

COE782- ML - Lista2 - Parte prática - E21

Teorema Central do Limite

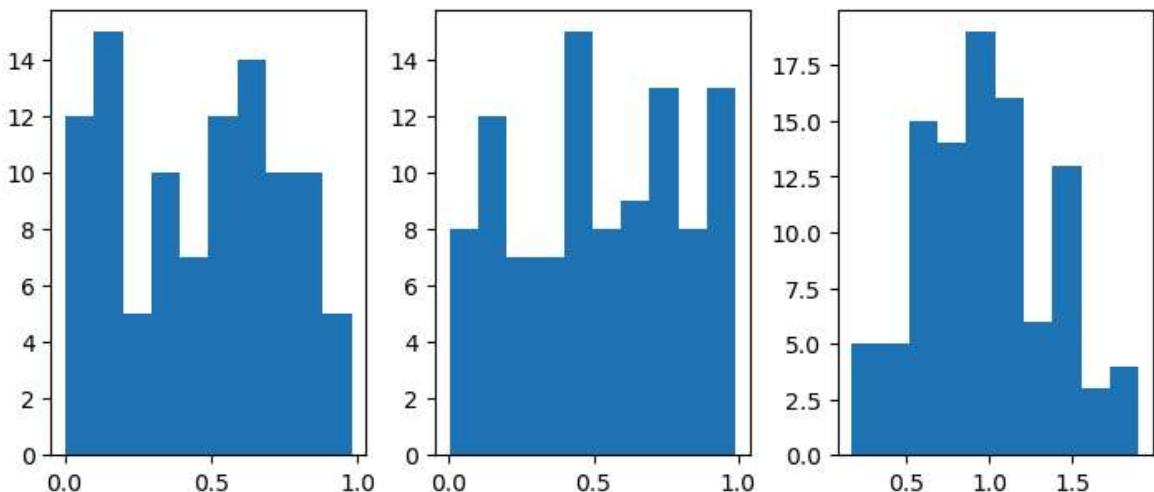
Vivian de Carvalho Rodrigues

DRE:125228569

```
In [1]: import numpy as np  
import matplotlib.pyplot as plt
```

