64_avx2.exe")
stockfish = Stockfish('C:/Users/meinzecp/Downloads/stockfish_14.1_win_x64_avx2/stockfish_14.1_win_x64_avx2.exe')
stockfish.set_elo_rating(2600)
df = pd.read_csv('./chess_subsample.csv')
```

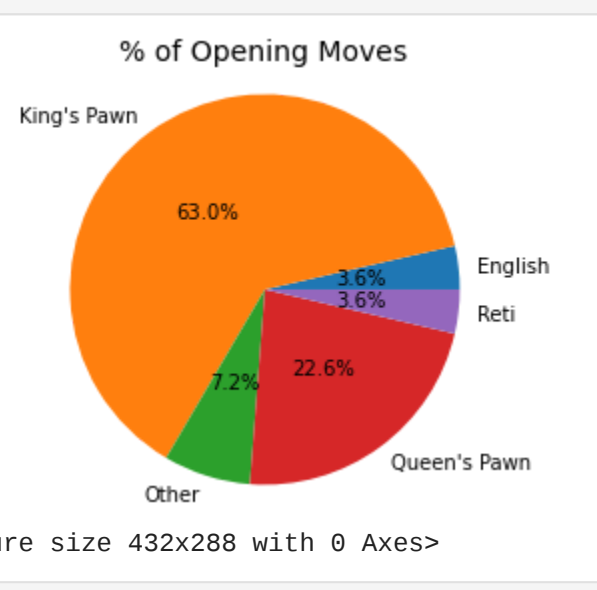
In [3]:
```
print(df.dtypes)
df.head(1)
```

