auction-simulator

July 9, 2023

[ ]:
```
import scipy.stats as rng
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import numpy as np
from tqdm import tqdm
```

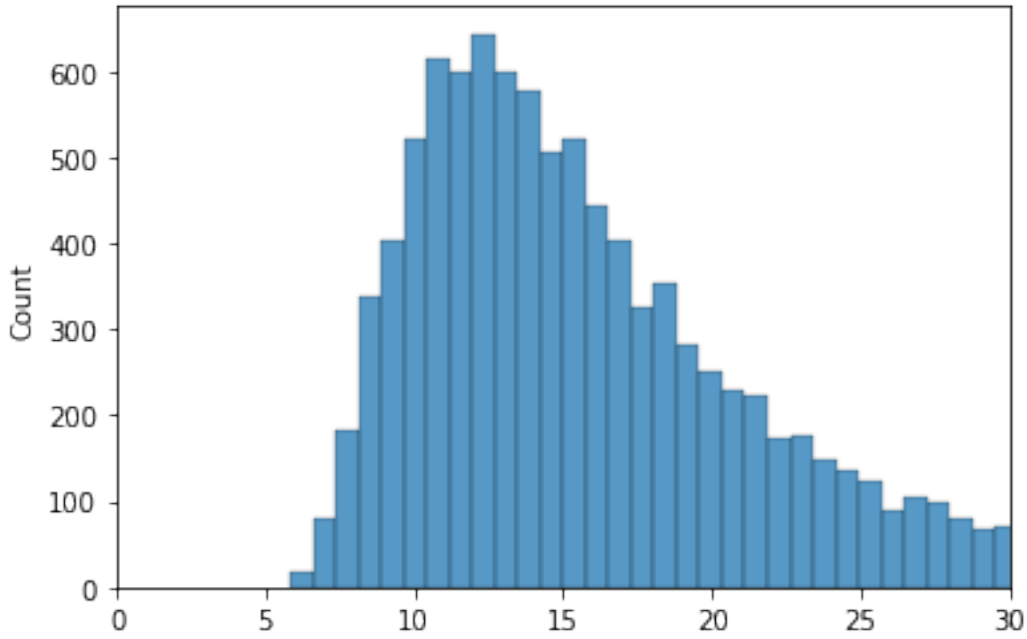
[ ]:
```
import warnings
warnings.filterwarnings("ignore")
```

#Rough Work

[ ]:
```
temp=rng.lognorm.rvs(0.6, loc = 5, scale = 10, size=10000)
print(temp.mean())
print(np.median(temp))
sns.histplot(temp).set_xlim(0,30)
#1
```

```
16.839104196437773
14.86328732730297
```

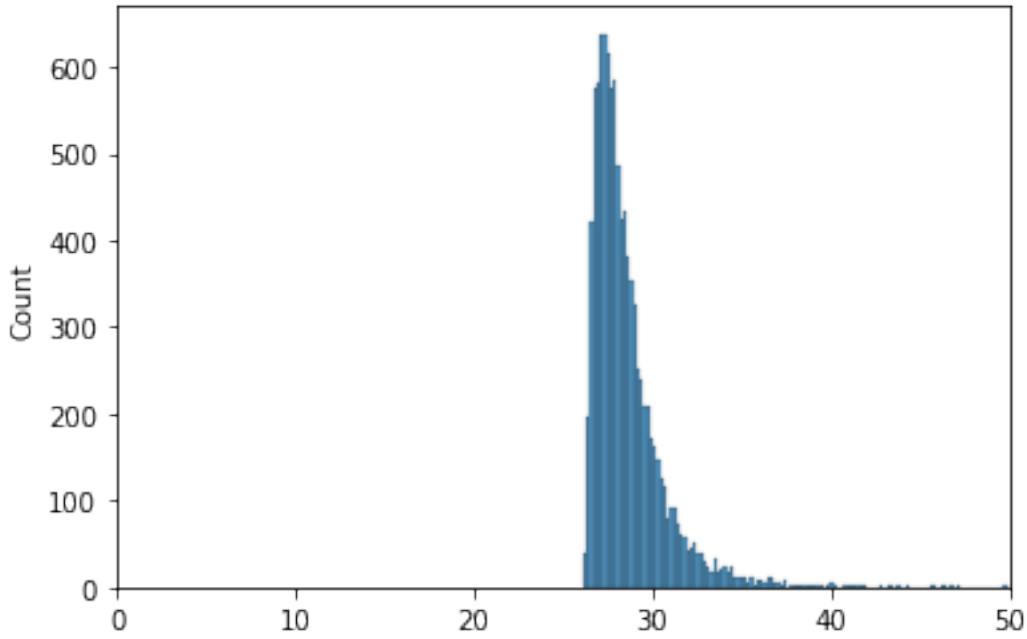
[ ]:
```
(0.0, 30.0)
```



[ ]:
```
temp=rng.lognorm.rvs(0.7, loc = 26, scale = 2, size=10000)
print(temp.mean())
print(np.median(temp))
sns.histplot(temp).set_xlim(0,50)
#2
```

```
28.601772614815697
28.03152862895805
```

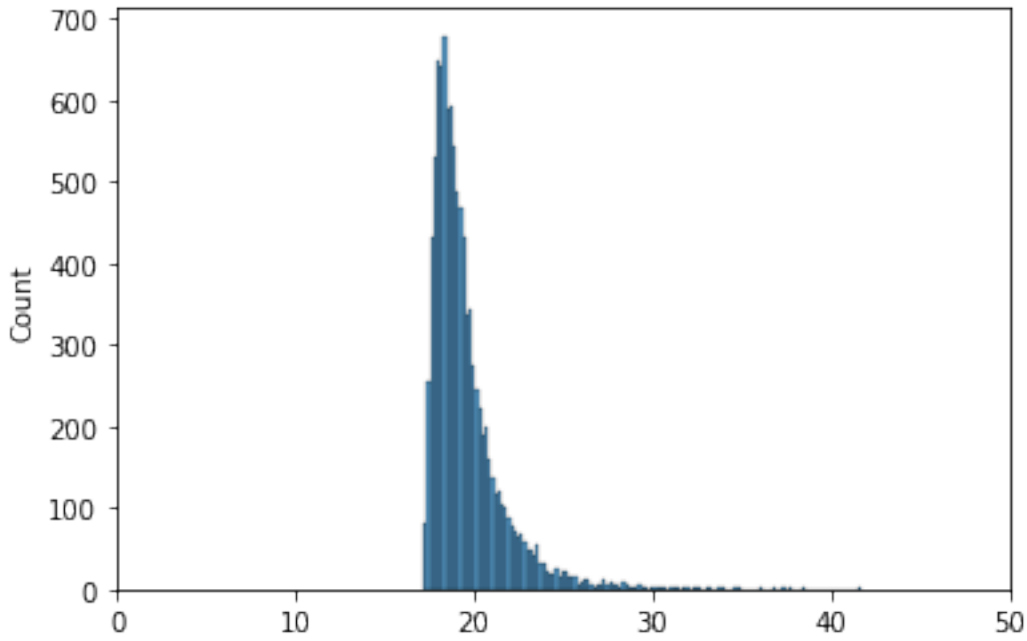
[ ]:
```
(0.0, 50.0)
```



[ ]:
```
temp=rng.lognorm.rvs(0.7, loc = 17, scale = 2, size=10000)
print(temp.mean())
print(np.median(temp))
sns.histplot(temp).set_xlim(0,50)
#3
```

```
19.54822767642387
18.981866600711193
```

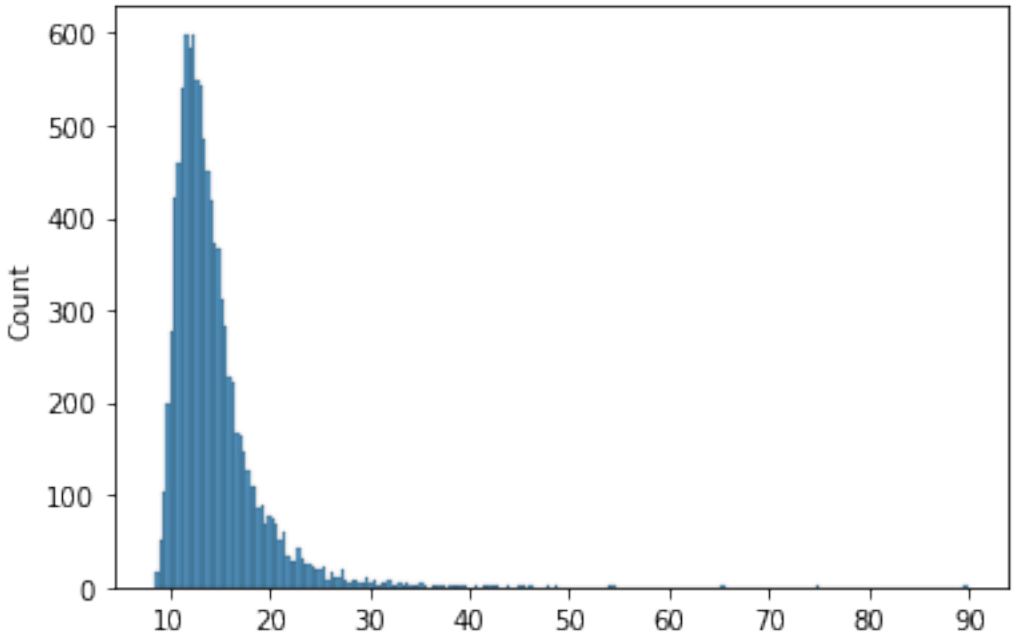
[ ]: (0.0, 50.0)



[ ]:
```
temp=rng.mielke.rvs(1000000, 5, loc = 1, scale = 1, size=10000)
print(temp.mean())
print(np.median(temp))
sns.histplot(temp)
```

```
14.369753489050403
13.3398453460702
```

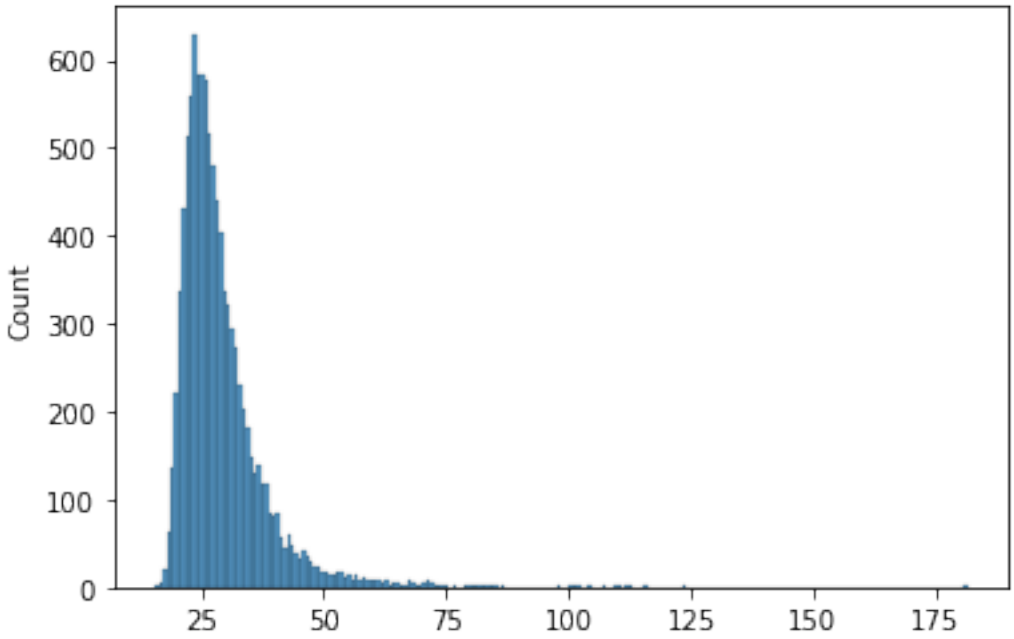
[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7faa3b6002b0>



[ ]:
```
temp=rng.mielke.rvs(40000000, 5, loc = 1, scale = 1, size=10000)
print(temp.mean())
print(np.median(temp))
sns.histplot(temp)
```

```
29.043198652740568
26.842808184553434
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7faa3ae02280>



#Typical Bidders

[ ]:
```
class early_bidder:
  def __init__(self, id):
    self.id = id
    self.name = "early_bidder"
    self.limit = rng.mielke.rvs(1000000, 5, loc = 1, scale = 1) #mielke mean=29.
↪04
    self.valuation = rng.lognorm.rvs(0.6, loc = 0, scale = 1.5) #lognorm mean=
    self.private_log = []
    #self.bidding_prob = 0.5

  def next_watch(self, clock, hard_close):
    wait_time = rng.erlang.rvs(50, loc = 0, scale = 1) #erlang mean = 50
    return wait_time + clock

  def new_valuation(self):
    c = rng.uniform.rvs(1.0,0.9) #uniform
    self.valuation = min(c * self.valuation, self.limit)
    return self.valuation

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id:
      return decision, 0
```

```
    new_bid = min(self.new_valuation(), self.limit)
    if second_highest_bid >= new_bid:
      return decision, 0
    if rng.uniform.rvs(0,1) > (clock / hard_close):
      decision = 'y'
    if decision == 'y':
      self.private_log.append((clock, new_bid))
    return decision, new_bid
```

[ ]:
```
class sniper:
  def __init__(self, id):
    self.id = id
    self.name = "sniper"
    self.limit = rng.mielke.rvs(40000000, 5, loc = 1, scale = 1) #mean = 14.3
    self.private_log = []

  def next_watch(self, clock, hard_close):
    wait_time = rng.uniform.rvs(0,40)
    if clock == 0:
      return hard_close - 20 + wait_time
    return clock + wait_time

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
 ↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id:
      return decision, 0
    new_bid = min(2 * second_highest_bid, self.limit)
    if second_highest_bid >= new_bid:
      return decision, 0
    decision = 'y'
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

#For Part2

[ ]:
```
class special_sniper:
  def __init__(self, id, sniping_time):
    self.id = id
    self.name = "special_sniper"
    self.limit = rng.mielke.rvs(40000000, 5, loc = 1, scale = 1) #mielke␣
 ↪mean=29.04
    self.sniping_time = sniping_time
    self.private_log = []

  def next_watch(self, clock, hard_close):
    wait_time = self.sniping_time
```

```
    if clock==0:
      return wait_time
    return hard_close + 1

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id:
      return decision, 0
    new_bid = min(2 * second_highest_bid, self.limit)
    if second_highest_bid >= new_bid:
      return decision, 0
    decision = 'y'
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

#For Part 4

[ ]:
```
class reserve_shiller:
  def __init__(self, id, hard_close):
    self.id = id
    self.name = "reserve_shiller"
    self.target = rng.lognorm.rvs(0.7, loc = 26 , scale = 2) #adjust parameters␣
↪11.7, 17, 26
    self.stoppage_time = hard_close - 100
    self.private_log = []

  def next_watch(self, clock, hard_close):
    wait_time = rng.erlang.rvs(5, loc = 0, scale = 1) #erlang mean = 5
    return wait_time + clock

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id or clock > self.stoppage_time or self.
↪target < second_highest_bid:
      return decision , 0
    new_bid = min(rng.uniform.rvs(1.5,1) * second_highest_bid, self.target)
    decision = 'y'
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

#For Part 6

[ ]:
```
class buy_back_shiller:
  def __init__(self, id):
    self.id = id
```

```
    self.name = "buy_back_shiller"
    self.target = rng.lognorm.rvs(0.6, loc = 5 , scale = 10)
    self.private_log = []

  def next_watch(self, clock, hard_close):
    if clock == 0:
      wait_time = hard_close - 5
    else:
      wait_time = hard_close + 1
    return wait_time

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id or second_highest_bid > self.target:
      return decision, 0
    new_bid = rng.uniform.rvs(1.5,1)*second_highest_bid
    decision = 'y'
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

1 For Part 5

[ ]:
```
class competitive_shiller:
  def __init__(self, id, hard_close):
    self.id = id
    self.name = "competitive_shiller"
    self.stoppage_time = hard_close - 100
    self.private_log = []

  def next_watch(self, clock, hard_close):
    wait_time = rng.erlang.rvs(2, loc = 0, scale = 1) #erlang mean = 5
    return wait_time + clock

  def wt_moving_avg(self):
    x1 = self.private_log[-1][1] - self.private_log[-2][1]
    x2 = self.private_log[-2][1] - self.private_log[-3][1]
    x3 = self.private_log[-3][1] - self.private_log[-4][1]
    return (3*x1+2*x2+1*x3)/6

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id or clock > self.stoppage_time:
      return decision, 0
```

```
    new_bid = (rng.uniform.rvs(1.5,1)*second_highest_bid) if (len(self.
↪private_log) < 4) else (second_highest_bid + self.wt_moving_avg())
    decision = 'y'
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

2 For Part 7

[ ]:
```
class cCompetitive_shiller:
  def __init__(self, id, hard_close):
    self.id = id
    self.name = "cCompetitive_shiller"
    self.stoppage_time = hard_close - 100
    self.private_log = []
    self.threshold = hard_close/(rng.norm.rvs(14.5, 2.9))

  def next_watch(self, clock, hard_close):
    wait_time = rng.erlang.rvs(2, loc = 0, scale = 1) #erlang mean = 5
    return wait_time + clock

  def congestion_calculation(self, logs):
    factor = 1
    if logs[-1][0] > self.threshold:
      factor = rng.uniform.rvs(1,1)
    else:
      factor = rng.uniform.rvs(2,1)
    return factor

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'n'
    if id_highest_bidder == self.id or clock > self.stoppage_time or len(logs)␣
↪== 0:
      return decision, 0
    decision = 'y'
    new_bid = second_highest_bid * self.congestion_calculation(logs)
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

3 For Part 8

[ ]:
```
class false_bidder:
  def __init__(self, id):
    self.id = id
    self.name = 'false_bidder'
```

```
    self.private_log = []
    self.increment = max(rng.lognorm.rvs(s=0.6089, loc=-1.92278, scale=6.
↪5193),0)*0.5

  def next_watch(self, clock, hard_close):
    if clock == 0:
      wait_time = hard_close - 2
    else:
      wait_time = hard_close + 1
    return wait_time

  def bid_valuation(self, second_highest_bid, id_highest_bidder, clock,␣
↪hard_close, logs):
    decision = 'y'
    new_bid = second_highest_bid + self.increment
    self.private_log.append((clock, new_bid))
    return decision, new_bid
```

#Auction

[ ]:
```
class auction:
  def __init__(self, num_snipers, num_early_bidders, num_special_snipers,␣
↪num_reserve_shillers, num_competitive_shillers, num_bb_shillers,␣
↪num_cc_shillers, num_fbidders, hard_close):
    self.hard_close = hard_close
    self.clock = 0
    self.highest_bid = 0
    self.second_highest_bid = 0
    self.id_highest_bidder = -1
    self.event_list = []
    self.bidder_queue = []
    self.bid_trend = []
    self.total_bidders = 0

    for i in range(0, num_early_bidders):
      obj = early_bidder(i+self.total_bidders)
      self.bidder_queue.append(obj)
      next_watch_time =  obj.next_watch(self.clock, self.hard_close)
      self.event_list.append(next_watch_time)
    self.total_bidders += num_early_bidders

    for i in range(0, num_snipers):
      obj = sniper(i+self.total_bidders)
      self.bidder_queue.append(obj)
      next_watch_time = obj.next_watch(self.clock, self.hard_close)
      self.event_list.append(next_watch_time)
    self.total_bidders += num_snipers
```