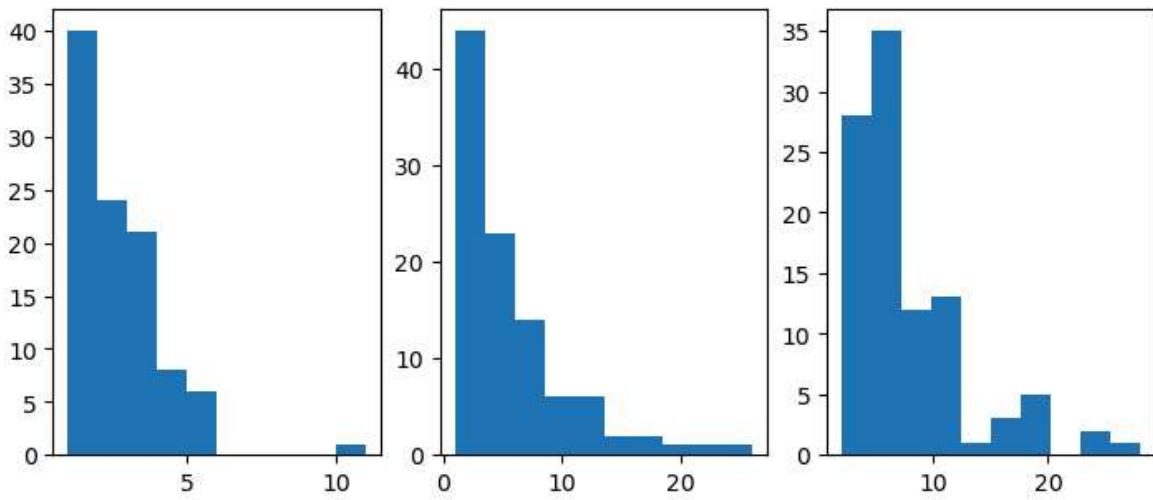
```
In [2]: #distribuição uniforme  
s = np.random.default_rng().uniform(0, 1, size = 100)  
s1 = np.random.default_rng().uniform(0, 1, size = 100)
```

```
In [3]: fig, axs = plt.subplots(1, 3, figsize=(7, 3), layout='constrained')  
  
axs[0].hist(s, bins = 10)  
axs[1].hist(s1, bins = 10)  
axs[2].hist(s+s1, bins = 10)  
plt.show()
```



```
In [4]: #distribuição Bernoulli  
m = np.random.default_rng().geometric(p=0.4, size=100)  
m1 = np.random.default_rng().geometric(p=0.2, size=100)
```

```
In [5]: fig, axs = plt.subplots(1, 3, figsize=(7, 3), layout='constrained')  
  
axs[0].hist(m, bins = 10)  
axs[1].hist(m1, bins = 10)  
axs[2].hist(m+m1, bins = 10)  
plt.show()
```



```
In [6]: #gerando N variáveis aleatórias
N = 500                                #quantidade de variáveis
n = 100                                 #quantidade de registros por variável

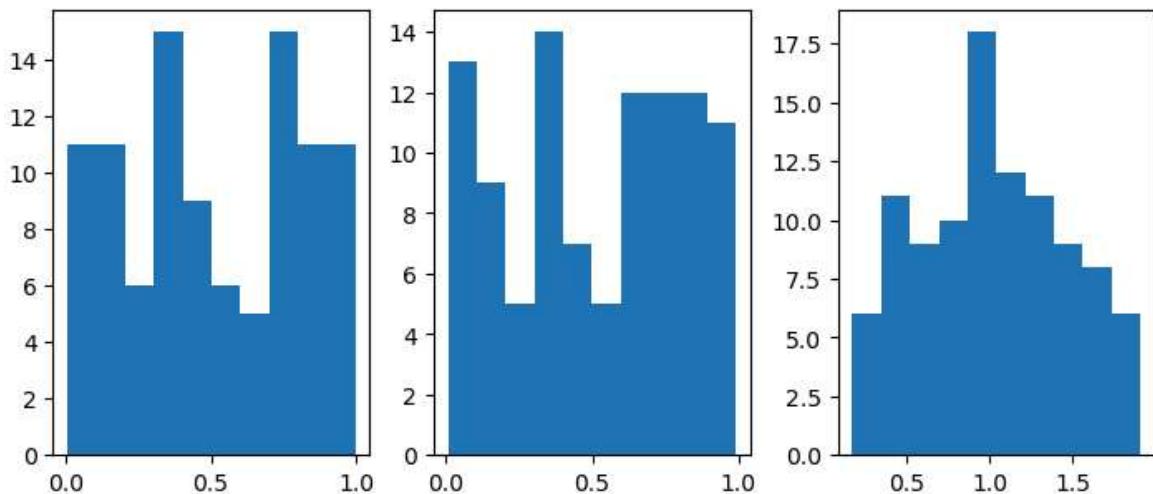