```
game_id               int64
rated                  bool
turns                 int64
victory_status       object
winner               object
time_increment       object
white_id             object
white_rating          int64
black_id             object
black_rating          int64
moves                object
opening_code         object
opening_moves         int64
opening_fullname     object
opening_shortname    object
opening_response     object
opening_variation    object
dtype: object
```

Out[3]:

	game_id	rated	turns	victory_status	winner	time_increment	white_id	white_rating	black_id	black_rating	moves	opening_code	opening_moves	opening_fullname	opening_shortname	opening_response	opening_variatior
0	1	False	13	Out of Time	White	15+2	bourgris	1500	a-00	1191	d4 d5 c4 c6 cxd5 e6 dxe6 fxe6 Nf3 Bb4+ Nc3 Ba5...	D10	5	Slav Defense: Exchange Variation	Slav Defense	NaN	Exchange Variatior

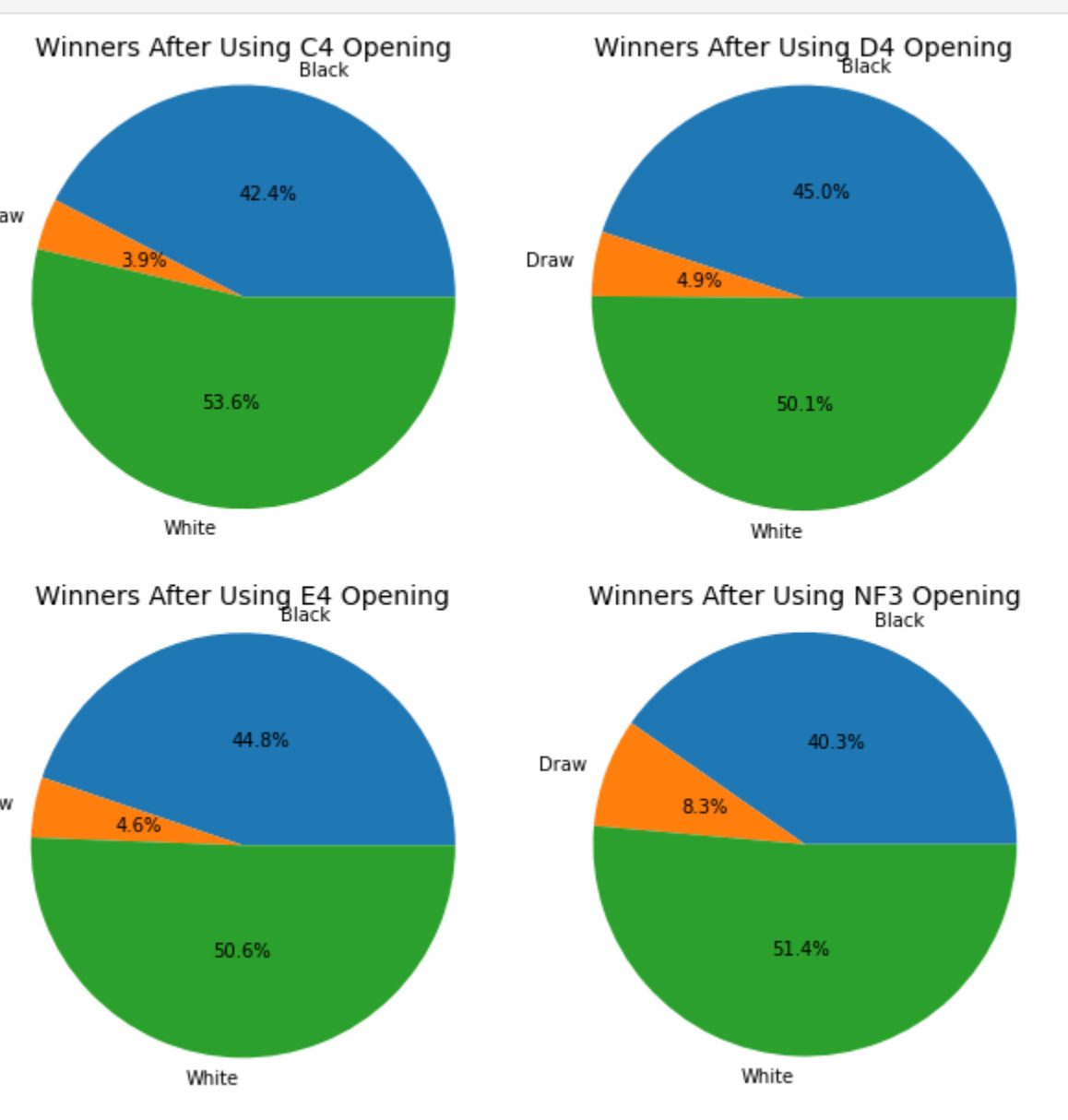
In [4]:
```
# Remove any games that were cut short
df = df[df.turns >= 3]
df['moves_list'] = df.moves.apply(lambda x: x.split())

# Add features for opening moves and response to the opening move
df['opening_move'] = df.moves_list.apply(lambda x: x[0])
df['response'] = df.moves_list.apply(lambda x: x[1])

# Manually adding opening move names
df['opening_name'] = df.moves_list.apply(lambda x: 'King\'s Pawn'
                                         if x[0] == 'e4'
                                         else ('Queen\'s Pawn'
                                               if x[0] == 'd4'
                                               else ('English'
                                                     if x[0] == 'c4'
                                                     else ('Reti'
                                                           if x[0] == 'Nf3'
                                                           else 'Other'))))
df['rating_gap'] = abs(df['white_rating'] - df['black_rating'])

# Feature for determining if higher-rated player won
df['higher_rated_victory'] = np.where((df['winner'] == 'White') & (df['white_rating'] > df['black_rating']) | (df['winner'] == 'Black') & (df['black_rating'] > df['white_rating']),

# Generate function for getting different rating gaps
df['rating_gap_class'] = df.rating_gap.apply(lambda x: '0-50'
                                             if (x <= 50)
                                             else ('51-100'
                                                   if (x > 50 and x <= 100)
                                                   else ('101-150'
                                                         if (x > 100 and x <= 150)
                                                         else ('151-200'
                                                               if (x > 150 and x <= 200)
                                                               else ('201-250'
                                                                     if (x > 200 and x <= 250)
                                                                     else '>250')))))
df['white_victory'] = np.where(df['winner'] == 'White', 1, 0)