```
  for i in range(0, num_special_snipers):
    obj = special_sniper(i+self.total_bidders, 495) #sniping_time CHANGE HERE
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_special_snipers

  for i in range(0, num_reserve_shillers):
    obj = reserve_shiller(i+self.total_bidders, self.hard_close)
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_reserve_shillers

  for i in range(0, num_competitive_shillers):
    obj = competitive_shiller(i+self.total_bidders, self.hard_close)
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_competitive_shillers

  for i in range(0, num_bb_shillers):
    obj = buy_back_shiller(i+self.total_bidders)
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_bb_shillers

  for i in range(0, num_cc_shillers):
    obj = cCompetitive_shiller(i+self.total_bidders, self.hard_close)
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_cc_shillers

  for i in range(0, num_fbidders):
    obj = false_bidder(i+self.total_bidders)
    self.bidder_queue.append(obj)
    next_watch_time = obj.next_watch(self.clock, self.hard_close)
    self.event_list.append(next_watch_time)
  self.total_bidders += num_fbidders

def run_auction(self):
  next_event_time = min(self.event_list)
  while next_event_time < self.hard_close:
    self.clock = next_event_time
```

```
      bidder_id = self.event_list.index(next_event_time)
      bidder = self.bidder_queue[bidder_id]
      decision, bid = bidder.bid_valuation(self.second_highest_bid, self.
↪id_highest_bidder, self.clock, self.hard_close, self.bid_trend)
      if decision == 'y':
        if bid < self.highest_bid:
          self.second_highest_bid = bid
        else:
          self.second_highest_bid = self.highest_bid
          self.highest_bid = bid
          self.id_highest_bidder = bidder_id
        self.bid_trend.append((self.clock, self.second_highest_bid))
      self.event_list[bidder_id] = bidder.next_watch(self.clock, self.
↪hard_close)
      next_event_time = min(self.event_list)

    winner = self.id_highest_bidder
    bidder_type = self.bidder_queue[winner].name
    highest = self.highest_bid
    second_highest = self.second_highest_bid
    return winner, bidder_type, highest, second_highest, len(self.bid_trend)
```

#1 Sniper Vs Early Bidder

[ ]:
```
Auction = auction(3,7,0,0,0,0,0,0,500)
Auction.run_auction()
```

[ ]:
```
(9, 'sniper', 23.545626132675572, 20.705938143274448, 17)
```

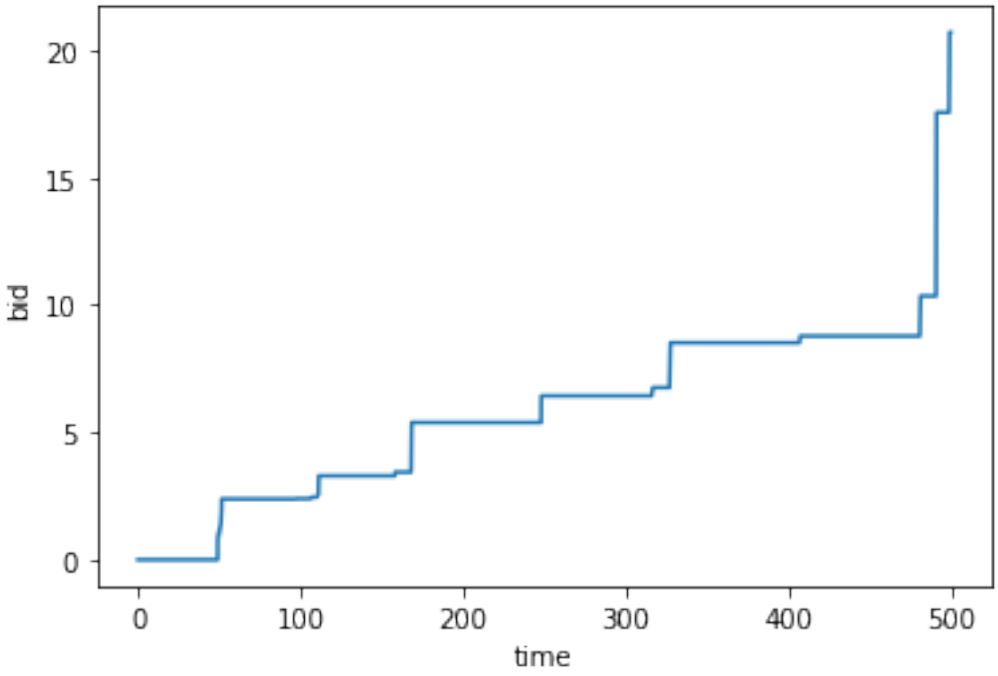
[ ]:
```
Auction.bid_trend
```

[ ]:
```
[(42.934051092594125, 0),
 (49.125402947261435, 0.8840804816361003),
 (51.47245644164307, 1.9701402639135976),
 (51.512444685785475, 2.383977801957772),
 (97.6348119545925, 2.396292991815981),
 (106.78903076406657, 2.454272920937541),
 (110.97217108822844, 2.5562225866937522),
 (111.22035688736929, 3.292533757409369),
 (158.2524054460099, 3.438703459756629),
 (168.38990006092826, 5.387176289006348),
 (248.14698605400653, 6.433153746573698),
 (316.78706028244306, 6.757766541824676),
 (327.5830951464237, 8.517690614129785),
 (407.48278094910324, 8.779643655495617),
 (481.4975735574231, 10.352969071637224),
 (491.3131471081557, 17.559287310991234),
```

```
 (499.3421609198751, 20.705938143274448)]
```

[ ]:
```
trend_log = pd.DataFrame(Auction.bid_trend, columns=['time','bid'])
trend_log_list = [(0,0)]
for i in range(1,len(trend_log)):
  trend_log_list.append((int(trend_log.loc[i][0]),trend_log.loc[i-1][1]))
trend_log_list.append((500, trend_log.loc[len(trend_log)-1][1]))
trend_log2 = pd.DataFrame(trend_log_list, columns=['time','bid'])
trend_log=trend_log.append(trend_log2, ignore_index=True)
trend_log=trend_log.sort_values('time').reset_index()
sns.lineplot(data=trend_log, x='time', y='bid')
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd153e1340>
```

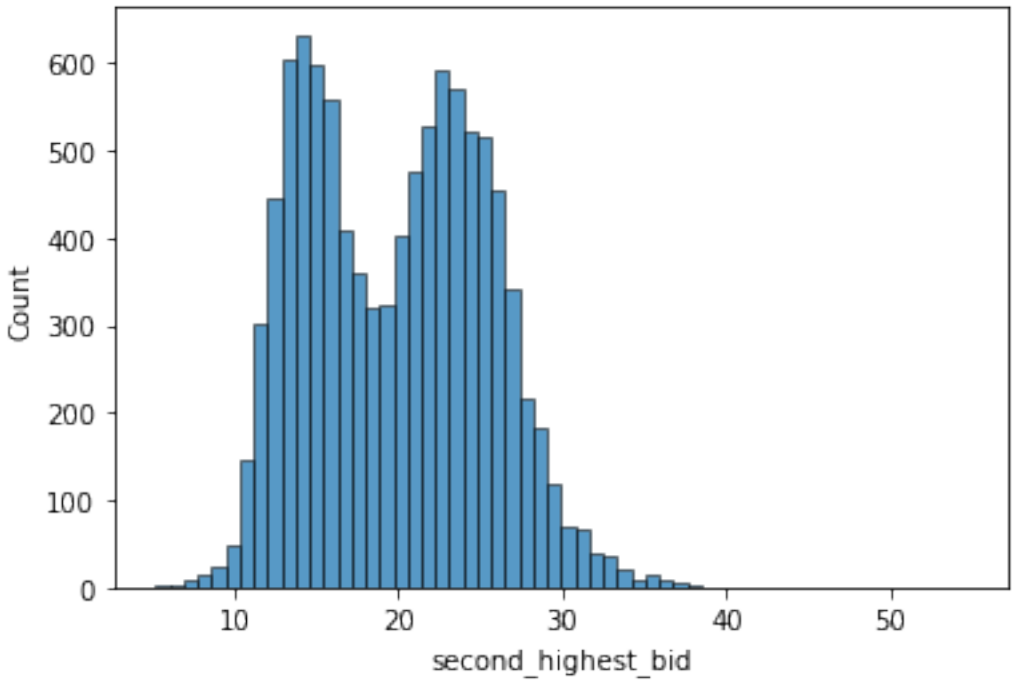


[ ]:
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,7,0,0,0,0,0,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [01:56<00:00, 85.70it/s]
```

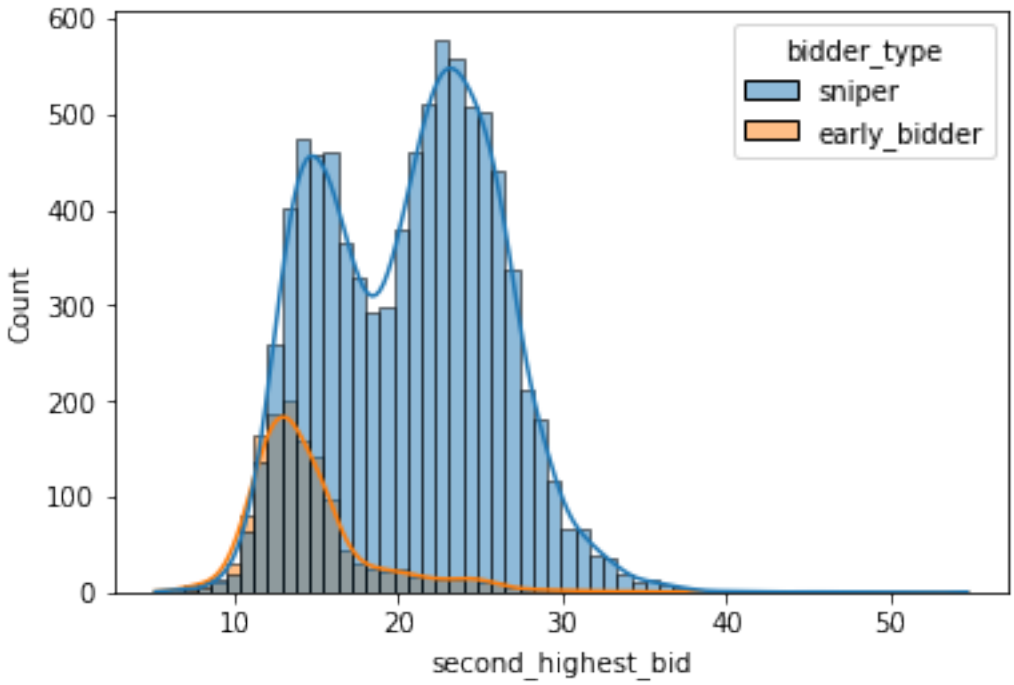
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd14e33310>



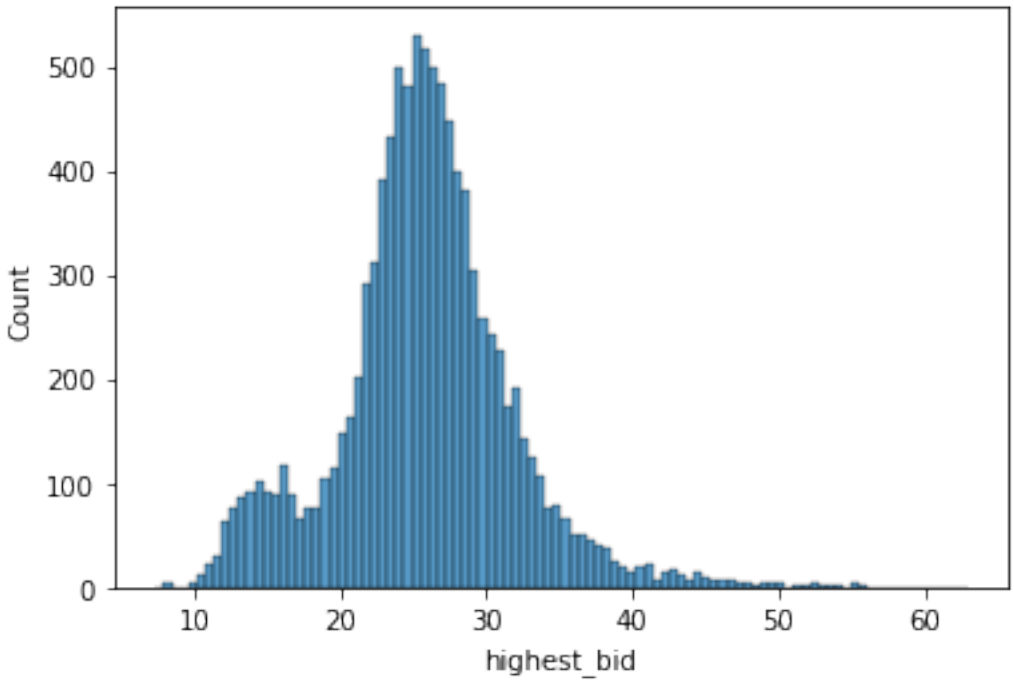
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd141b1be0>



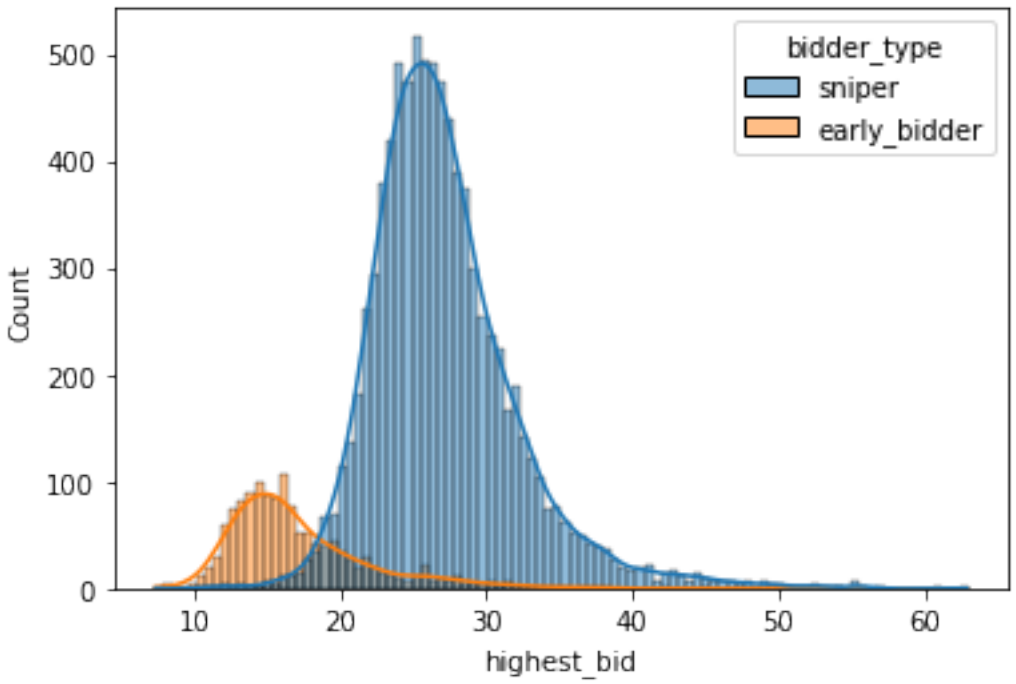
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd1205cd60>
```



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd11ebd400>



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	8640.000000	8640.000000	8640.000000	8640.000000
mean	8.000579	27.141714	20.721119	14.739931
std	0.816473	5.069055	5.307256	2.923903
min	7.000000	10.740961	5.947906	5.000000
25%	7.000000	23.910298	16.028284	13.000000
50%	8.000000	26.405534	21.246055	15.000000
75%	9.000000	29.416137	24.656741	17.000000
max	9.000000	62.900452	54.668904	26.000000

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	1360.000000	1360.000000	1360.000000	1360.000000
mean	3.020588	17.242696	14.626981	13.178676
std	1.986974	5.033991	3.978456	2.815596
min	0.000000	7.350829	5.210102	5.000000

```
25%        1.000000    13.911379           12.250676    11.000000
50%        3.000000    15.961367           13.667697    13.000000
75%        5.000000    19.244392           15.626786    15.000000
max        6.000000    53.971249           37.805448    22.000000
```

[ ]:
```
df_logs.describe()
```

[ ]:
```
          bidder_id   highest_bid  second_highest_bid     bid_count
count  10000.000000  10000.000000        10000.000000  10000.000000
mean       7.323300     25.795447           19.892316     14.527600
std        2.006734      6.095903            5.554412      2.958093
min        0.000000      7.350829            5.210102      5.000000
25%        7.000000     22.728349           14.939185     12.000000
50%        8.000000     25.716318           20.133955     14.000000
75%        9.000000     28.869500           24.215129     16.000000
max        9.000000     62.900452           54.668904     26.000000
```

[ ]:
```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part1.csv')
```

#2 What makes a sniper a SNIPER

[ ]:
```
Auction = auction(2,7,1,0,0,0,0,0,500)
Auction.run_auction()
```

[ ]:
```
Auction.bid_trend
```

[ ]:
```
logs = []
for i in tqdm(range(0,2000)):
  Auction = auction(2,7,1,500)
  logs.append(Auction.run_auction())
```

```
100%|      | 2000/2000 [00:25<00:00, 78.65it/s]
```

[ ]:
```
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid'])
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(100)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
bidder_id              9.000000
highest_bid           17.019847
second_highest_bid    15.508607
dtype: float64
Probability(100)
0.44999999999999996
```

```
<ipython-input-52-8f61f2f26c66>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(150)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
bidder_id              9.000000
highest_bid           18.697036
second_highest_bid    15.982566
dtype: float64
Probability(150)
4.2
```

```
<ipython-input-56-7ef8fc404c0c>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(250)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
bidder_id              9.000000
highest_bid           21.539201
second_highest_bid    17.197975
dtype: float64
Probability(250)
19.650000000000002
```

```
<ipython-input-60-f71548f926a7>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(350)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
bidder_id              9.000000
highest_bid           24.088471
second_highest_bid    18.680364
dtype: float64
Probability(350)
```

```
36.1

<ipython-input-64-94e578ea9830>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(450)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
bidder_id              9.000000
highest_bid           25.521006
second_highest_bid    19.188321
dtype: float64
Probability(450)
44.05

<ipython-input-68-cdaa5b4804a2>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
```

[ ]:
```
print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())
print("Probability(495)")
print(len(df_logs[df_logs['bidder_type']=='special_sniper'])/len(df_logs)*100)
```

```
<ipython-input-72-72cfc6ee13c9>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  print(df_logs[df_logs['bidder_type']=='special_sniper'].mean())

bidder_id              9.000000
highest_bid           27.087007
second_highest_bid    20.861946
dtype: float64
Probability(495)
60.699999999999996
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].mean()
```

```
<ipython-input-16-f190879c5d35>:1: FutureWarning: Dropping of nuisance columns
in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future
version this will raise TypeError.  Select only valid columns before calling the
reduction.
  df_logs[df_logs['bidder_type']=='early_bidder'].mean()
```