U = np.zeros((N,n))                      #matriz zerada para receber as distribuições unif
B = np.zeros((N,n))                      #matriz zerada para receber as distribuições Bern
```

```
In [7]: for i in range(N):
    s = np.random.default_rng().uniform(0, 1, size = 100)           #uniforme 1
    m = np.random.default_rng().geometric(p=0.4, size=100)          #Bernoulli 1

    #salva a variável matriz correspondente
    for j in range(n):
        U[i][j] = s[j]
        B[i][j] = m[j]
```

```
In [8]: fig, axs = plt.subplots(1, 3, figsize=(7, 3), layout='constrained')

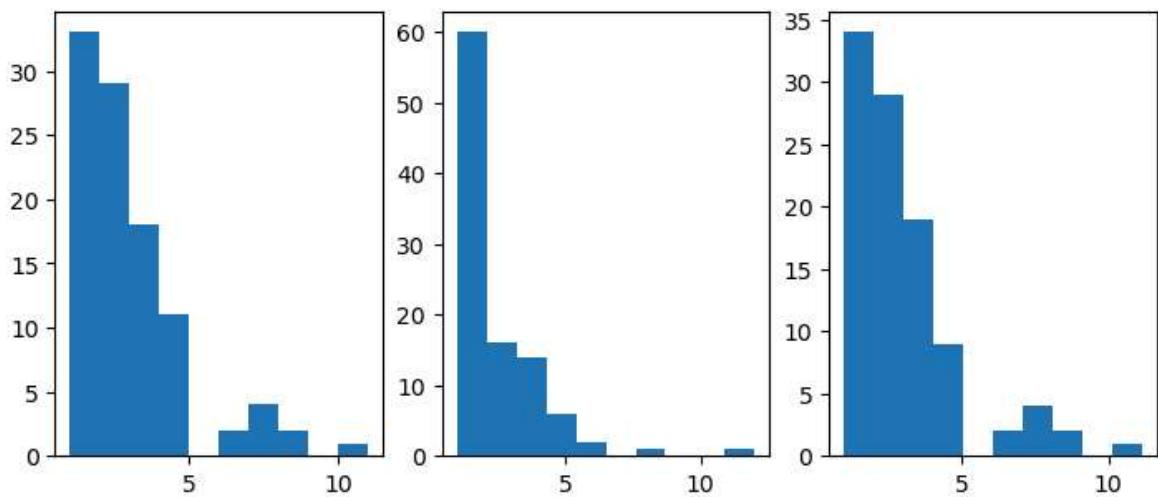
axs[0].hist(U[1], bins = 10)
axs[1].hist(U[4], bins = 10)
axs[2].hist(U[1]+U[4], bins = 10)
plt.show()
```



```
In [9]: fig, axs = plt.subplots(1, 3, figsize=(7, 3), layout='constrained')

axs[0].hist(B[1], bins = 10)
axs[1].hist(B[4], bins = 10)
```

```
    axs[2].hist(B[1]+U[4], bins = 10)
    plt.show()
```