# Manually split into top 4 opening moves of white
english = df[df.opening_move == 'c4']
queens_pawn = df[df.opening_move == 'd4']
kings_pawn = df[df.opening_move == 'e4']
reti = df[df.opening_move == 'Nf3']

# Visualize most used openings
opening_data = df.groupby('opening_name')['game_id'].count()
plt.pie(x=opening_data,
        autopct='%.1f%%',
        labels=opening_data.keys(),
        pctdistance=0.5)
plt.title('% of Opening Moves', fontsize=14)
plt.axis('equal')
plt.show()
plt.clf()
```




```
<Figure size 432x288 with 0 Axes>
```

In [5]:
```
# Create new df that contains the count of who won
english_wins = english.groupby('winner')['game_id'].count()
queen_wins = queens_pawn.groupby('winner')['game_id'].count()
king_wins = kings_pawn.groupby('winner')['game_id'].count()
reti_wins = reti.groupby('winner')['game_id'].count()
```

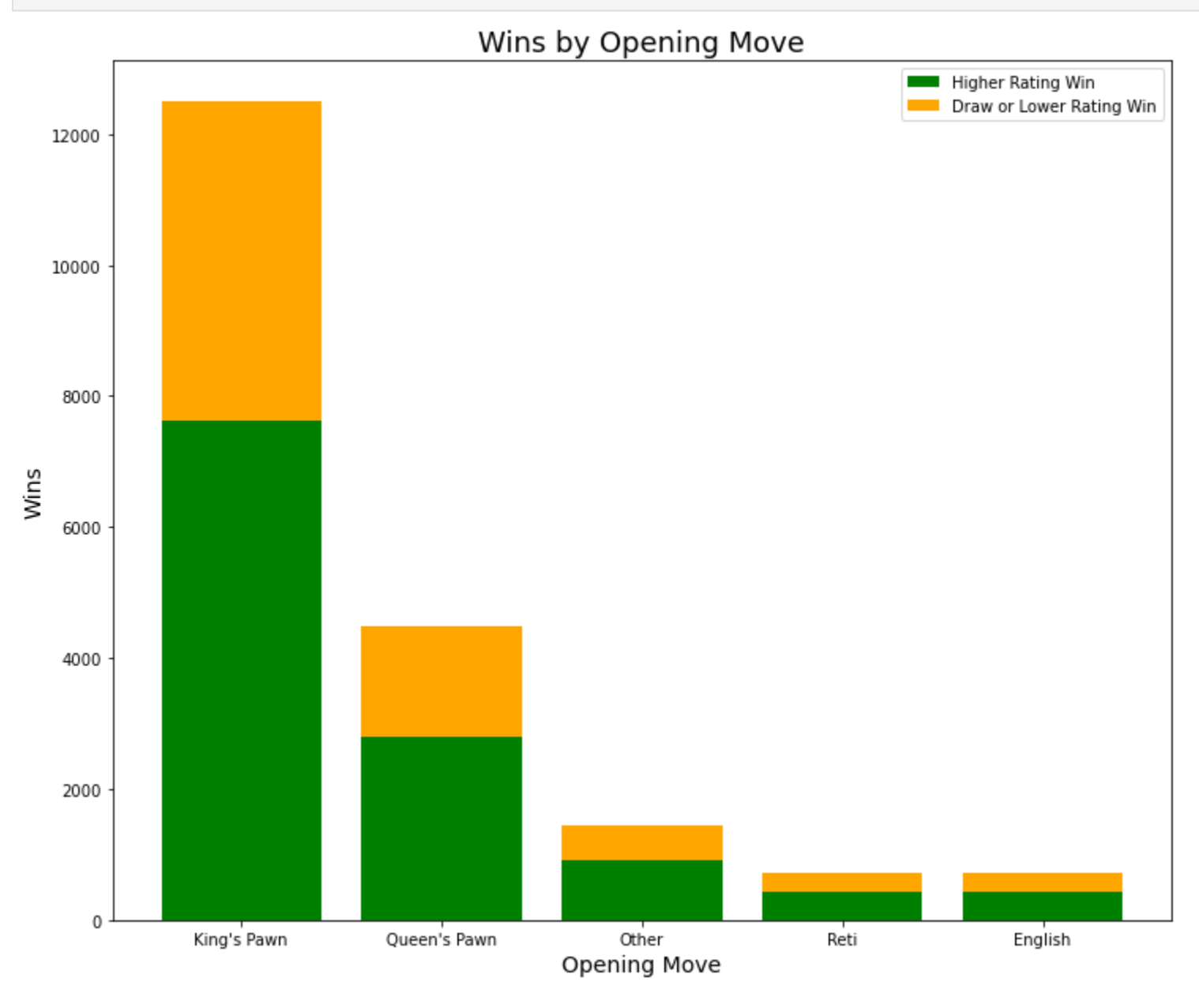
In [6]:
```
# Visualize wining results
pie, axs = plt.subplots(2,2, figsize=[10,10])