```
bidder_id              2.940080
highest_bid           17.260438
second_highest_bid    14.656343
dtype: float64
```

#3 HB-SHB Difference & Bid Count Analysis

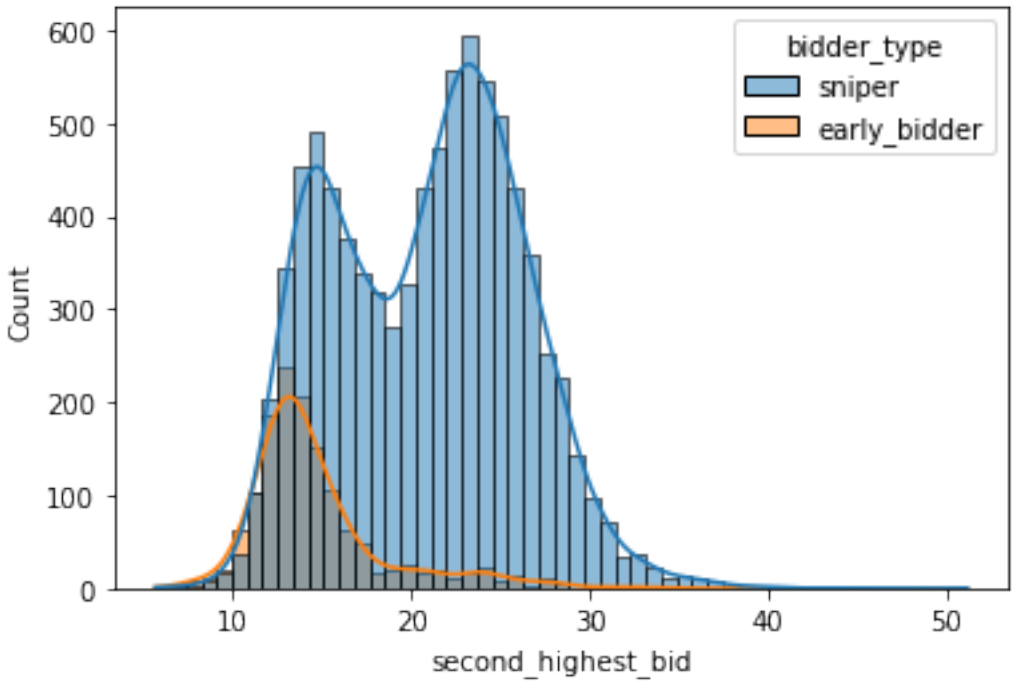
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,7,0,0,0,0,0,0,500)
  logs.append(Auction.run_auction())
```

```
100%|      | 10000/10000 [02:16<00:00, 73.23it/s]
```

```
df_logs = pd.DataFrame(logs,␣
↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

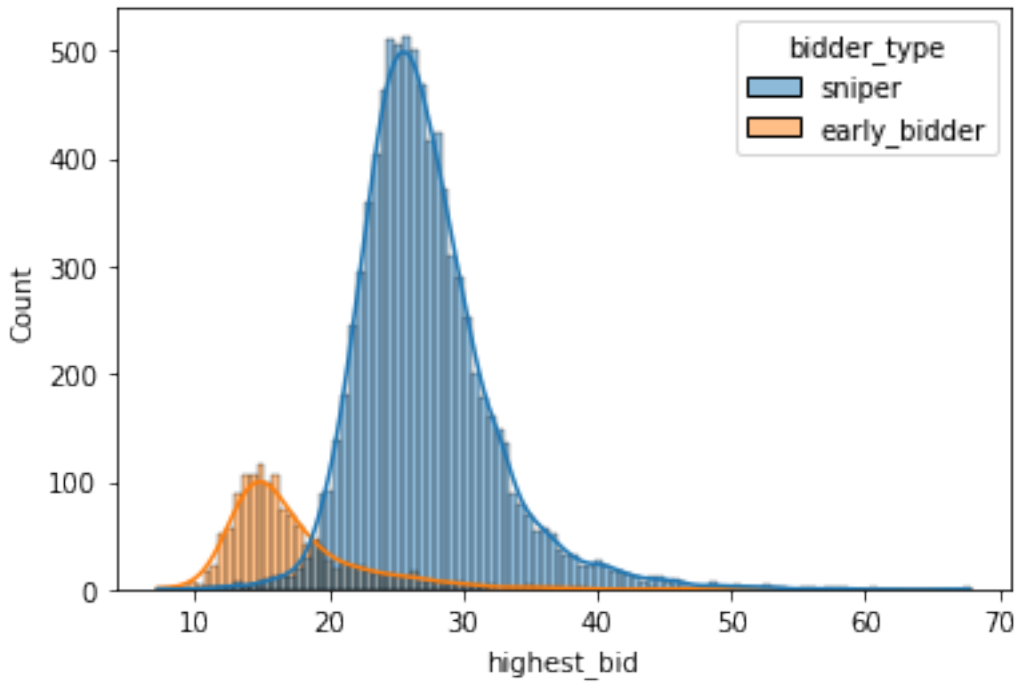
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd143f7760>
```




```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

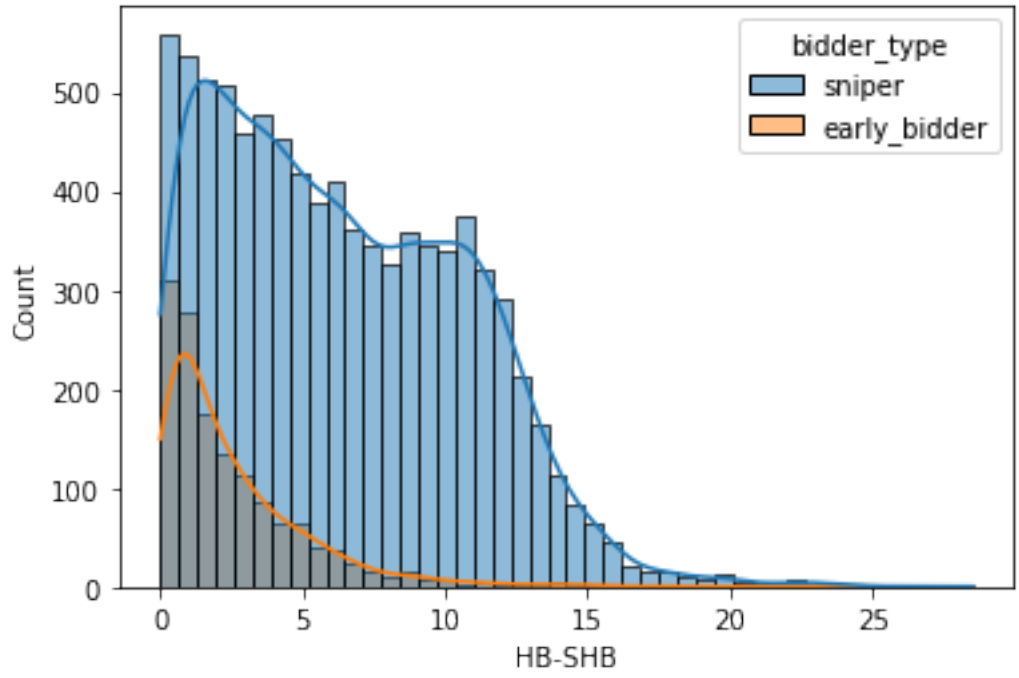
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd1196e820>
```



[ ]:
```
df_logs['HB-SHB'] = df_logs['highest_bid']-df_logs['second_highest_bid']
```

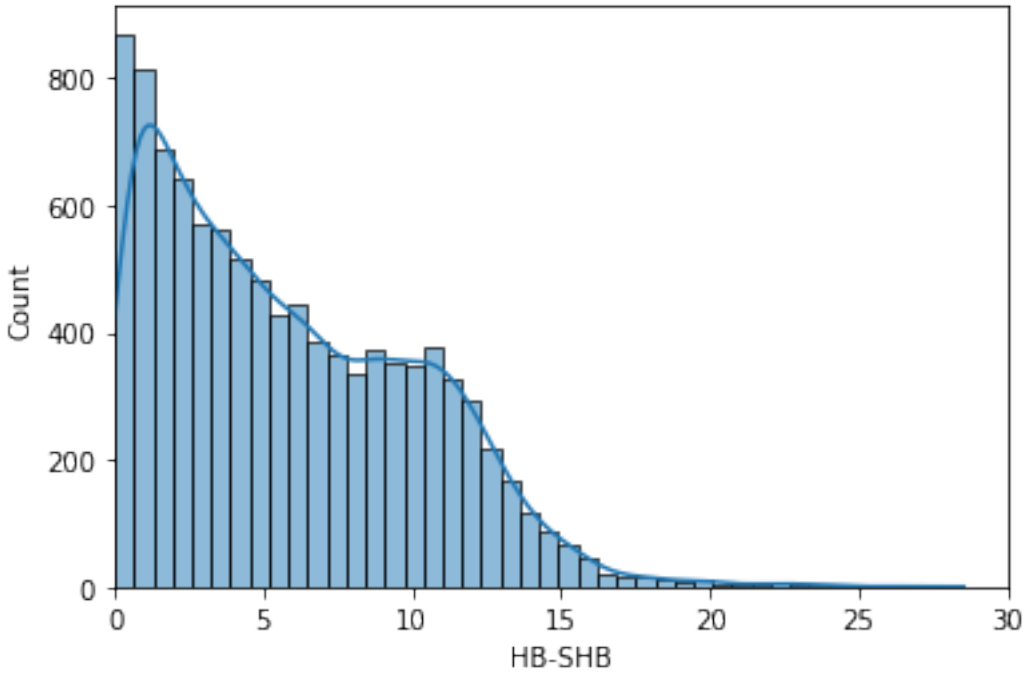
[ ]:
```
sns.histplot(data=df_logs, x='HB-SHB', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd115b78b0>
```



[ ]:
```
sns.histplot(data=df_logs, x='HB-SHB', hue=None, kde=True).set_xlim(0,30)
```

[ ]: (0.0, 30.0)



[ ]:
```
df_logs['HB-SHB'].describe()
```

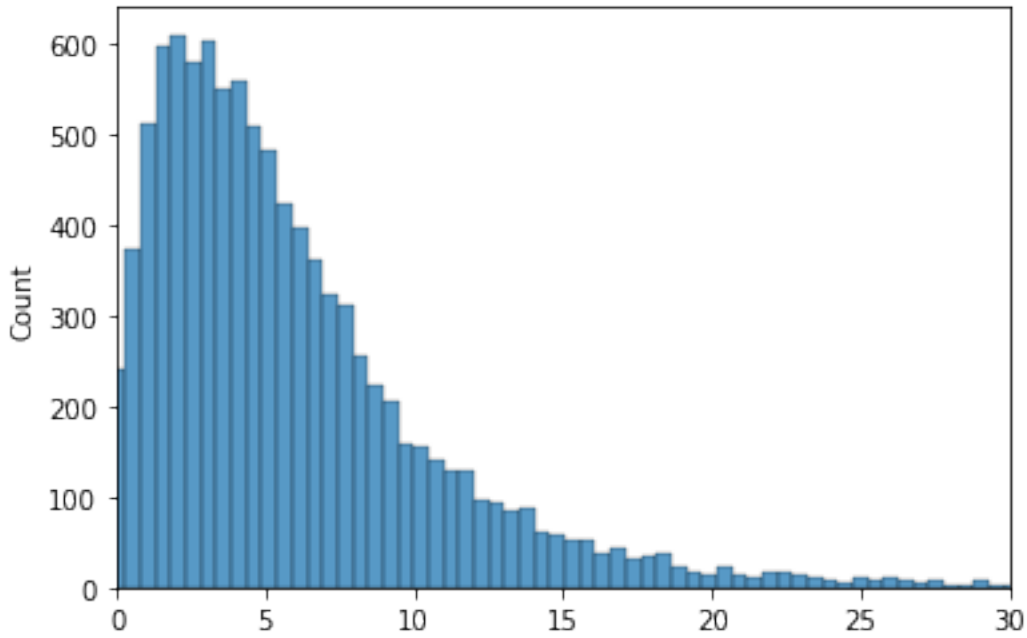
[ ]:
```
count    10000.000000
mean         5.822388
std          4.355859
min          0.001335
25%          2.058686
50%          4.980617
75%          9.113672
max         28.512564
Name: HB-SHB, dtype: float64
```

[ ]:
```
s, loc, scale = rng.lognorm.fit(df_logs['HB-SHB'])
```

[ ]:
```
test = rng.lognorm.rvs(s=s, loc=loc, scale=scale, size=10000)
print(np.mean(test))
print(np.std(test))
sns.histplot(test).set_xlim(0,30)
```

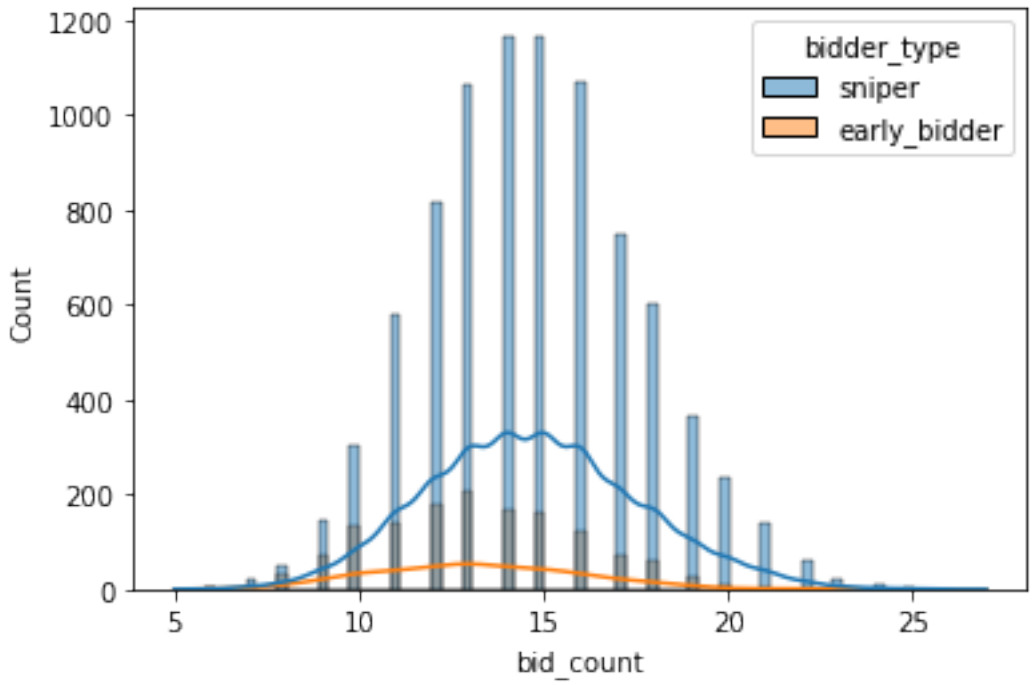
```
5.942752800227478
5.297577404592256
```

[ ]: (0.0, 30.0)



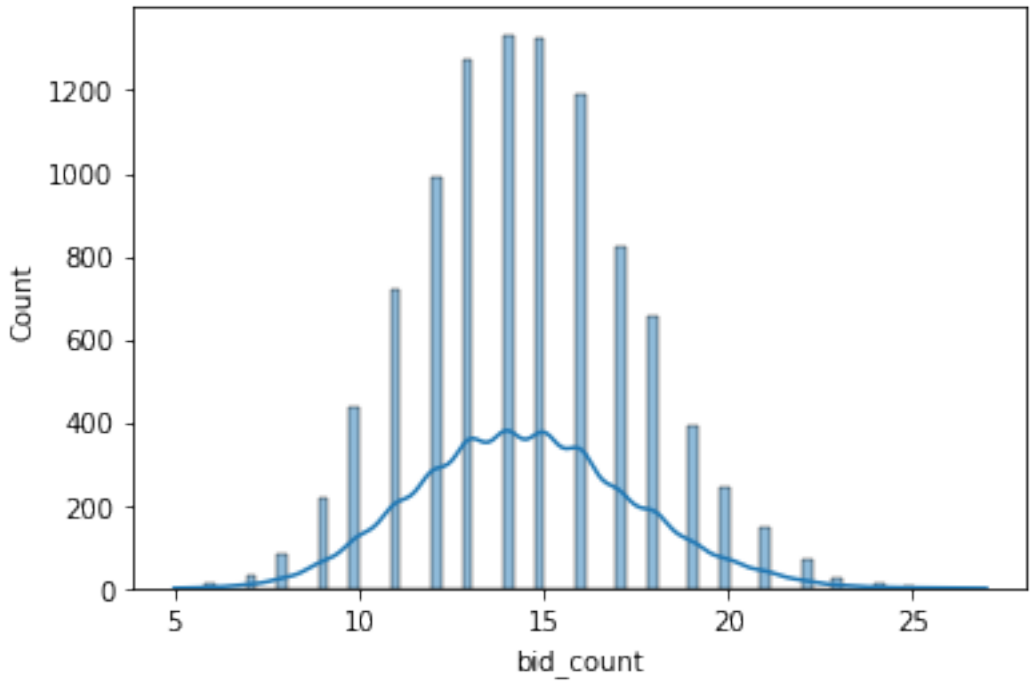
[ ]:
```
sns.histplot(data=df_logs, x='bid_count', hue='bidder_type', kde=True)
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd113d5d90>



[ ]:
```
sns.histplot(data=df_logs, x='bid_count', hue=None, kde=True)
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd111d3fd0>



[ ]:
```
df_logs['bid_count'].describe()
```

[ ]:
```
count    10000.000000
mean        14.515800
std          2.919624
min          5.000000
25%         13.000000
50%         14.000000
75%         16.000000
max         27.000000
Name: bid_count, dtype: float64
```

[ ]:
```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part3.csv')
```

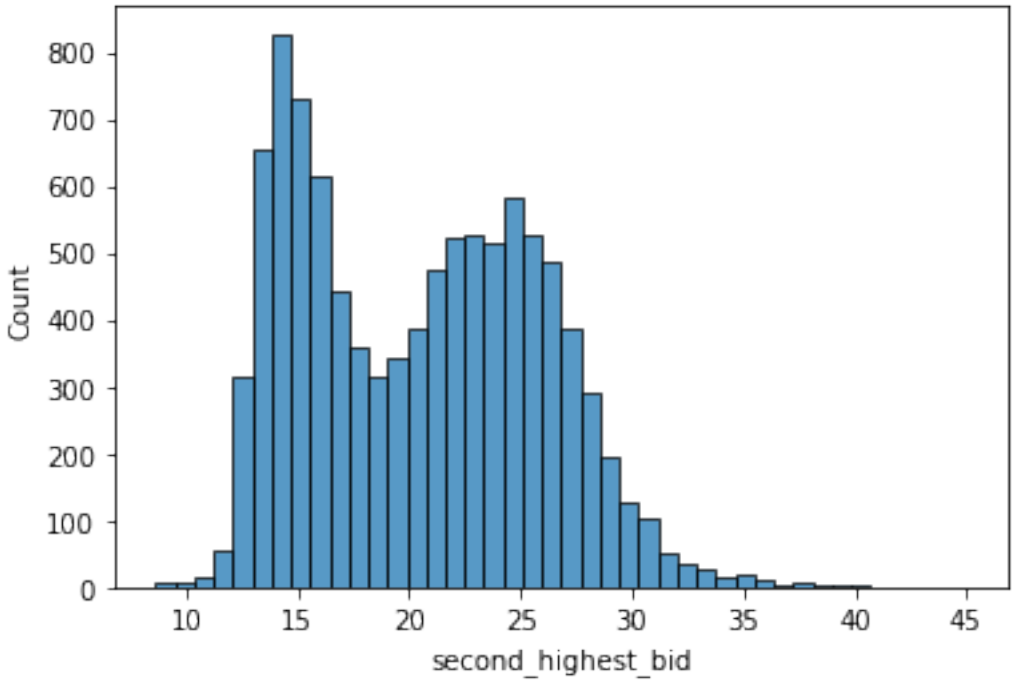
4 4a Reserve Price Shilling (target set around EB pay limit)