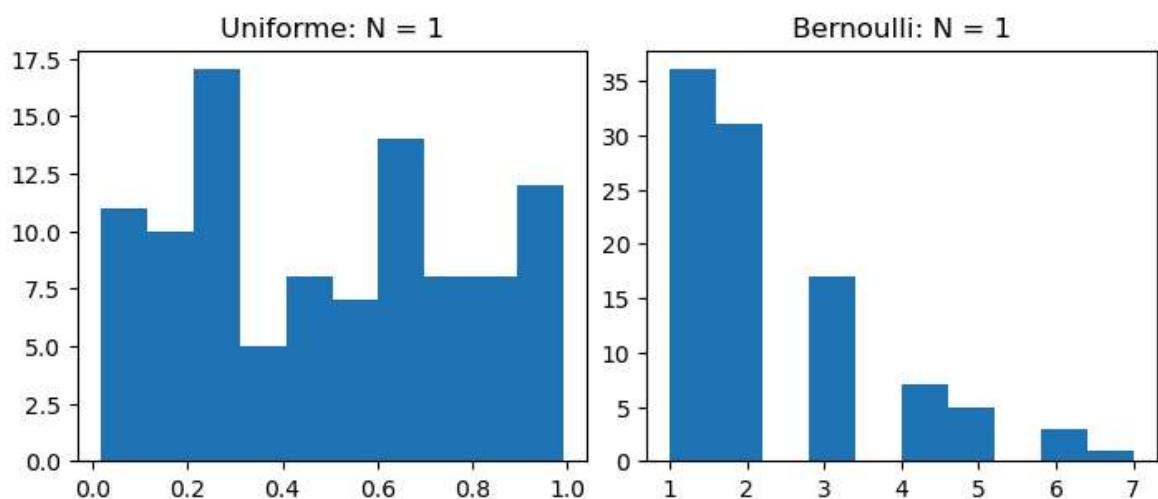


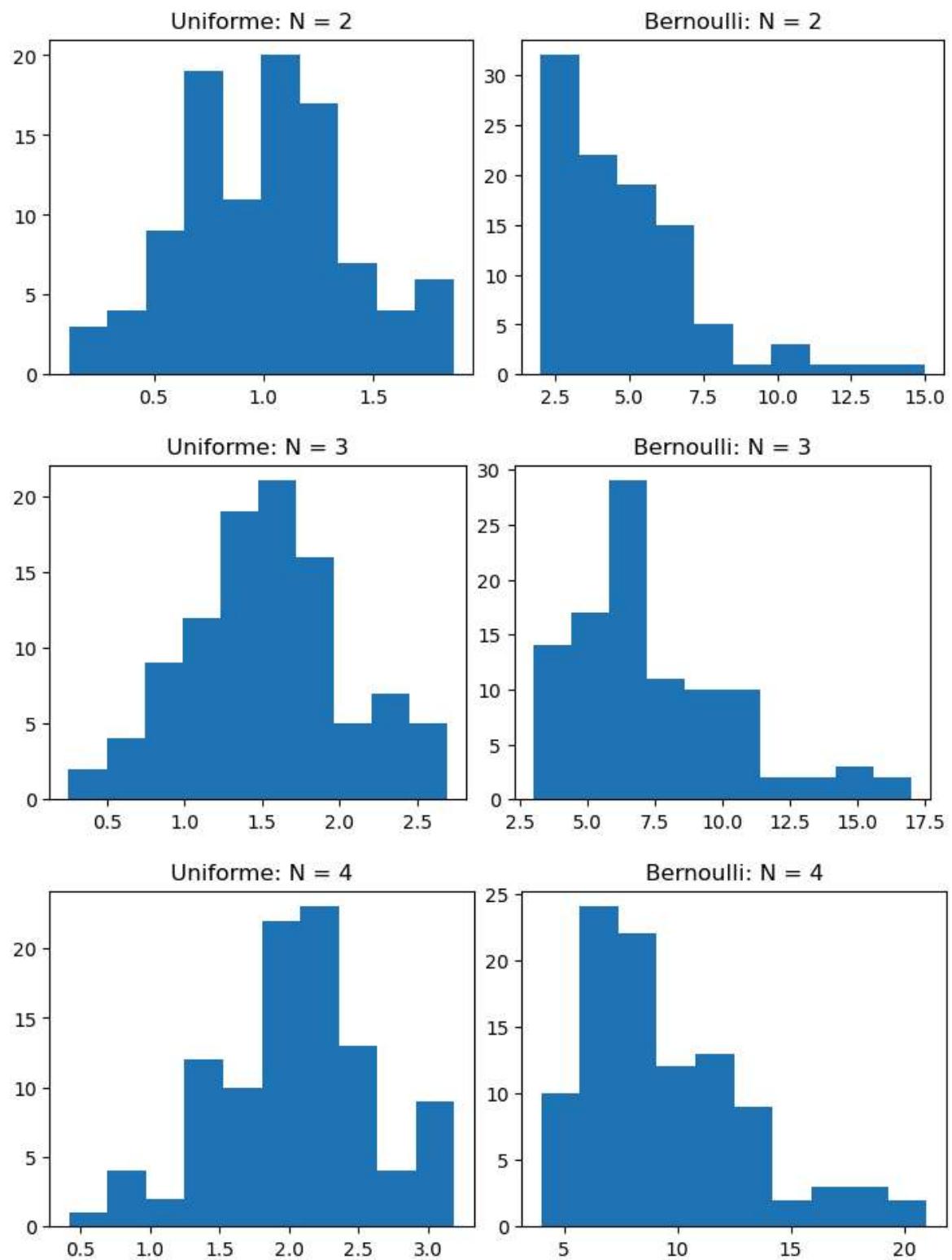
```
In [10]: #verificação do Teorema Central do Limite
Ut = np.zeros(n)
Bt = np.zeros(n)
for i in range(N):
    Ut = Ut+U[i]
    Bt = Bt+B[i]