plt.subplot(2,2,1)
plt.pie(x=english_wins,
        autopct="%.1f%%",
        labels=english_wins.keys(),
        pctdistance=0.5)
plt.title("Winners After Using C4 Opening", fontsize=14)
plt.axis('equal')

plt.subplot(2,2,2)
plt.pie(x=queen_wins,
        autopct="%.1f%%",
        labels=queen_wins.keys(),
        pctdistance=0.5)
plt.title("Winners After Using D4 Opening", fontsize=14)
plt.axis('equal')

plt.subplot(2,2,3)
plt.pie(x=king_wins,
        autopct="%.1f%%",
        labels=king_wins.keys(),
        pctdistance=0.5)
plt.title("Winners After Using E4 Opening", fontsize=14)
plt.axis('equal')

plt.subplot(2,2,4)
plt.pie(x=reti_wins,
        autopct="%.1f%%",
        labels=reti_wins.keys(),
        pctdistance=0.5)
plt.title("Winners After Using NF3 Opening", fontsize=14)
plt.axis('equal')
plt.show()
```



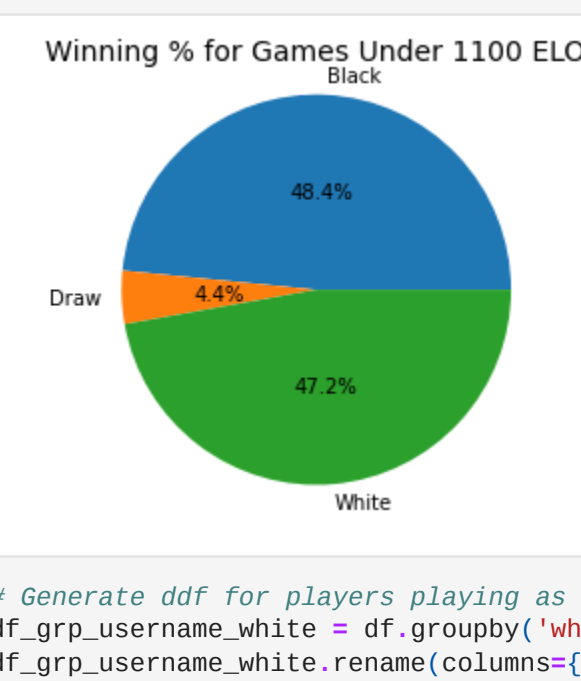
In [7]:
```
# Create df with the total # of wins by the white pieces using top 4 common openings
df_grp_rating = df.groupby('opening_name')['higher_rated_victory'].sum()
df_grp_rating = df_grp_rating.to_frame()

# Add feature for the total # of games
df_grp_rating['totals'] = df.groupby('opening_name')['higher_rated_victory'].count()