[ ]:
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,1,0,0,0,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [03:19<00:00, 50.16it/s]
```

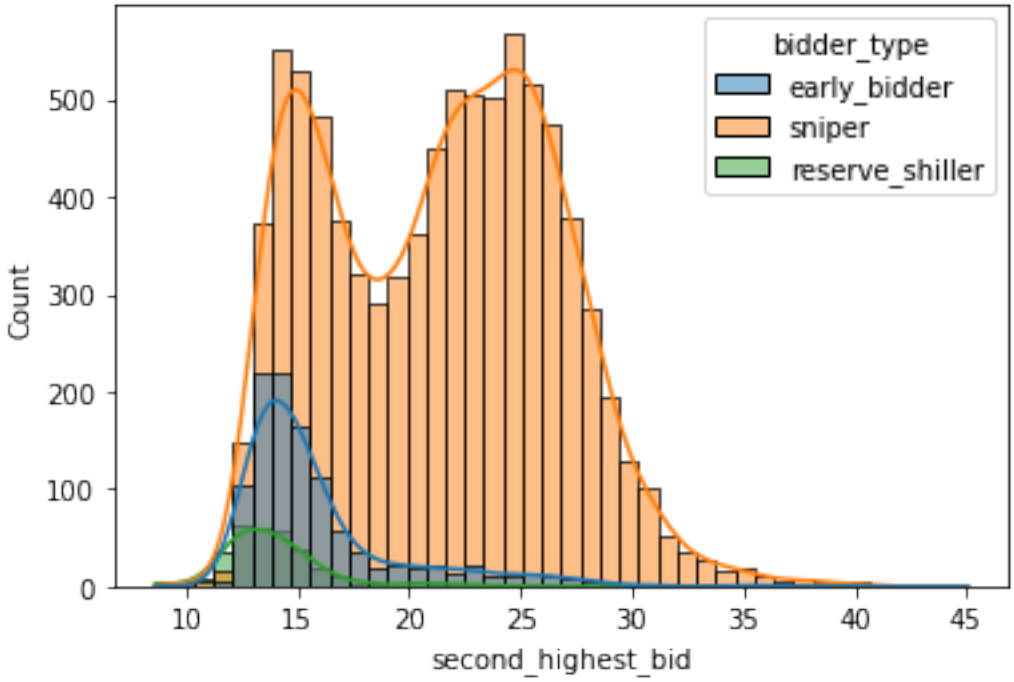
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc268369a00>
```



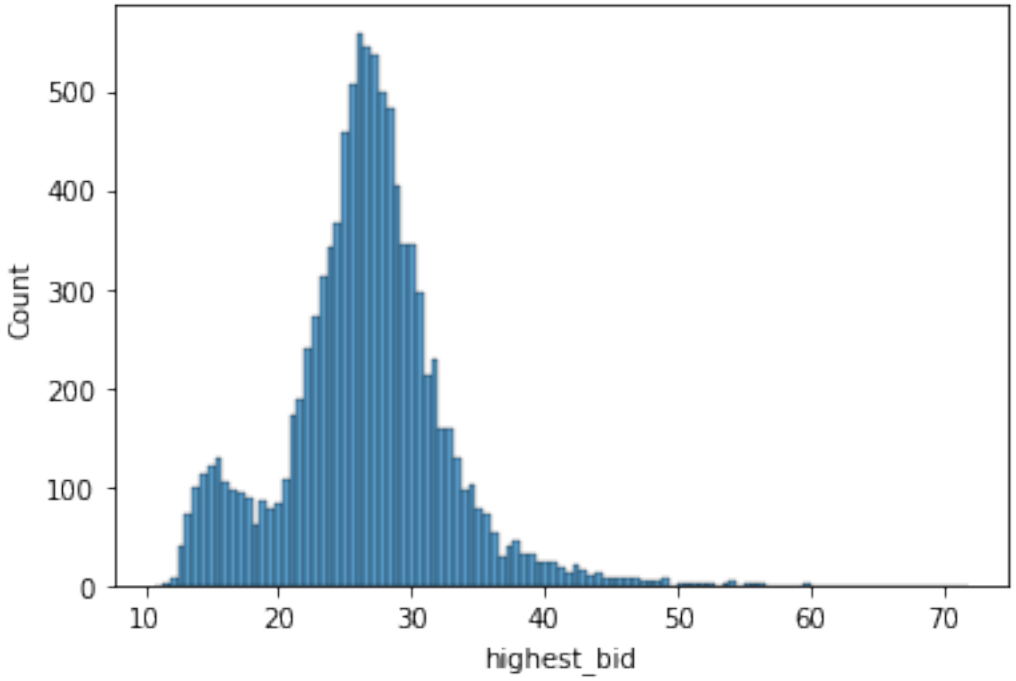
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2681d1fa0>
```



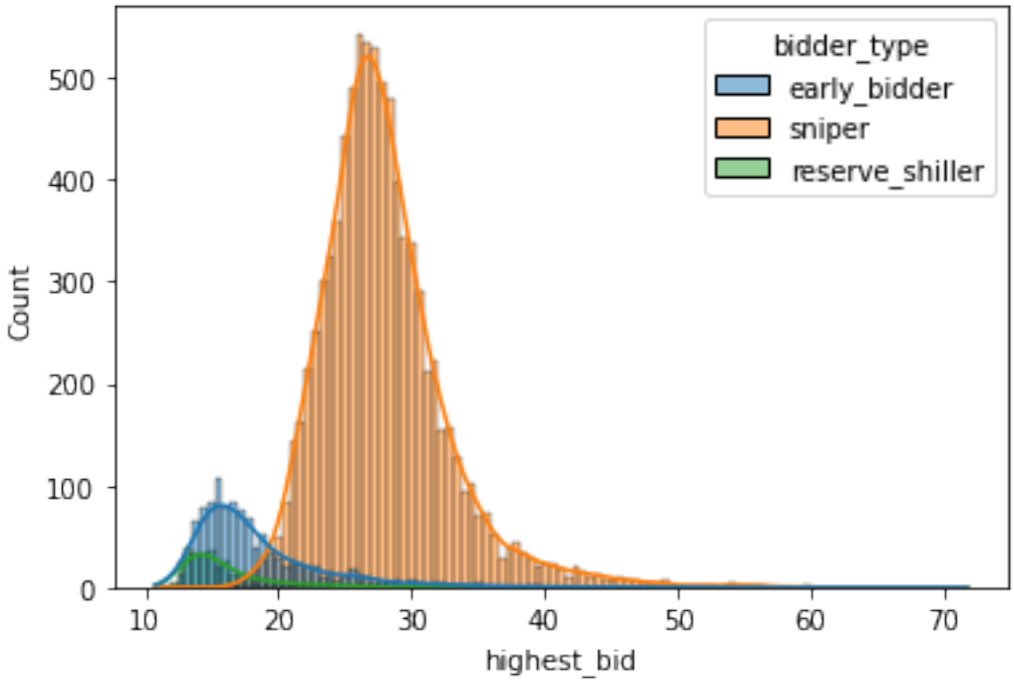
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2687d1f40>
```



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc267ee1a90>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              6.985068
highest_bid           27.955488
second_highest_bid    21.321356
bid_count             27.992301
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id              2.511251
highest_bid           18.462473
second_highest_bid    15.931576
bid_count             30.470747
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='reserve_shiller'].describe()
```

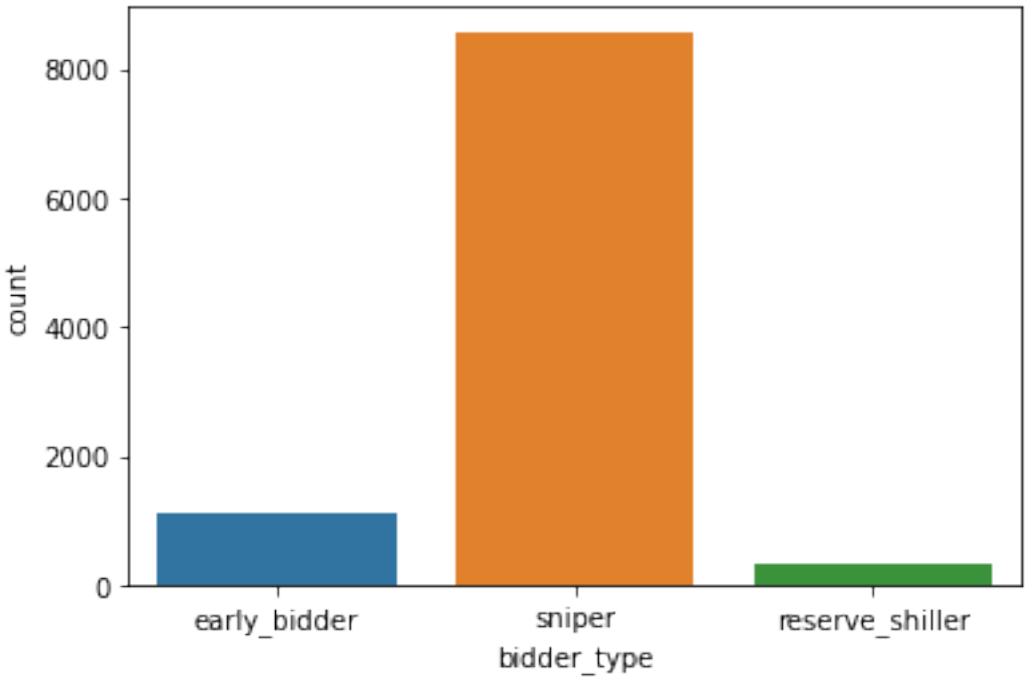
[ ]:
```
bidder_id              9.000000
highest_bid           15.800368
second_highest_bid    13.936050
bid_count             13.296530
dtype: float64
```

[ ]:
```
df_logs.describe()
```

```
bidder_id              6.551900
highest_bid           26.515497
second_highest_bid    20.488438
bid_count             27.801800
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc267e6c6d0>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part4a.csv')
```

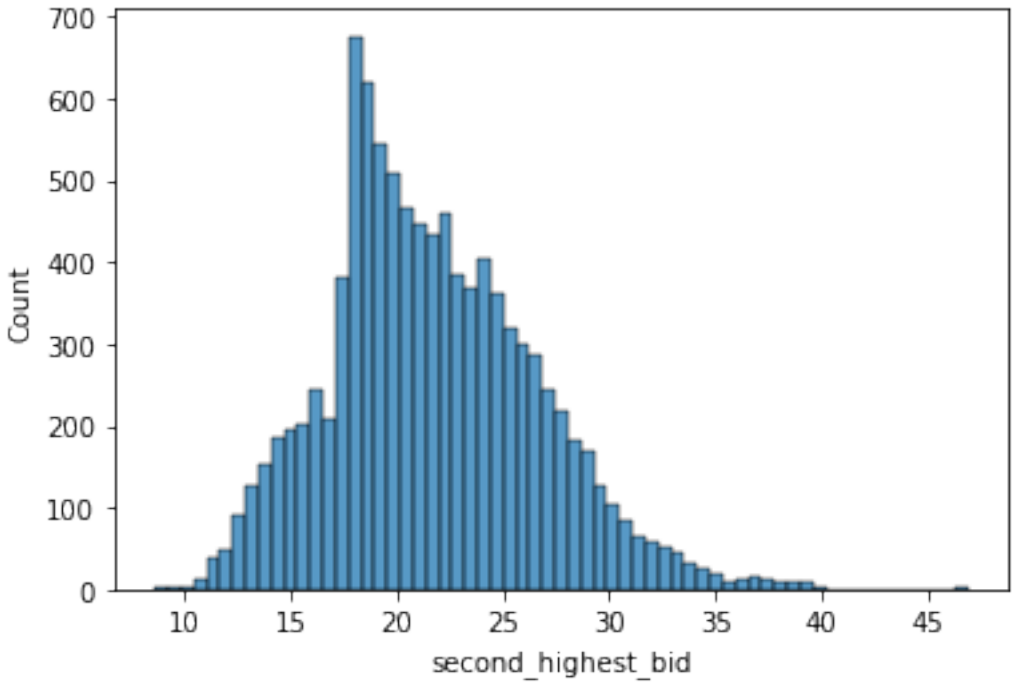
5 4b Reserve Price Shilling (target set between EB & Sn pay limits)

```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,1,0,0,0,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [03:14<00:00, 51.48it/s]
```

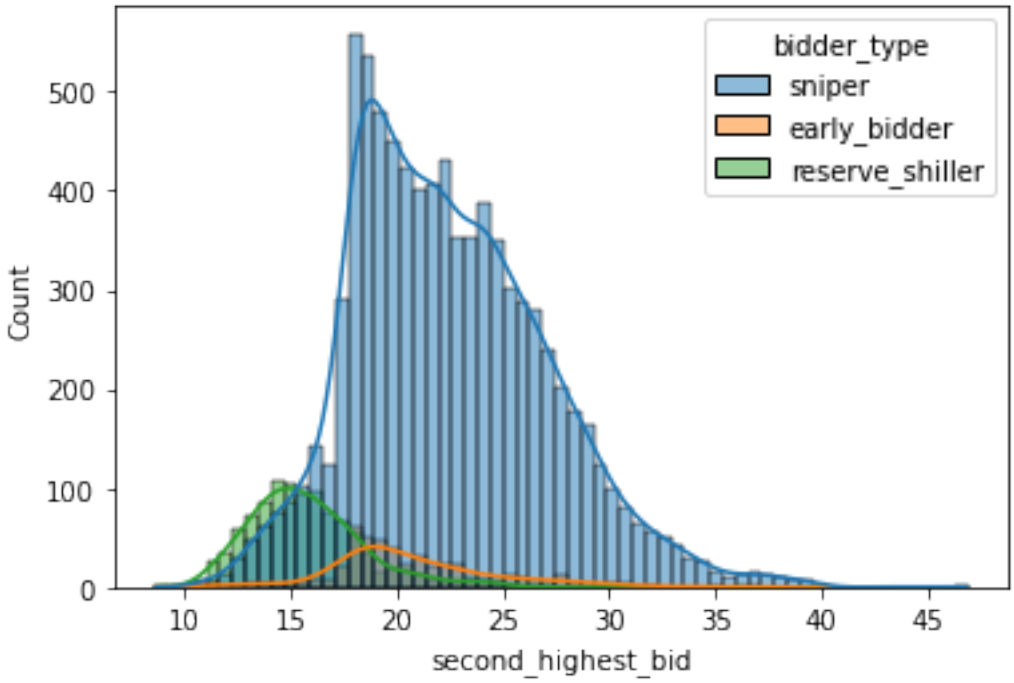
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc267afad00>
```



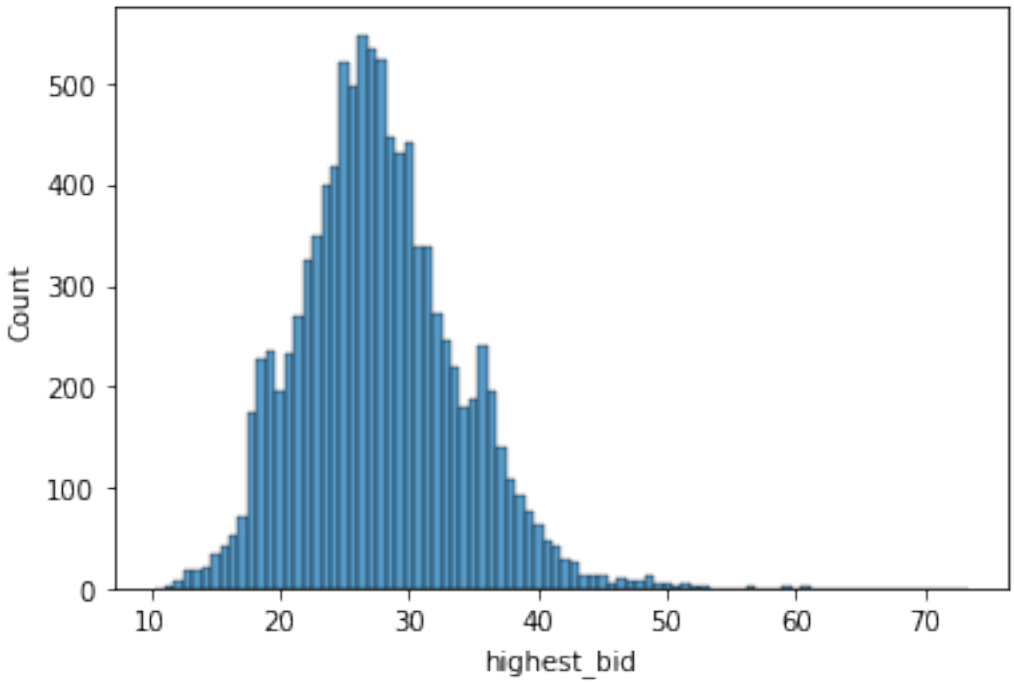
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc267af1460>
```



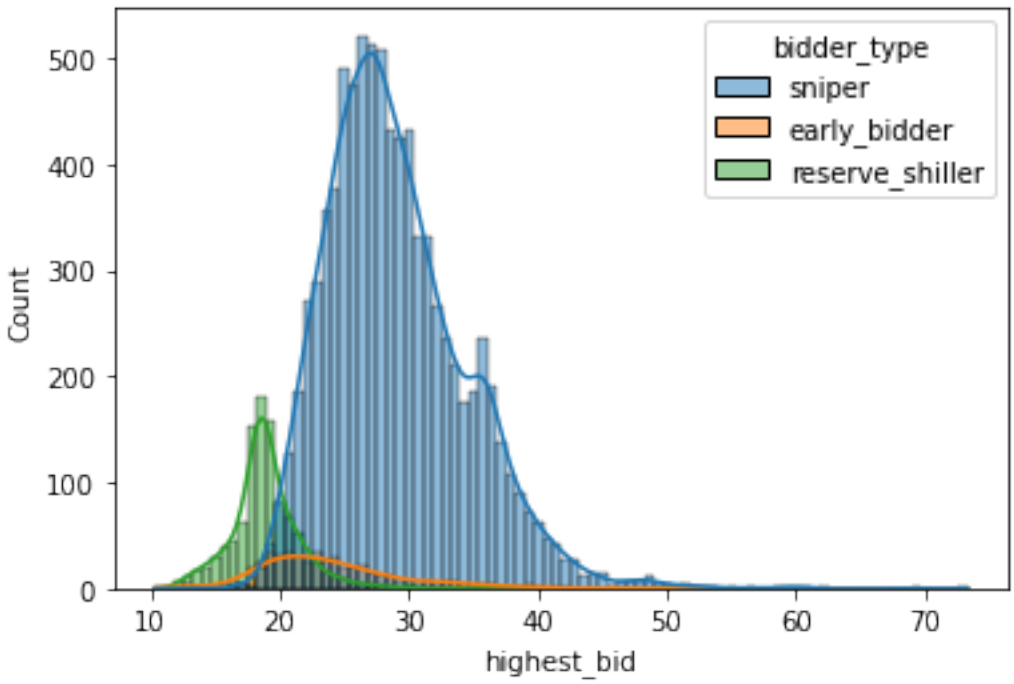
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc267759280>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc267656ca0>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              6.991482
highest_bid           29.033134
second_highest_bid    22.499256
bid_count             18.074766
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id              2.441584
highest_bid           24.118746
second_highest_bid    20.816782
bid_count             26.520792
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='reserve_shiller'].describe()
```