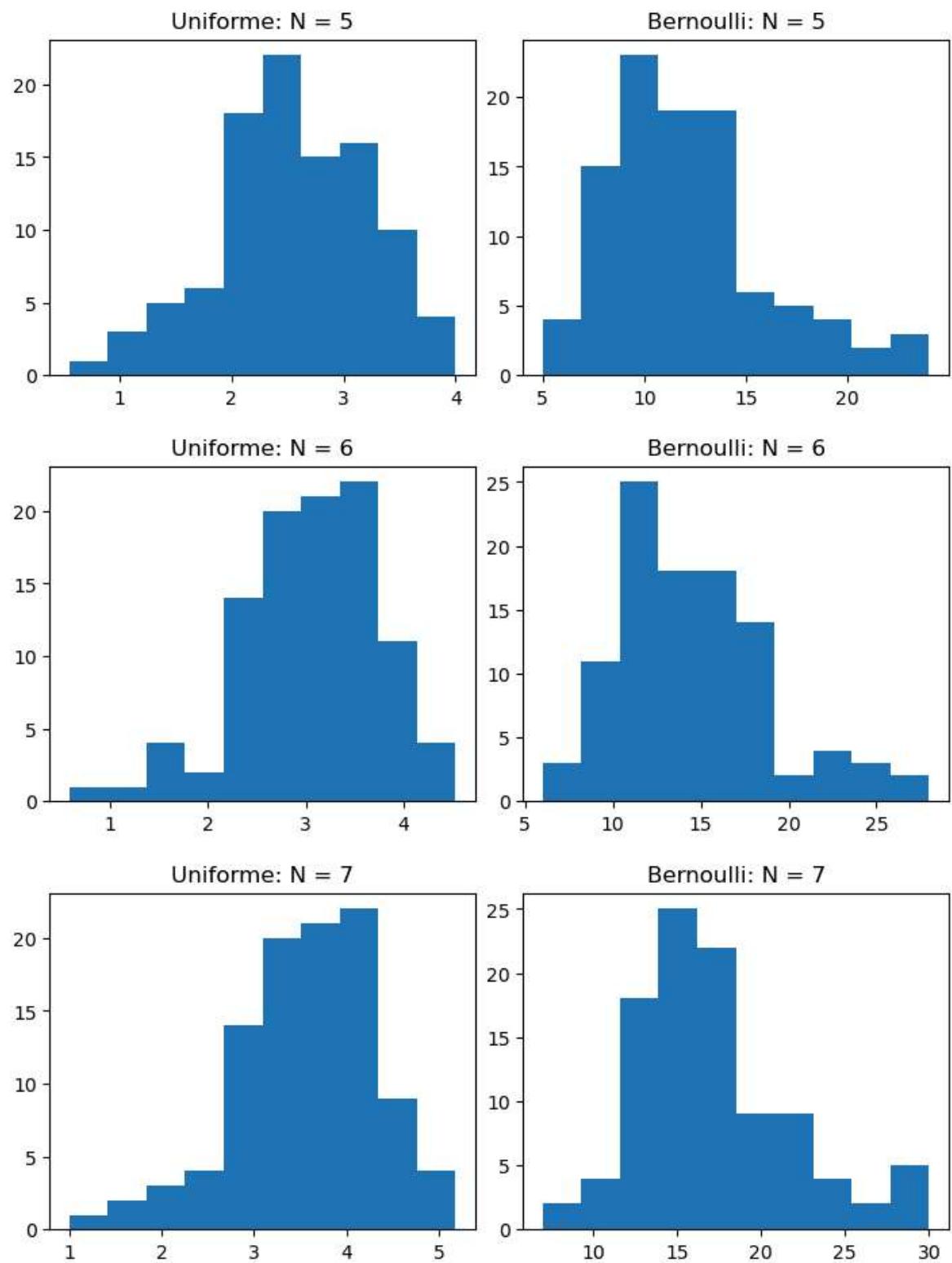
#imprime a soma das distribuições
fig, axs = plt.subplots(1, 2, figsize=(7, 3), layout='constrained')

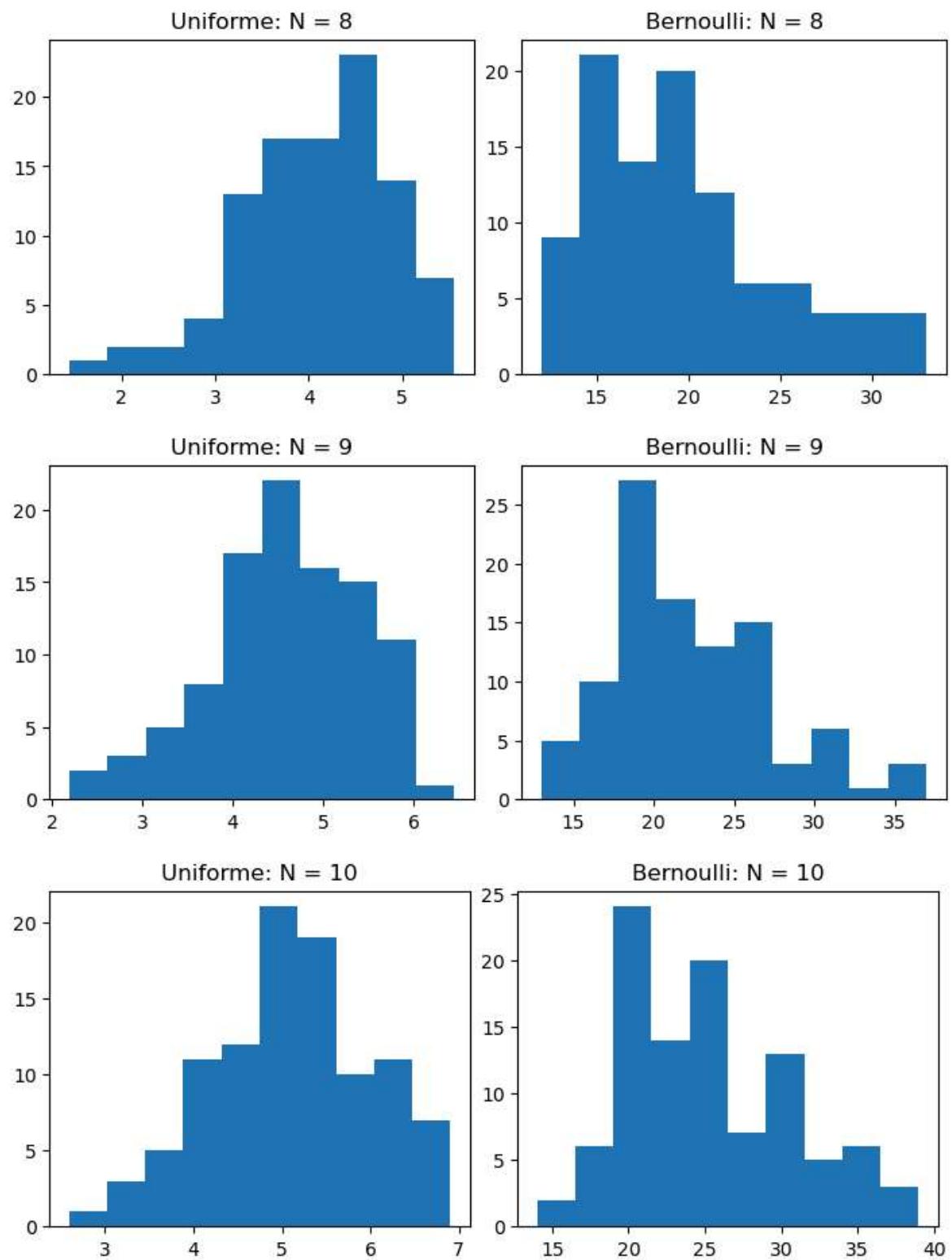
axs[0].hist(Ut, bins = 10)                                     #uniforme
axs[0].set_title("Uniforme: N = "+ str(i+1))

axs[1].hist(Bt, bins = 10)                                     #Bernoulli
axs[1].set_title("Bernoulli: N = "+ str(i+1))
plt.show()
```