# Add feature for draws/losses
df_grp_rating['losses_or_draws'] = df_grp_rating['totals'] - df_grp_rating['higher_rated_victory']
print(df_grp_rating.head(10))
```

```
              higher_rated_victory  totals  losses_or_draws
opening_name
English                        426     714              288
King's Pawn                   7626   12499             4873
Other                          915    1434              519
Queen's Pawn                  2798    4486             1688
Reti                           424     722              298
```

In [8]:
```
# Visualize which ratings dominate which opening
df_grp_rating = df_grp_rating.sort_values('totals', ascending=False)
fig, ax = plt.subplots(1, figsize=(12,10))

ax.bar([0,1,2,3,4], df_grp_rating['higher_rated_victory'],
       label='Higher Rating Win',
       color='green',
       tick_label=df_grp_rating.index)
ax.bar([0,1,2,3,4], df_grp_rating['losses_or_draws'],
       label='Draw or Lower Rating Win',
       bottom=df_grp_rating['higher_rated_victory'],
       color='orange')

ax.set_ylabel('Wins', fontsize=14)
ax.set_xlabel('Opening Move', fontsize=14)
ax.set_title('Wins by Opening Move', fontsize=18)
ax.legend()
plt.show()
```



In [9]:
```
# Create df if players under 1100 ELO
num = 1100
df_under_num = df[(df.white_rating < num) & (df.black_rating < num)]

df_under_num_winners = df_under_num.groupby('winner')['game_id'].count()
df_under_num_winners

plt.pie(x=df_under_num_winners,
        autopct="%.1f%%",
        labels=df_under_num_winners.keys(),
        pctdistance=0.5)
plt.title("Winning % for Games Under {} ELO".format(num), fontsize=14)
plt.axis('equal')
plt.show()
```



In [10]:
```
# Generate ddf for players playing as white
df_grp_username_white = df.groupby('white_id',as_index=False).agg({'white_victory':'sum', 'game_id':'count'})
df_grp_username_white.rename(columns={'white_victory':'white_victories', 'game_id':'white_games'}, inplace=True)
df_grp_username_white = df_grp_username_white.set_index('white_id')

# Generate df for players playing as black
df_grp_username_black = df.groupby('black_id',as_index=False).agg({'white_victory':'sum', 'game_id':'count'})
df_grp_username_black.rename(columns={'white_victory':'white_victories', 'game_id':'black_games'}, inplace=True)
df_grp_username_black = df_grp_username_black.set_index('black_id')

# Calculate number of black victories
df_grp_username_black['black_victories'] = df_grp_username_black.black_games - df_grp_username_black.white_victories
df_grp_username_black.drop('white_victories', axis=1, inplace=True)

# Merge the two dataframes, replacing NaN with 0.
df_grp_username = df_grp_username_white.join(df_grp_username_black)
df_grp_username = df_grp_username.fillna(0)

# Calculate win percentage
df_grp_username['victories'] = df_grp_username.white_victories + df_grp_username.black_victories
df_grp_username['games_played'] = df_grp_username.white_games + df_grp_username.black_games
df_grp_username['win_pct'] = df_grp_username.victories / df_grp_username.games_played