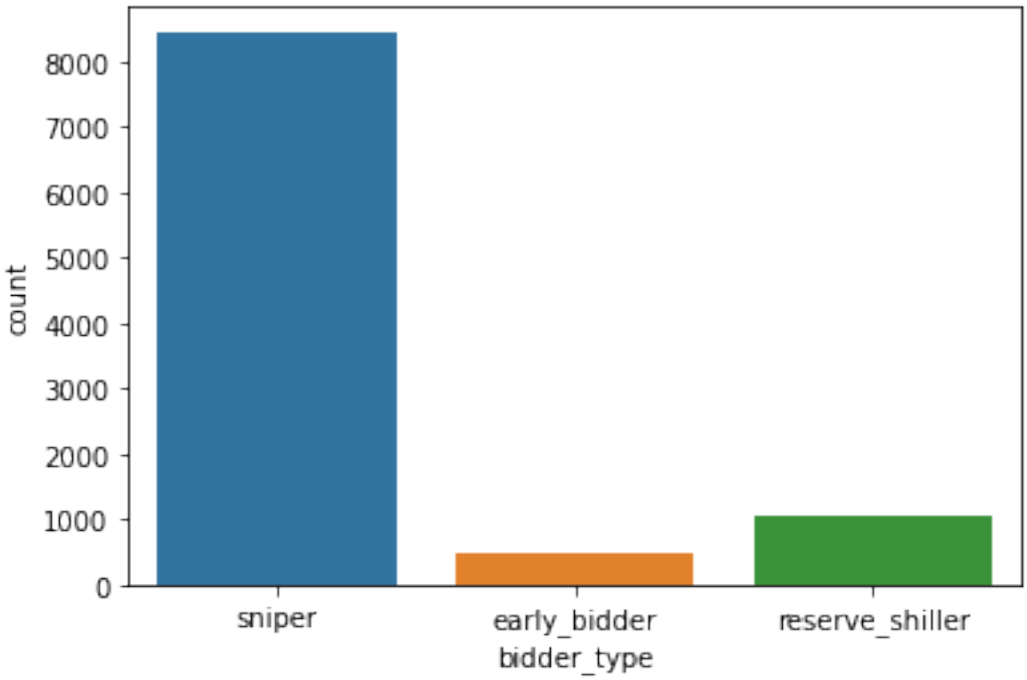
```
bidder_id              9.000000
highest_bid           18.882251
second_highest_bid    15.779589
bid_count             13.663148
dtype: float64
```

```
df_logs.describe()
```

```
bidder_id              6.971000
highest_bid           27.727235
second_highest_bid    21.714102
bid_count             18.041600
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2675fed00>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part4b.csv')
```

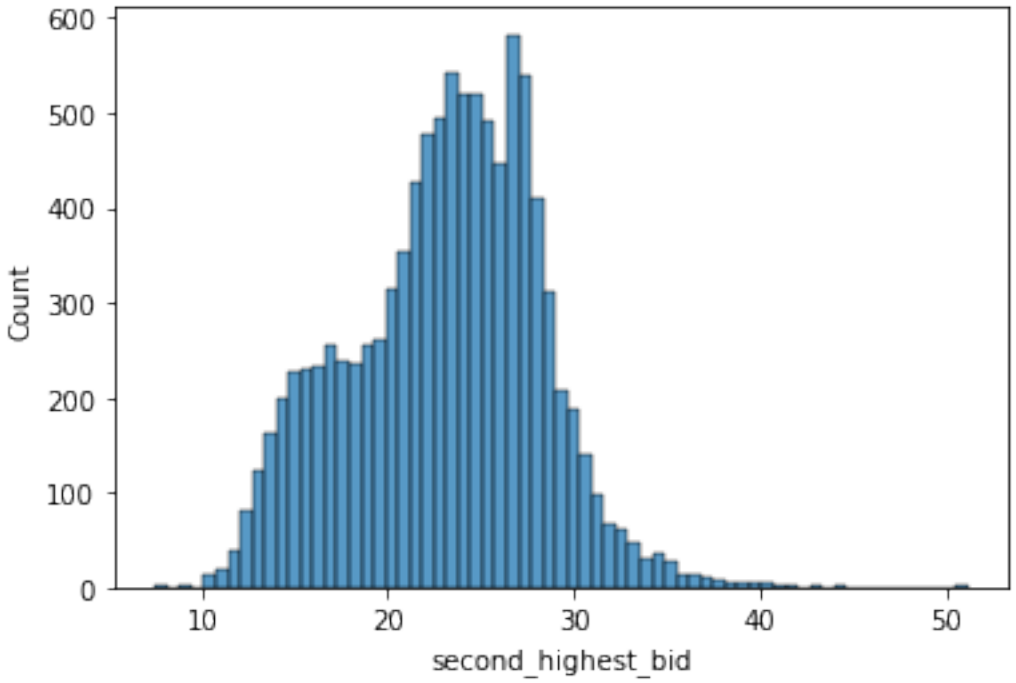
6 4c Reserve Price Shilling (target set around Sn pay limit)

[ ]:
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,1,0,0,0,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [05:23<00:00, 30.88it/s]
```

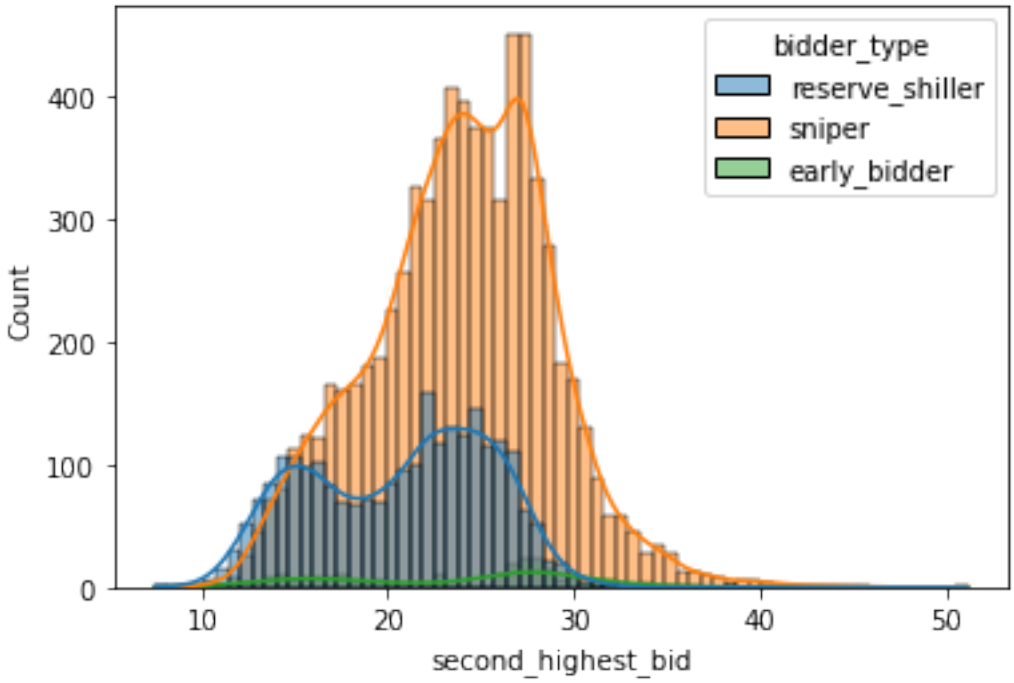
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2672911f0>
```



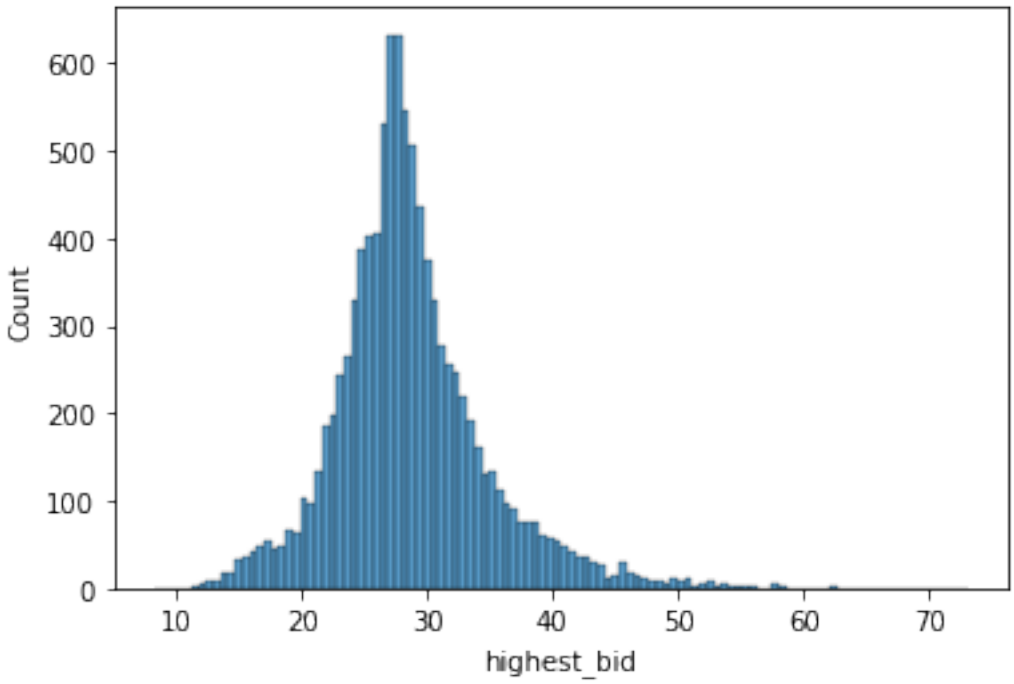
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc26727a8e0>
```



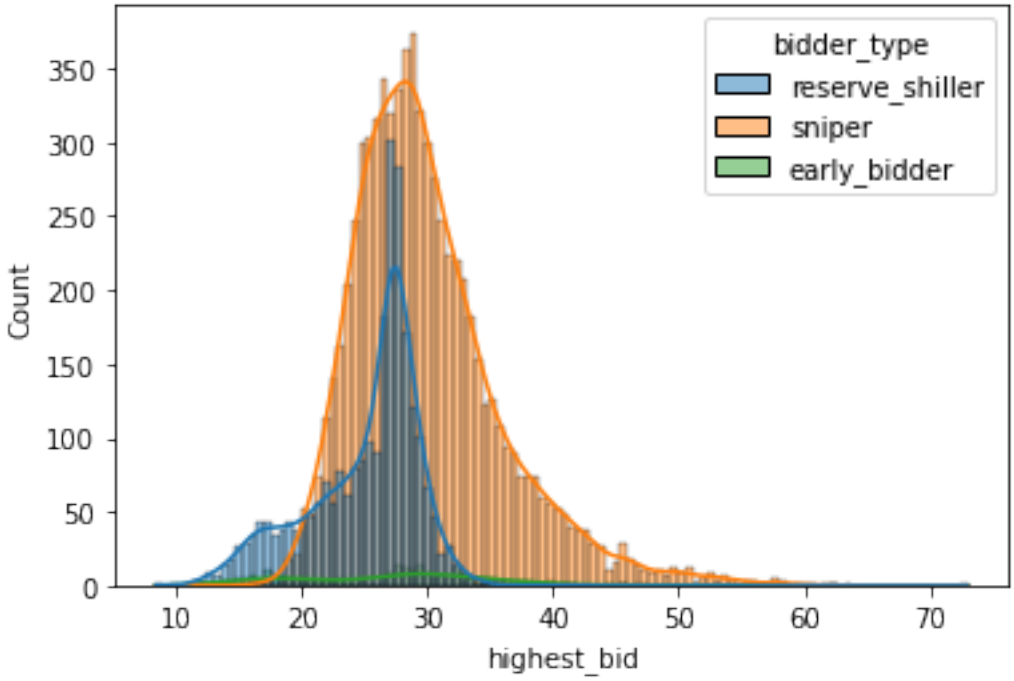
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc266f89490>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc266d8ebb0>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              6.998204
highest_bid           30.014417
second_highest_bid    23.962565
bid_count             15.267100
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id              2.495968
highest_bid           27.321552
second_highest_bid    23.538014
bid_count             20.754032
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='reserve_shiller'].describe()
```

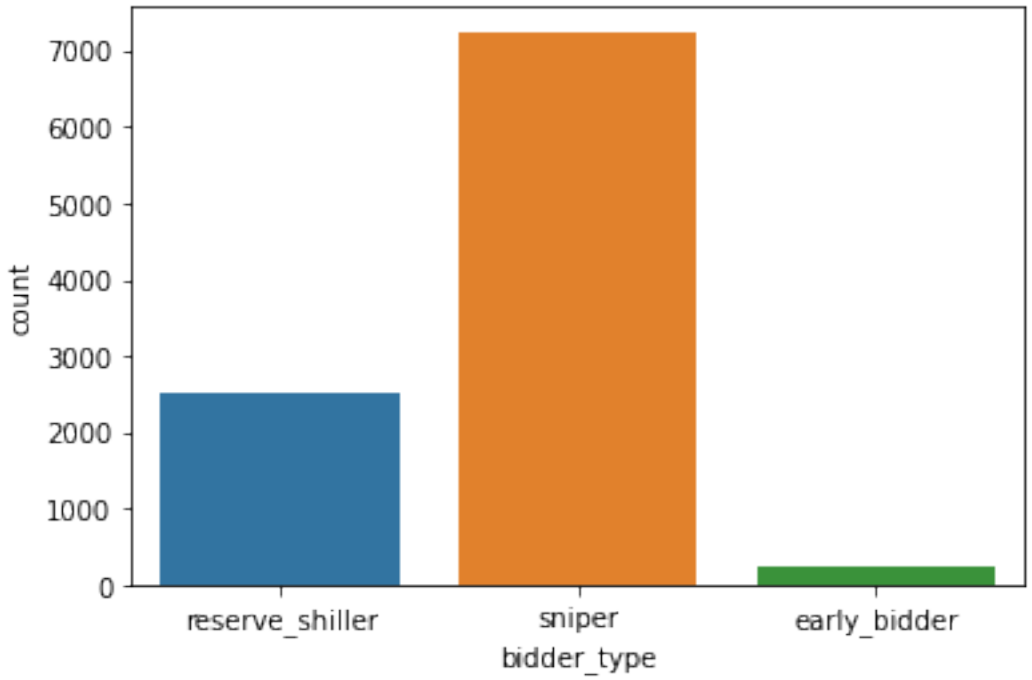
```
bidder_id              9.000000
highest_bid           25.032977
second_highest_bid    20.648972
bid_count             14.335586
dtype: float64
```

```
df_logs.describe()
```

```
bidder_id              7.390000
highest_bid           28.694802
second_highest_bid    23.118668
bid_count             15.168900
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2669c6f40>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part4c.csv')
```

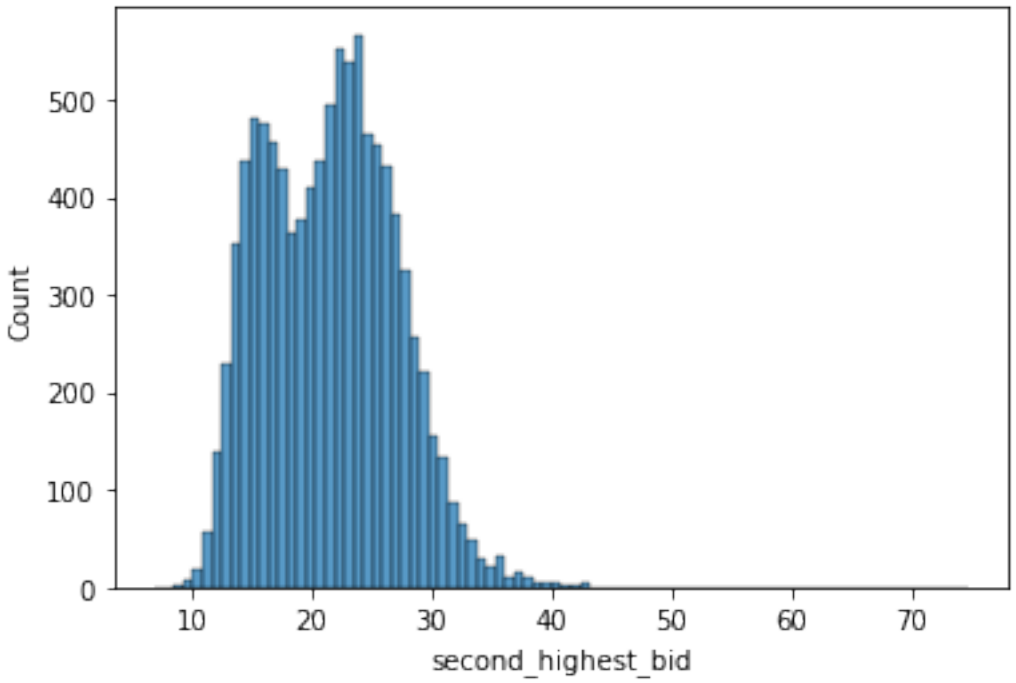
7 5a Competitive Shiller(T=500 units)

[ ]:
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,0,1,0,0,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [06:17<00:00, 26.49it/s]
```

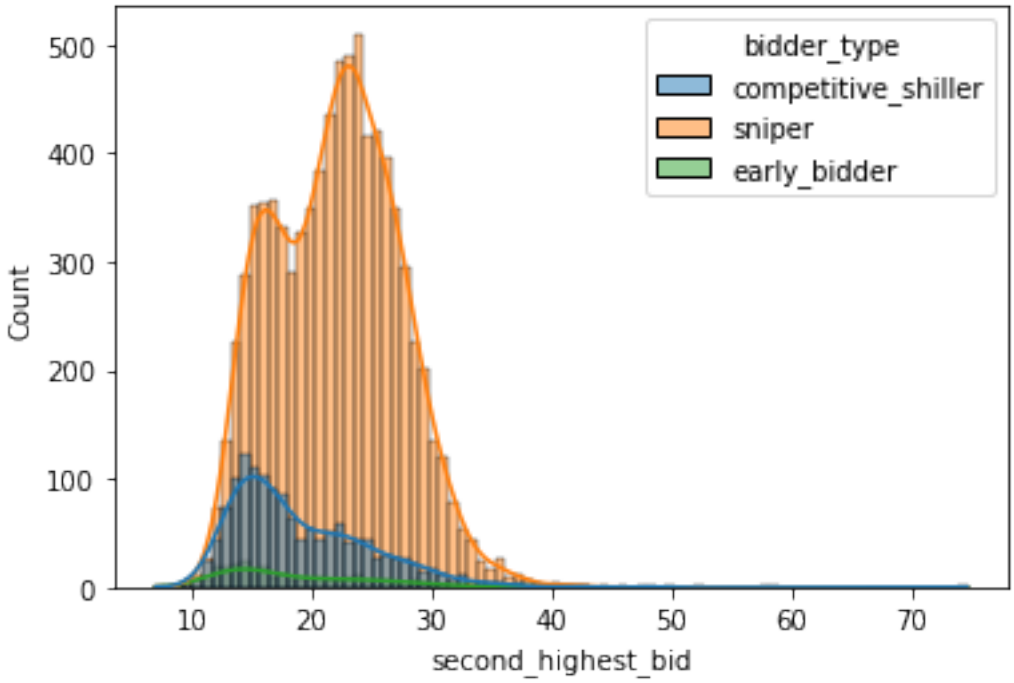
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc261508280>
```