# Sort by people who have the highest win percentage
df_grp_username_sorted = df_grp_username.sort_values(by=['win_pct'], ascending=False)
df_grp_username_sorted.head(5)
```

Out[10]:

white_id	white_victories	white_games	black_games	black_victories	victories	games_played	win_pct
rahza	1	1	0.0	0.0	1.0	1.0	1.0
houdini1ply	2	2	0.0	0.0	2.0	2.0	1.0
pakz91	1	1	0.0	0.0	1.0	1.0	1.0
holger1111	1	1	0.0	0.0	1.0	1.0	1.0
hola_yehmi	1	1	0.0	0.0	1.0	1.0	1.0

In [11]:
```
game_threshold = 24
df_grp_username_many_games = df_grp_username[(df_grp_username.games_played >= game_threshold)]
df_grp_username_many_games_sorted = df_grp_username_many_games.sort_values(by=['win_pct'], ascending=False)
df_grp_username_many_games_sorted.head(10)
```

Out[11]:

white_id	white_victories	white_games	black_games	black_victories	victories	games_played	win_pct
chesswithmom	14	14	10.0	10.0	24.0	24.0	1.000000
siindbad	13	13	13.0	13.0	26.0	26.0	1.000000
smartduckduckcow	3	3	21.0	21.0	24.0	24.0	1.000000
chesscarl	18	18	28.0	27.0	45.0	46.0	0.978261
lzchips	12	13	13.0	13.0	25.0	26.0	0.961538
christina-a-11	14	15	11.0	11.0	25.0	26.0	0.961538
smilsydov	15	16	22.0	21.0	36.0	38.0	0.947368
doraemon61	18	19	23.0	21.0	39.0	42.0	0.928571
gmanderson	12	12	12.0	10.0	22.0	24.0	0.916667
laode_syahril	16	20	22.0	22.0	38.0	42.0	0.904762

In [12]:
```
df_carl = df[(df.white_id == 'chesscarl') | (df.black_id == 'chesscarl')]
df_carl.rated.unique()
```

Out[12]:
```
array([ True])
```

In [13]:
```
# Get all the unique ids in the games chesscarl has played
print(df_carl.white_id.unique())
print(df_carl.black_id.unique())
```

```
['chilon' 'loebas' 'thelordoftheboard' 'lebbeusz2450' 'chesscarl'
 'angel2006' 'aca021' 'rigoberto_22' 'heisenberg3' 'vchess4' 'slobodan7'
 'fire_on_the_board' 'rodrigo-sagastegui' 'bdoq' 'hayki34' 'klemi'
 'mavrincbor' 'peshkach' 'ibonuribeetxebarria' 'foucheval' 'comped'
 'bshma' 'thorfabian' 'oilen1401' 'mahyir35' 'superii']
['chesscarl' 'christopho' 'kiterdekel' 'a_b_d_o' 'angel2006'
 'mario-panagiotis' 'grosschess' 'danielsor' 'sergey197316' 'anna1605'
 'wevertonsoares' 'withouttroble' 'g_king' 'krembrule' 'grewia'
 'ratnikmora' 'just_emza' 'gfinch' 'mahyir35']
```

In [14]:
```
# Calculate how many games that chesscarl was the higher-rated player
df_carl['carl_higher'] = np.where((df_carl['white_id'] == 'chesscarl') &
                                  (df_carl['white_rating'] > df_carl['black_rating']) |
                                  (df_carl['black_id'] == 'chesscarl') &
                                  (df_carl['black_rating'] > df_carl['white_rating']), 1, 0)

# number of games that chesscarl was rated higher than their opponents
num_carl_higher = df_carl.carl_higher.sum()
print('Chesscarl is a higher rating in', num_carl_higher, 'of their', len(df_carl), 'games.')
```

```
Chesscarl is a higher rating in 43 of their 46 games.
```

```
C:\Users\meinzecp\Anaconda3\lib\site-packages\ipykernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """
```

In [15]:
```
df_carl_is_higher = df_carl[(df_carl.carl_higher == 1)]
df_carl_is_lower = df_carl[(df_carl.carl_higher == 0)]

print('Average rating above opponents when higher-rated:', df_carl_is_higher.rating_gap.mean())
print('Average rating below opponents when lower-rated:', df_carl_is_lower.rating_gap.mean())
```

```
Average rating above opponents when higher-rated: 355.48837209302326
Average rating below opponents when lower-rated: 68.0
```

In [16]:
```
# This code was developed with the help of multiple StackOverflow posts

def generate_similarity_to_engine(df, username, top_moves_num=3):
    # create an empty list to store the similarity between chesscarl's moves and a 2600-rated engine's top 3 moves
    engine_pct = []
    df_white = df[(df.white_id == username)]
    df_black = df[(df.black_id == username)]