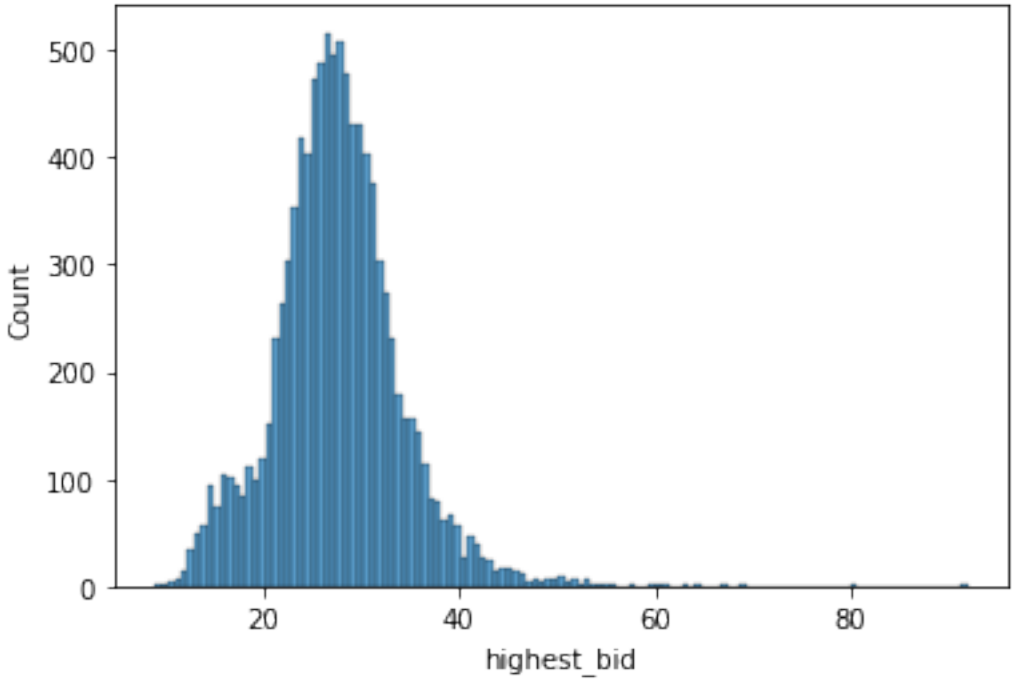
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2613c8550>
```



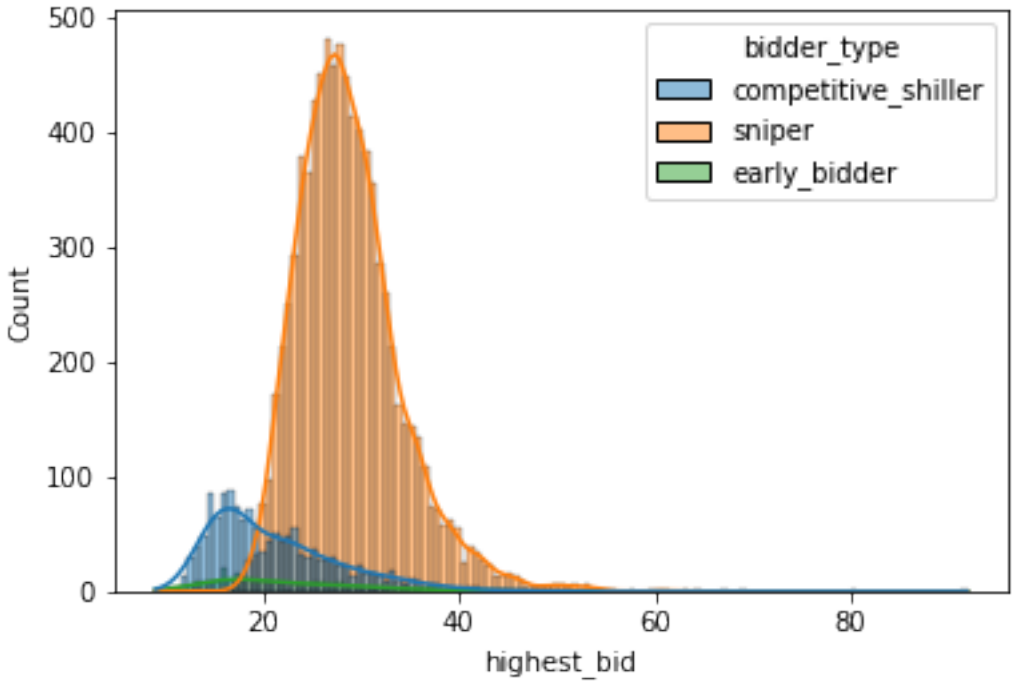
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc2610c1760>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc261b54fa0>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              7.010256
highest_bid           28.768413
second_highest_bid    22.016672
bid_count             21.284870
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id              2.472727
highest_bid           22.726710
second_highest_bid    19.134167
bid_count             23.483636
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='competitive_shiller'].describe()
```

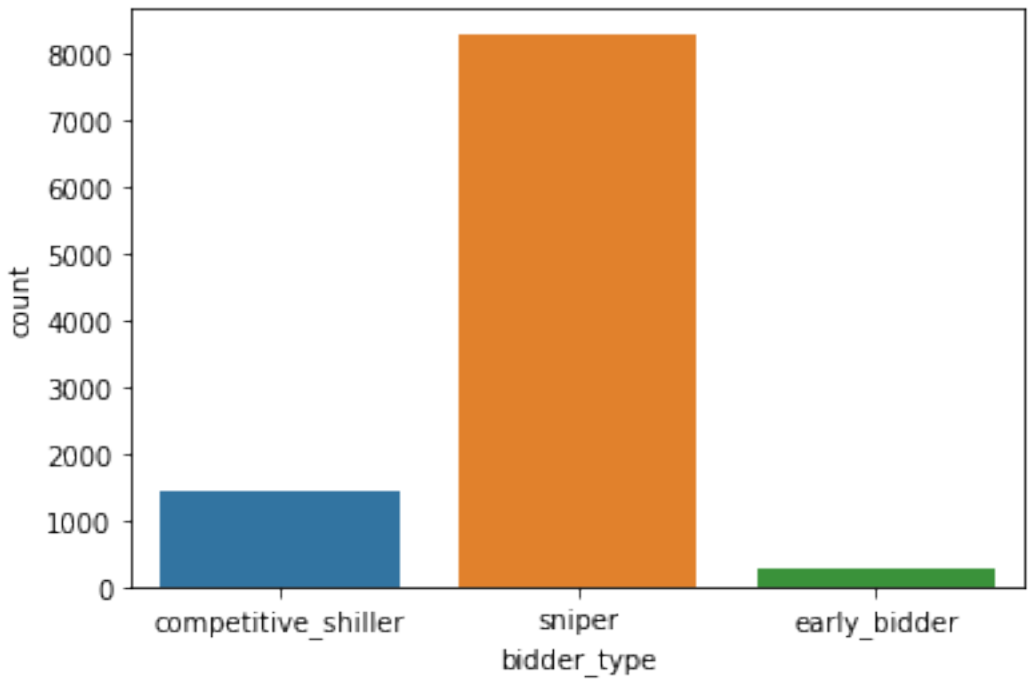
```
bidder_id              9.000000
highest_bid           21.235611
second_highest_bid    19.125909
bid_count             19.117606
dtype: float64
```

```
df_logs.describe()
```

```
bidder_id              7.171400
highest_bid           27.519803
second_highest_bid    21.522000
bid_count             21.033900
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc260af3df0>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/5a.csv')
```

#5b Competitive Shiller(T=1500 units)

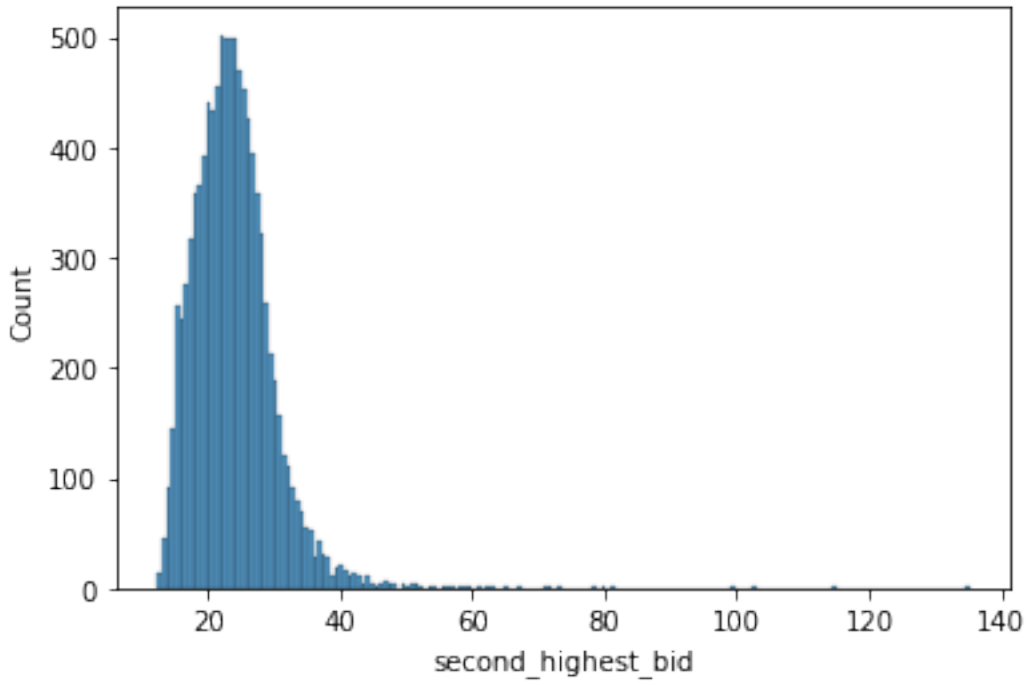
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,0,1,0,0,0,1500)
```

```
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [14:21<00:00, 11.60it/s]
```

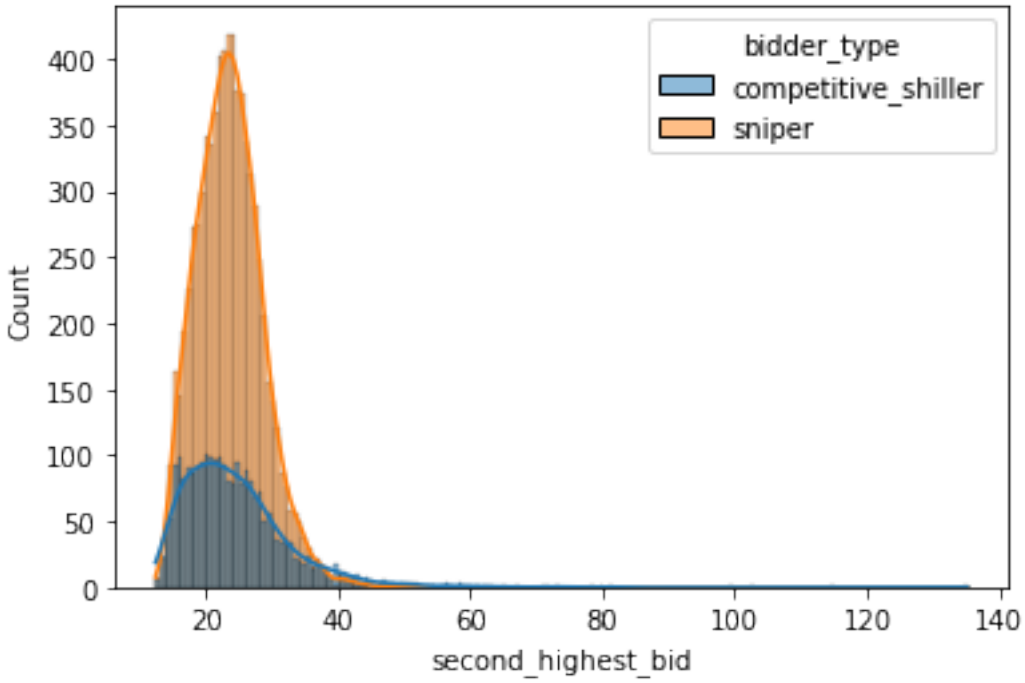
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25f54c0a0>
```



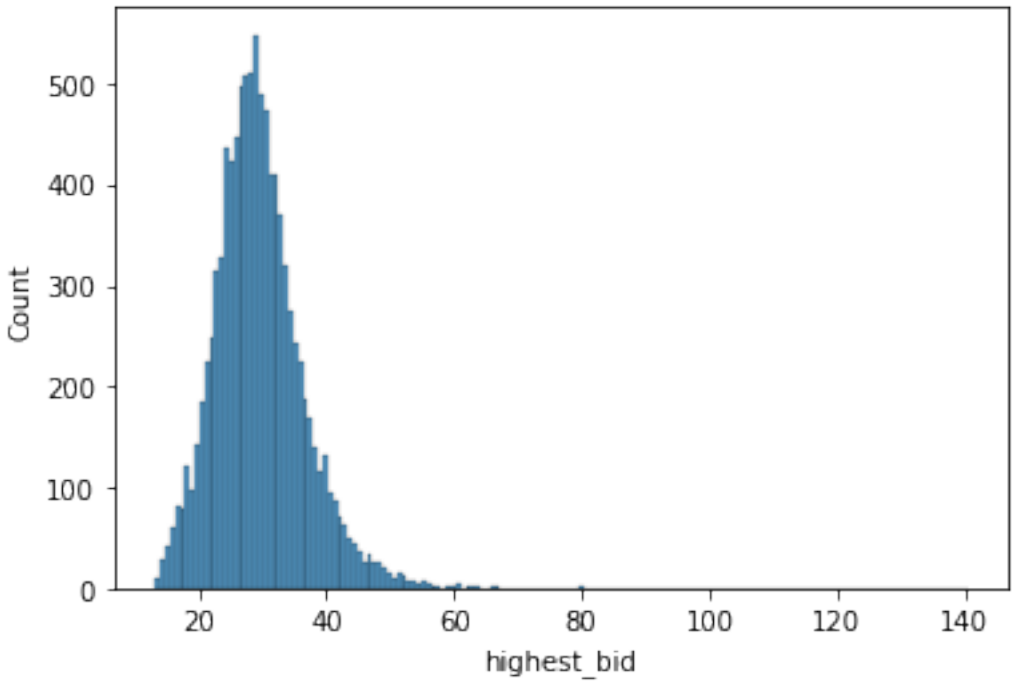
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25f30edf0>
```



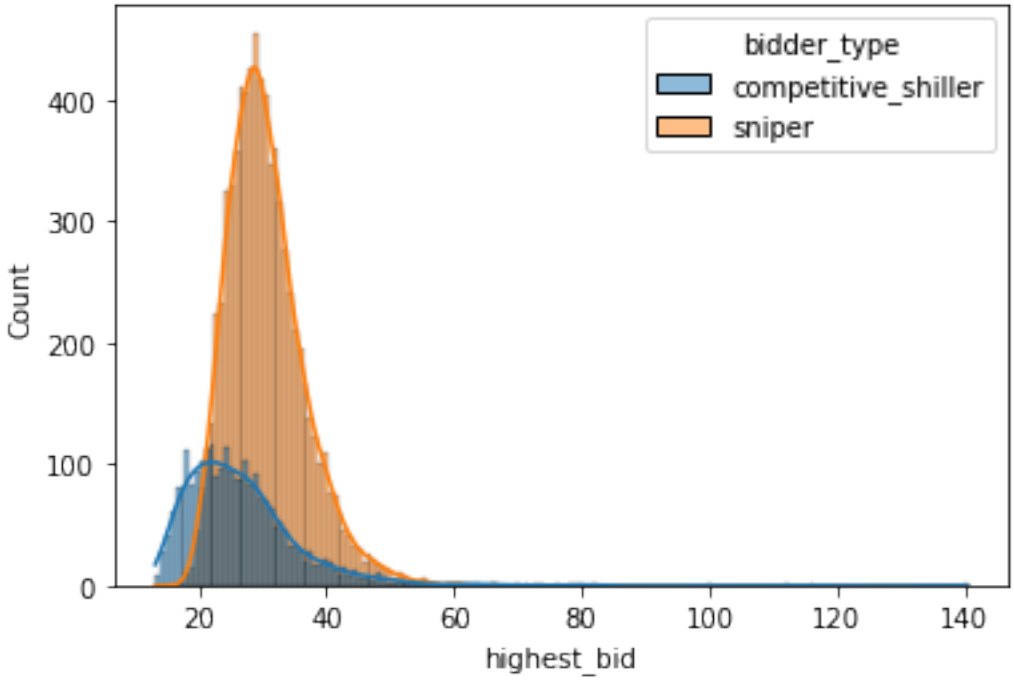
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc25ef9cf10>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25ecc69a0>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              6.988151
highest_bid           30.587135
second_highest_bid    23.669190
bid_count             24.154840
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id             NaN
bidder_type           NaN
highest_bid           NaN
second_highest_bid    NaN
bid_count             NaN
dtype: object
```

[ ]:
```
df_logs[df_logs['bidder_type']=='competitive_shiller'].describe()
```

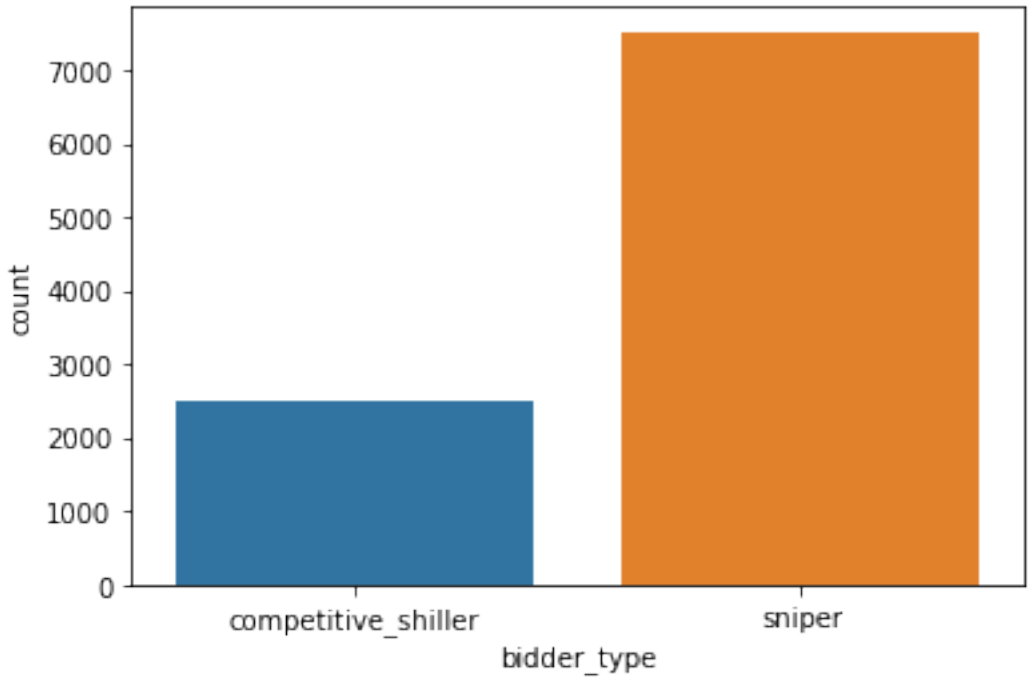
```
bidder_id              9.000000
highest_bid           26.606875
second_highest_bid    24.731758
bid_count             24.709924
dtype: float64
```

```
df_logs.describe()
```

```
bidder_id              7.488900
highest_bid           29.596448
second_highest_bid    23.933663
bid_count             24.293000
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25e8fbc10>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part5b.csv')
```