    # loop through the moves in each white game, comparing to top engine moves
    for index, row in df_white.iterrows():
        similar_moves = 0
        moves_list = row['moves_list'] # get moves made by specified user
        board = chess.Board()
        for i in range(len(moves_list)):
            if i % 2 == 0:
                stockfish = Stockfish('C:/Users/meinzecp/Downloads/stockfish_14.1_win_x64_avx2/stockfish_14.1_win_x64_avx2.exe')
                stockfish.set_fen_position(board.fen()) #updates the current board position for stockfish
                engine_moves = stockfish.get_top_moves(top_moves_num) #returns a list of dictionaries containing the top moves

                # get the fen notation for the move made by the specified user
                board.push_san(moves_list[i])
                fen1 = board.fen()
                board.pop()
                # get the fen notation for all of the top moves and compare it to the fen notation of the move made by the user
                for dic in engine_moves:
                    board.push_san(dic['Move'])
                    fen2 = board.fen()
                    board.pop()
                    if fen1 == fen2:
                        similar_moves = similar_moves + 1 # add 1 to counter if fen position of engine = fen position of user
                board.push_san(moves_list[i]) # make white move
            else:
                board.push_san(moves_list[i]) # make black move (no need to compare these moves to the engine)
        similarity_pct = similar_moves / math.ceil(len(moves_list)/2)
        engine_pct.append(similarity_pct)

    # loop through the moves in each black game, comparing to top engine moves
    for index, row in df_black.iterrows():
        similar_moves = 0
        moves_list = row['moves_list']
        board = chess.Board()
        for i in range(len(moves_list)):
            if i % 2 == 1:
                stockfish = Stockfish('C:/Users/meinzecp/Downloads/stockfish_14.1_win_x64_avx2/stockfish_14.1_win_x64_avx2.exe')
                stockfish.set_fen_position(board.fen())
                engine_moves = stockfish.get_top_moves(top_moves_num)
                board.push_san(moves_list[i])
                fen1 = board.fen()
                board.pop()
                for dic in engine_moves:
                    board.push_san(dic['Move'])
                    fen2 = board.fen()
                    board.pop()
                    if fen1 == fen2:
                        similar_moves = similar_moves + 1
                board.push_san(moves_list[i])
            else:
                board.push_san(moves_list[i])
        similarity_pct = similar_moves / math.floor(len(moves_list)/2)
        engine_pct.append(similarity_pct)

    return engine_pct
```

In [17]:
```
chesscarl_game_engine_analysis = generate_similarity_to_engine(df, 'chesscarl', 4)
print(chesscarl_game_engine_analysis)
```

```
[1.0, 0.72, 0.9090909090909091, 1.0, 0.9523809523809523, 1.0, 0.9565217391304348, 0.7096774193548387, 0.9, 0.9047619047619048, 0.8571428571428571, 0.8, 0.8857142857142857, 0.928571
4285714286, 0.8620689655172413, 0.9375, 0.9615384615384616, 0.9285714285714286, 0.8837209302325582, 0.896551724137931, 0.96, 0.9354838709677419, 0.9285714285714286, 0.9166666666666
666, 1.0, 1.0, 0.7857142857142857, 0.8918918918918919, 0.7916666666666666, 0.8666666666666667, 0.9166666666666666, 0.9230769230769231, 0.9411764705882353, 0.8928571428571429, 0.972
2222222222222, 0.7894736842105263, 0.75, 0.9130434782608695, 0.9090909090909091, 0.74, 1.0, 0.9166666666666666, 0.88, 0.8490566037735849, 0.9090909090909091, 0.6666666666666666]
```

In [18]:
```
plt.hist(chesscarl_game_engine_analysis, bins=20, color='green')
plt.xlabel('% of Moves Similar to Top 4 Engine Moves')
plt.ylabel('# of Occurrences')
plt.title("Engine Move Similarity to chesscarl's moves")
plt.show()
```