#6. Buy back Shiller

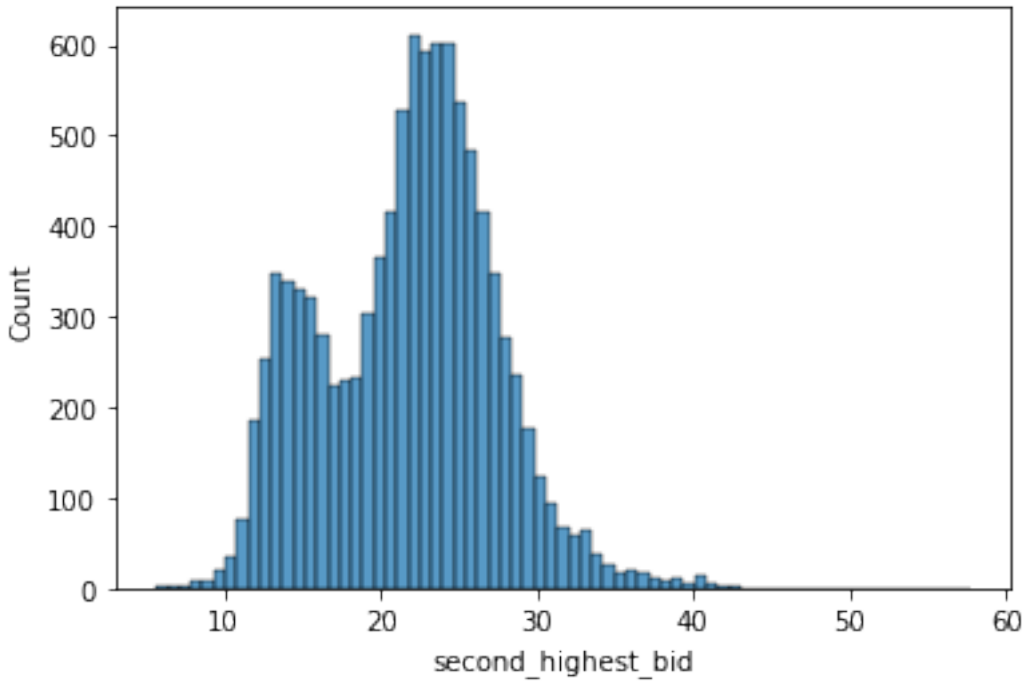
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,0,0,1,0,0,500)
```

```
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [01:49<00:00, 91.72it/s]
```

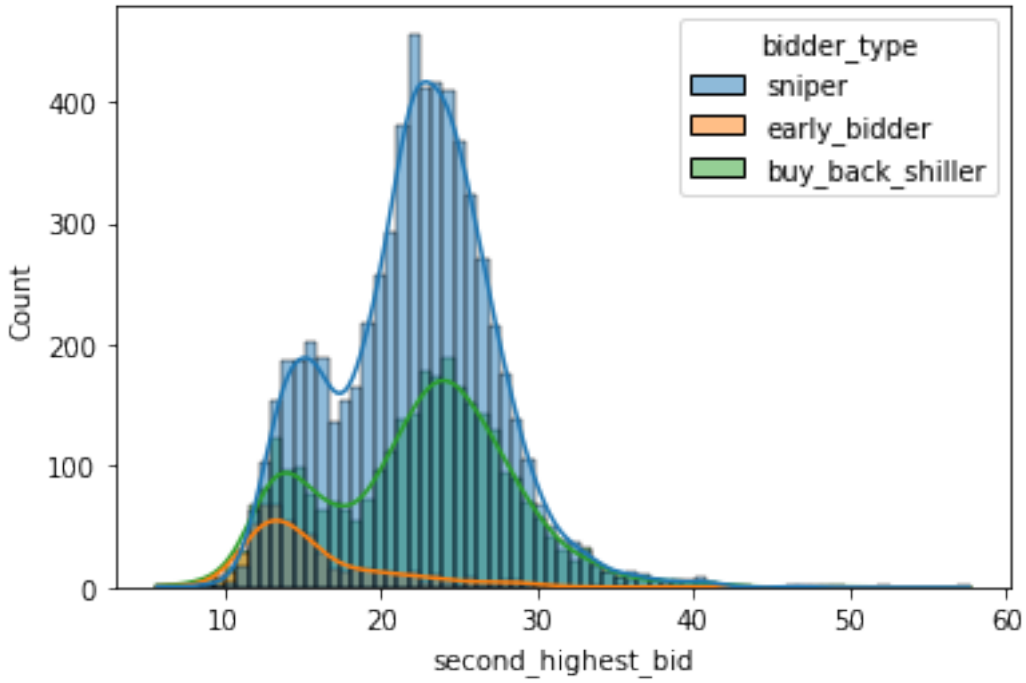
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25dd368e0>
```



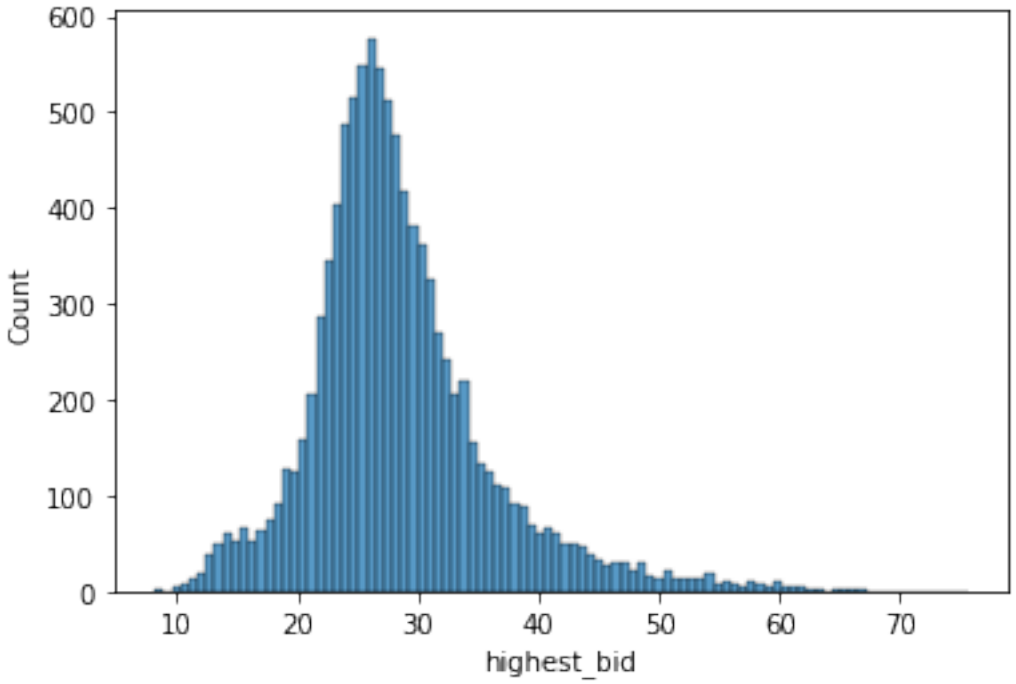
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25daa5790>
```



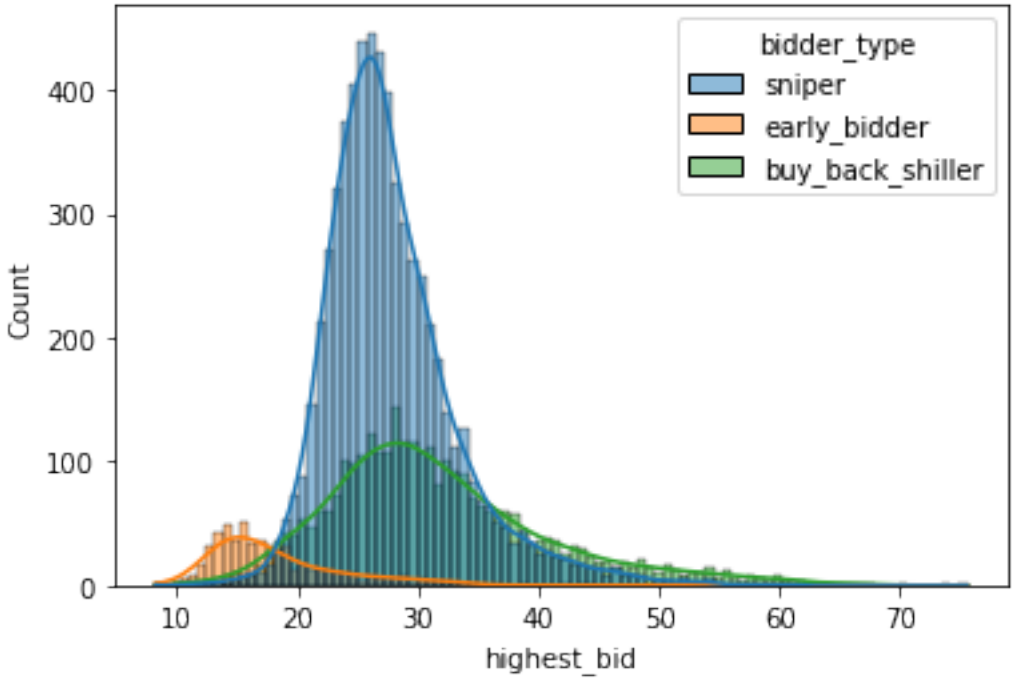
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc25dacfac0>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25f0877c0>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:
```
bidder_id              7.019899
highest_bid           27.826648
second_highest_bid    22.150343
bid_count             14.323752
dtype: float64
```

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:
```
bidder_id              2.436207
highest_bid           18.448156
second_highest_bid    15.781497
bid_count             12.670690
dtype: float64
```

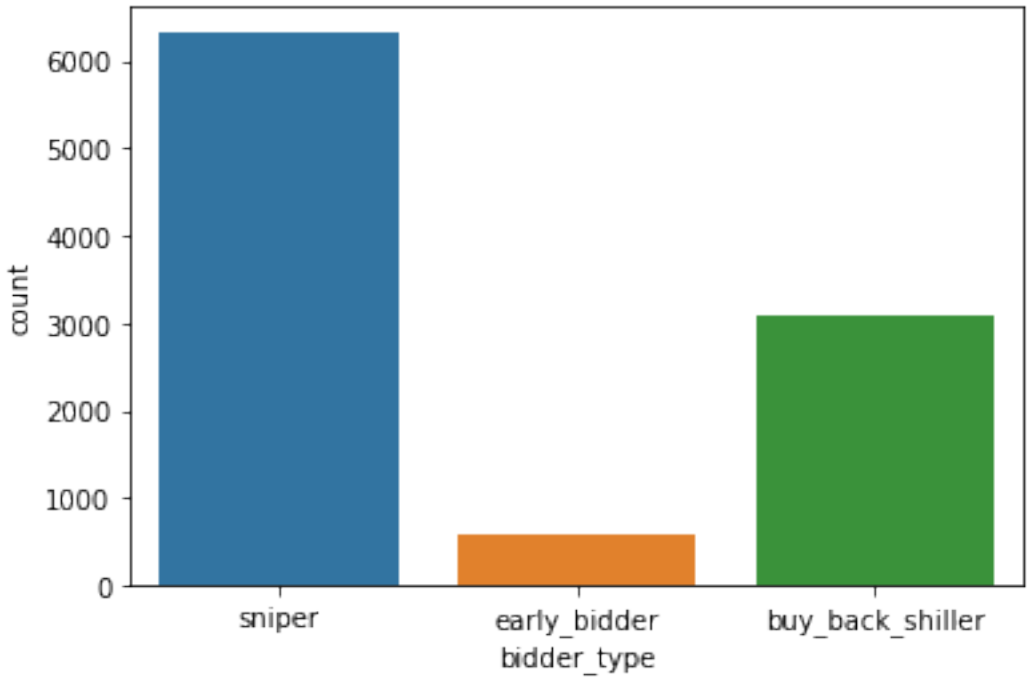
[ ]:
```
df_logs[df_logs['bidder_type']=='buy_back_shiller'].describe()
```

[ ]:
```
df_logs.describe()
```

```
bidder_id              7.365500
highest_bid           28.477351
second_highest_bid    21.831034
bid_count             14.213000
dtype: float64
```

```
sns.countplot(data=df_logs, x='bidder_type')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc25d418ee0>
```




```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part6.csv')
```

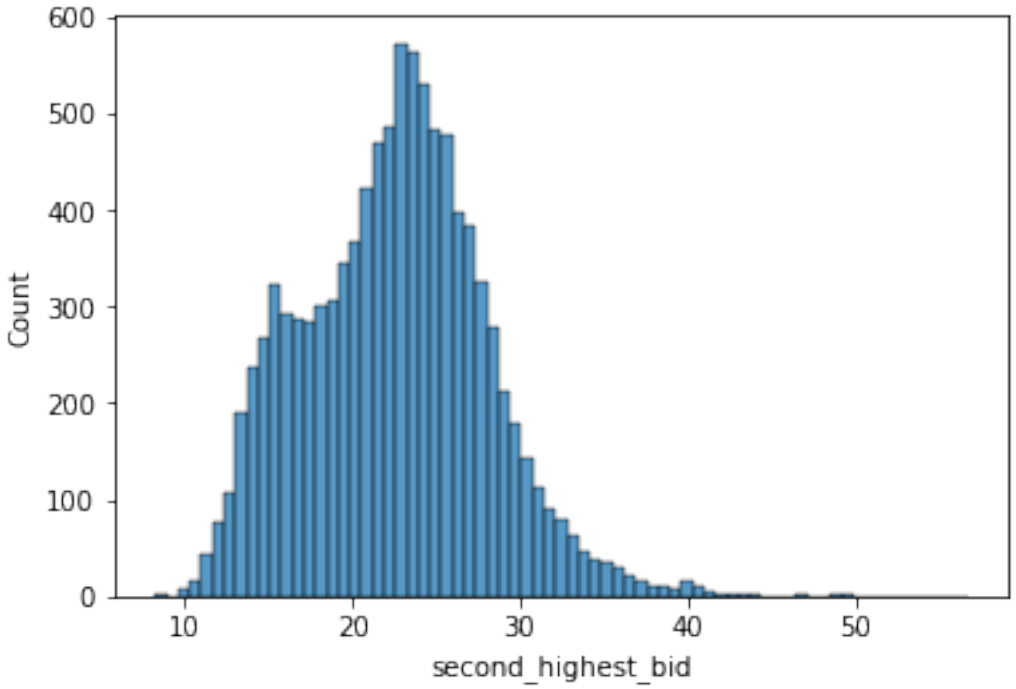
#7. Congenstion based Competitive Shiller

```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,0,0,0,1,0,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [05:20<00:00, 31.17it/s]
```

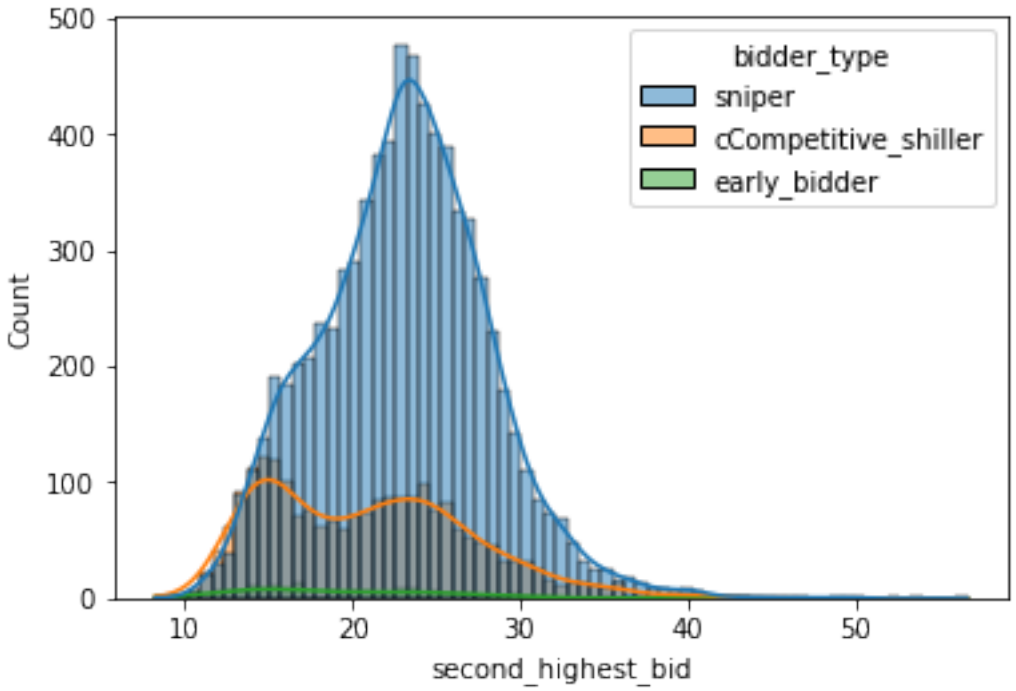
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd0fe0af40>



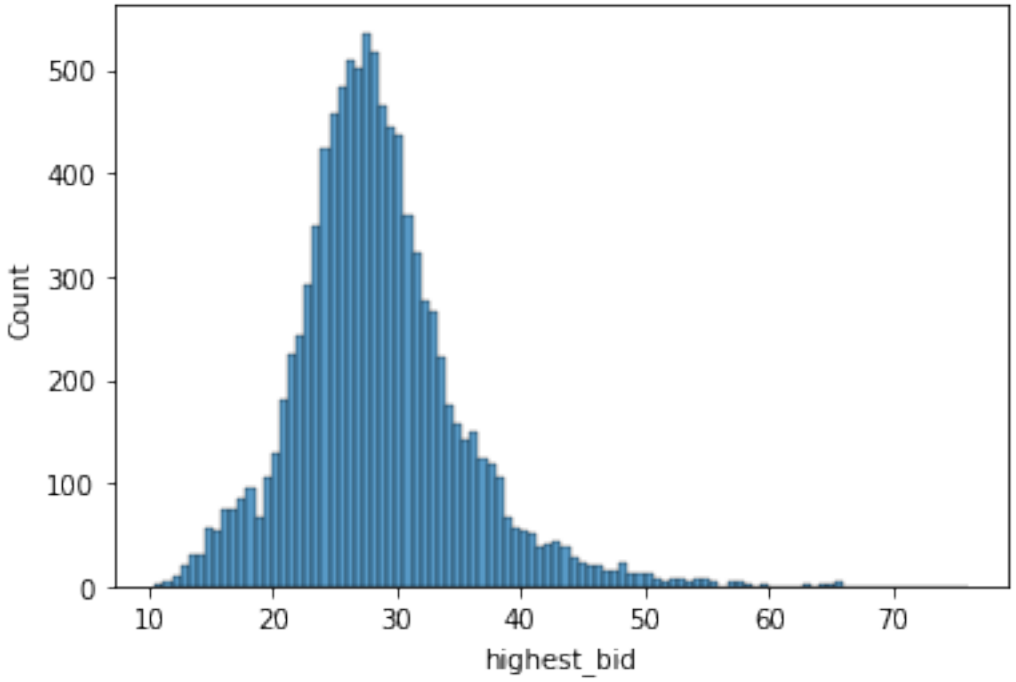
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd0f06fd00>



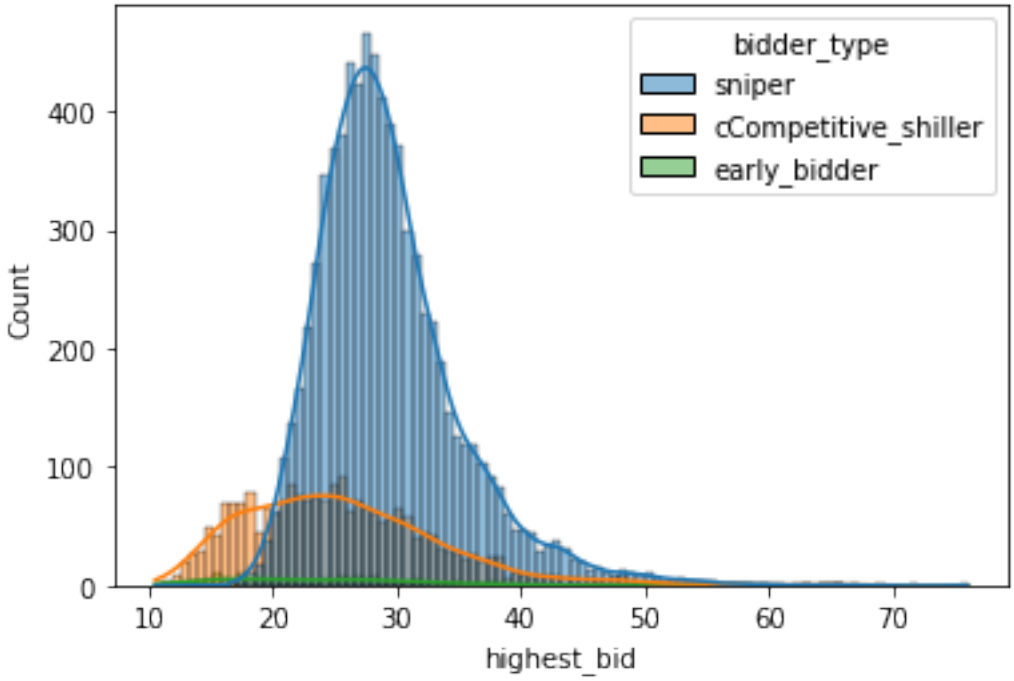
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0eda2220>
```



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0ed41760>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	7601.000000	7601.000000	7601.000000	7601.000000
mean	6.975924	29.396075	23.097153	17.723326
std	0.818744	5.864809	5.088857	3.676833
min	6.000000	13.302500	8.905521	6.000000
25%	6.000000	25.467172	19.689863	15.000000
50%	7.000000	28.406033	23.176085	18.000000
75%	8.000000	32.007638	26.291584	20.000000
max	8.000000	76.040757	53.731007	35.000000

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	175.00000	175.000000	175.000000	175.000000
mean	2.44000	23.875765	19.638439	17.245714
std	1.73059	8.336894	6.165657	3.647101
min	0.00000	10.506718	9.862698	9.000000

```
25%       1.00000    17.291930           14.834206   15.000000
50%       2.00000    23.898171           18.769225   17.000000
75%       4.00000    28.128905           23.759240   20.000000
max       5.00000    65.674839           42.455766   29.000000
```

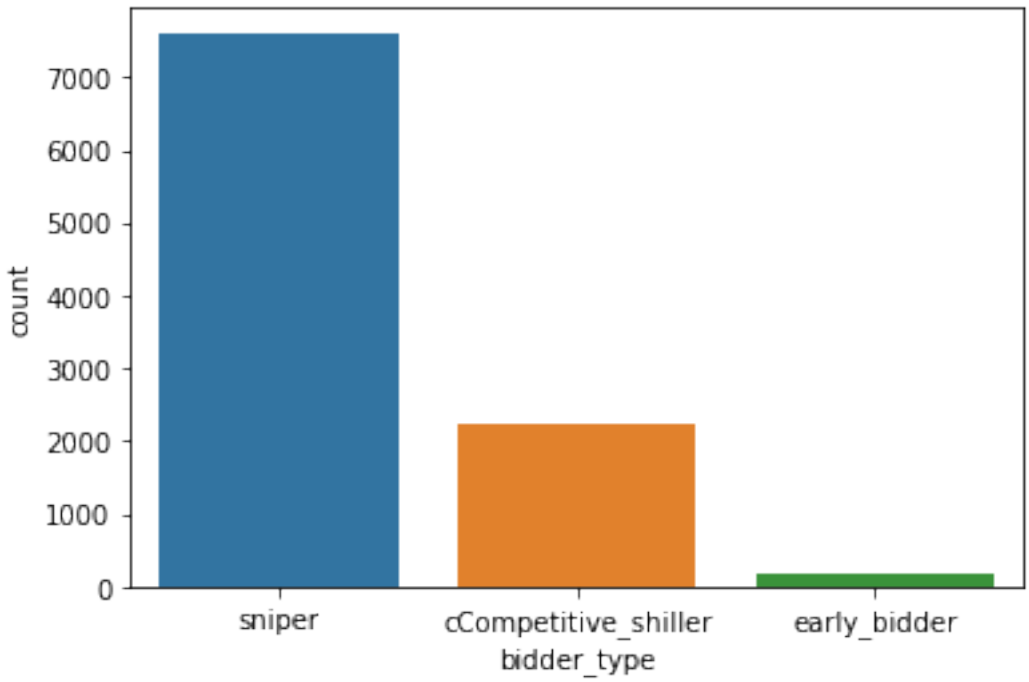
[ ]:
```
df_logs[df_logs['bidder_type']=='cCompetitive_shiller'].describe()
```

[ ]:
```
df_logs.describe()
```

[ ]:
```
          bidder_id   highest_bid  second_highest_bid     bid_count
count  10000.000000  10000.000000        10000.000000  10000.000000
mean       7.346700     28.488380           22.582128     17.522000
std        1.302102      6.744813            5.495113      3.702551
min        0.000000     10.506718            8.236199      6.000000
25%        6.000000     24.453861           18.612544     15.000000
50%        7.000000     27.824620           22.776640     17.000000
75%        8.000000     31.673316           26.053848     20.000000
max        9.000000     76.040757           56.690583     35.000000
```

[ ]:
```
sns.countplot(data=df_logs, x='bidder_type')
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0eb27f70>
```



[ ]:
```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part7.csv')
```

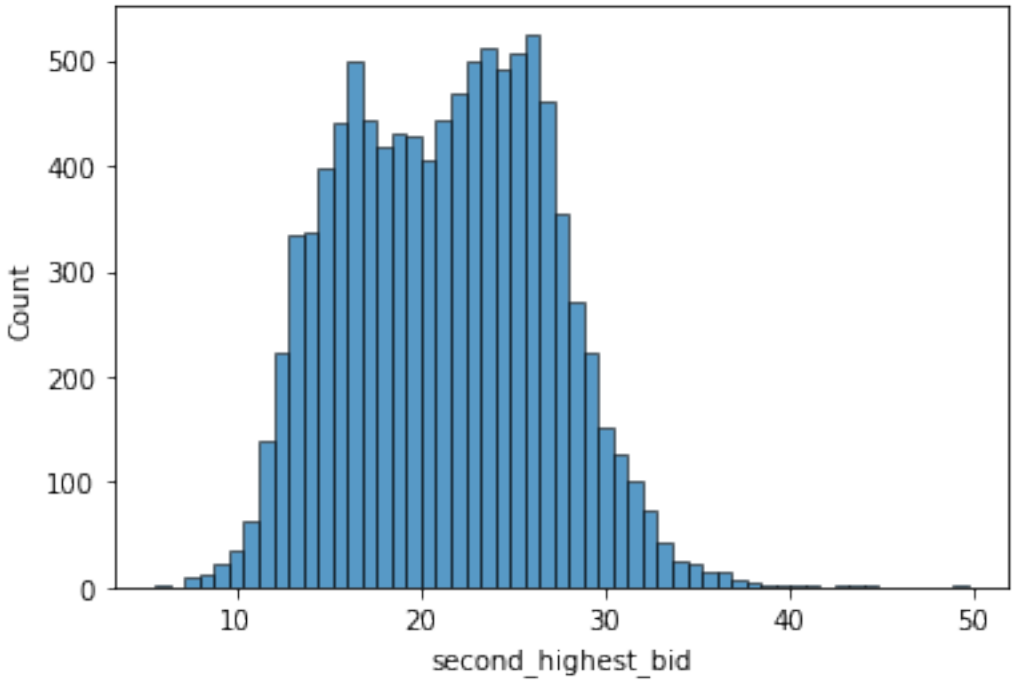
#8. False Bidder

[ ]:
```
logs = []
for i in tqdm(range(0,10000)):
  Auction = auction(3,6,0,0,0,0,0,1,500)
  logs.append(Auction.run_auction())
df_logs = pd.DataFrame(logs,␣
 ↪columns=['bidder_id','bidder_type','highest_bid','second_highest_bid','bid_count'])
```

```
100%|      | 10000/10000 [01:44<00:00, 95.80it/s]
```

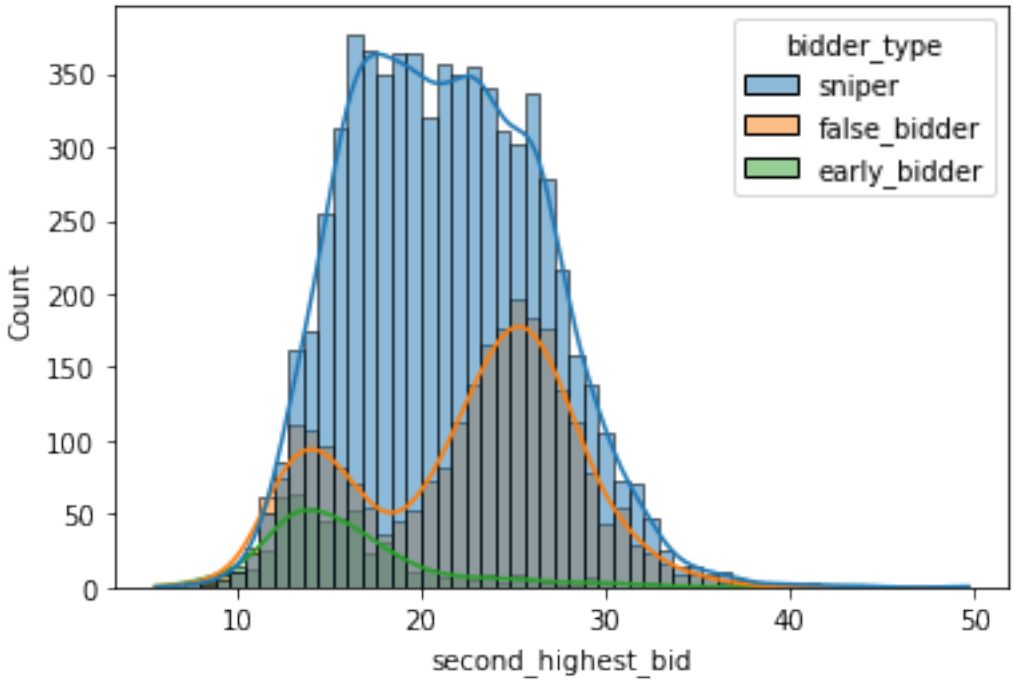
[ ]:
```
sns.histplot(df_logs['second_highest_bid'])
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0d59d280>
```



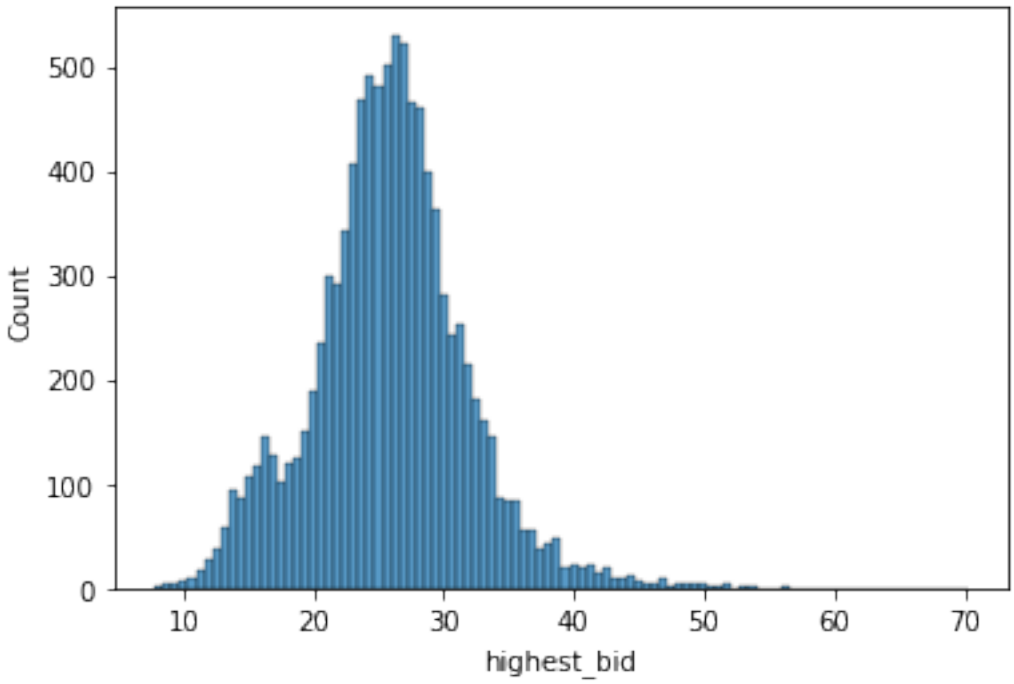
[ ]:
```
sns.histplot(data=df_logs, x='second_highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0d59d5e0>
```



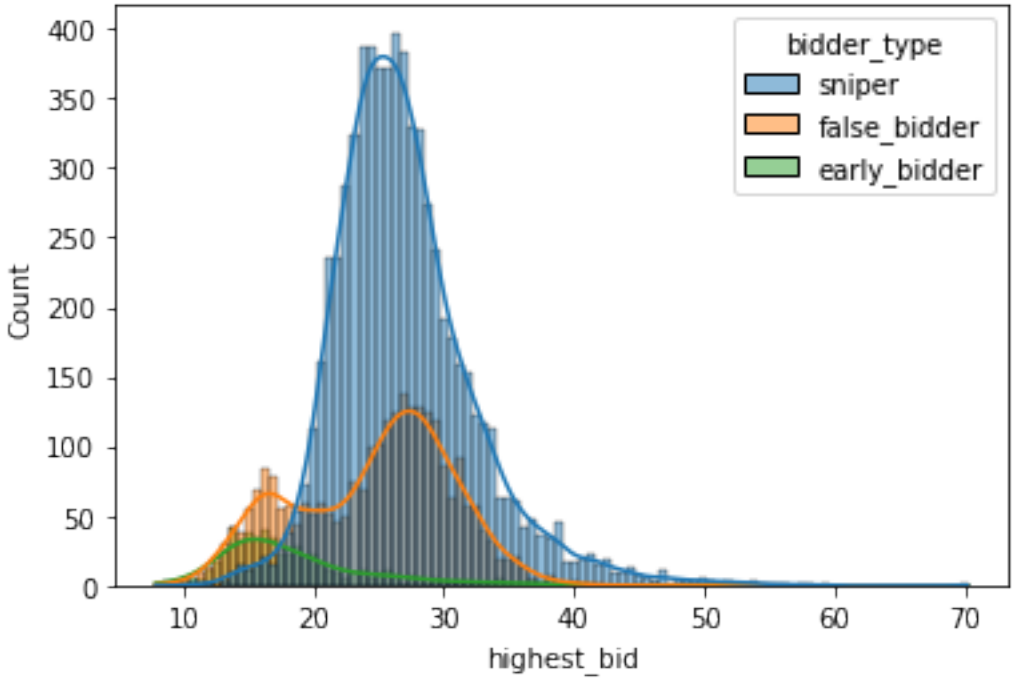
[ ]:
```
sns.histplot(df_logs['highest_bid'])
```

[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbd0d2eac70>



[ ]:
```
sns.histplot(data=df_logs, x='highest_bid', hue='bidder_type', kde=True)
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0d119d60>
```



[ ]:
```
df_logs[df_logs['bidder_type']=='sniper'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	6755.000000	6755.000000	6755.000000	6755.000000
mean	7.002517	27.045261	21.408932	14.936936
std	0.815616	5.459380	5.191163	2.766747
min	6.000000	10.751742	7.245663	7.000000
25%	6.000000	23.531923	17.348642	13.000000
50%	7.000000	26.273776	21.153524	15.000000
75%	8.000000	29.576220	25.186572	17.000000
max	8.000000	70.221683	49.673937	25.000000

[ ]:
```
df_logs[df_logs['bidder_type']=='early_bidder'].describe()
```

[ ]:

	bidder_id	highest_bid	second_highest_bid	bid_count
count	568.000000	568.000000	568.000000	568.000000
mean	2.484155	18.503168	16.000674	13.403169
std	1.699599	5.821968	4.750633	2.852232
min	0.000000	7.868697	5.722707	6.000000

```
25%      1.000000    14.501676           12.935116   11.000000
50%      2.000000    16.937472           14.998185   13.000000
75%      4.000000    20.808047           17.779471   15.000000
max      5.000000    46.272875           36.236309   21.000000
```

[ ]:
```
df_logs[df_logs['bidder_type']=='false_bidder'].describe()
```

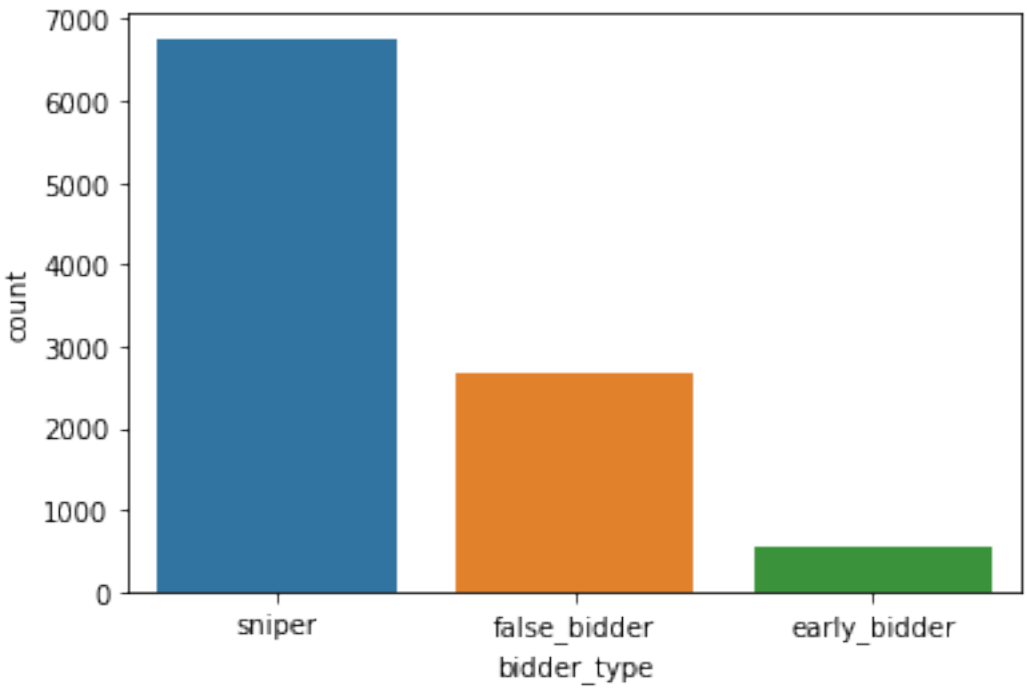
[ ]:
```
       bidder_id  highest_bid  second_highest_bid    bid_count
count     2677.0  2677.000000         2677.000000  2677.000000
mean         9.0    24.610619           22.307518    14.769518
std          0.0     6.038505            5.947895     2.833100
min          9.0     8.318309            5.600407     5.000000
25%          9.0    19.761193           16.964031    13.000000
50%          9.0    25.680811           23.655060    15.000000
75%          9.0    28.929757           26.612128    17.000000
max          9.0    44.685030           42.504413    25.000000
```

[ ]:
```
df_logs.describe()
```

[ ]:
```
         bidder_id   highest_bid  second_highest_bid     bid_count
count  10000.00000  10000.000000        10000.000000  10000.000000
mean       7.28060     25.908317           21.342295     14.805000
std        1.66245      6.020964            5.551900      2.811364
min        0.00000      7.868697            5.600407      5.000000
25%        6.00000     22.476510           16.791313     13.000000
50%        7.00000     25.882334           21.484619     15.000000
75%        9.00000     29.202421           25.539550     17.000000
max        9.00000     70.221683           49.673937     25.000000
```

[ ]:
```
sns.countplot(data=df_logs, x='bidder_type')
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbd0cec2820>
```



[ ]:
```
df_logs.to_csv('/content/drive/MyDrive/BTP Data/Part8.csv')
```