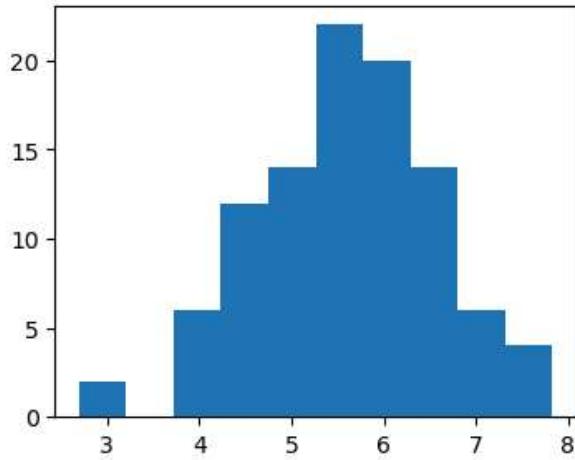




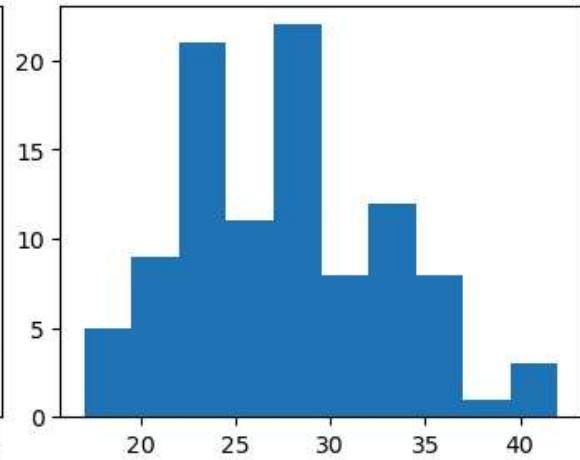




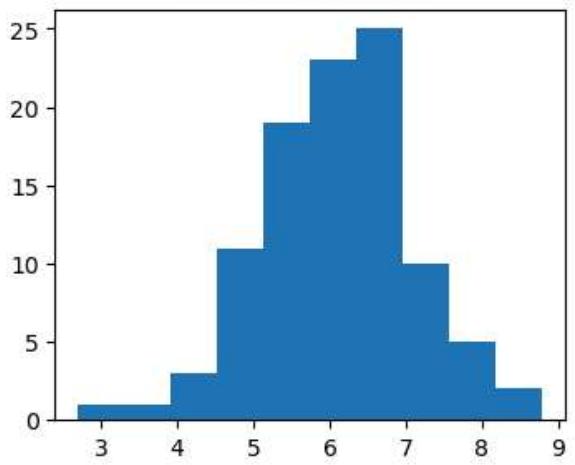
Uniforme: N = 11



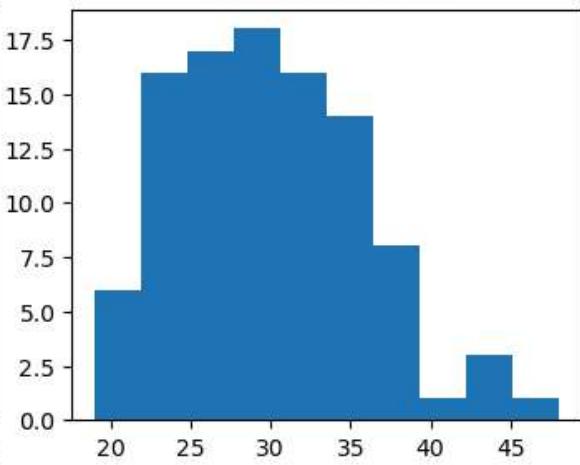
Bernoulli: N = 11



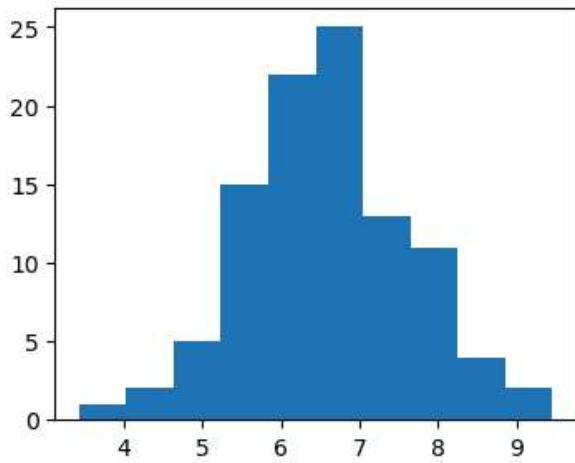
Uniforme: N = 12



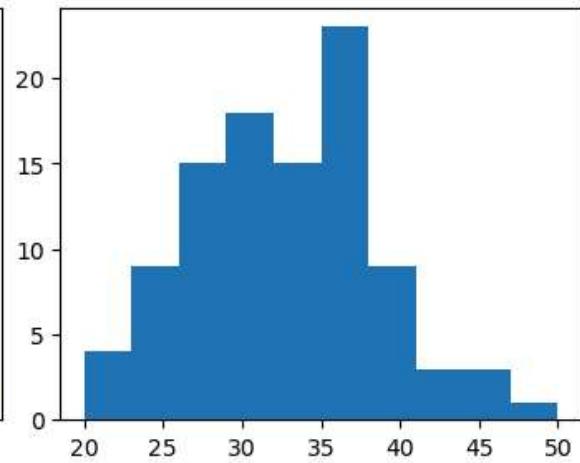
Bernoulli: N = 12



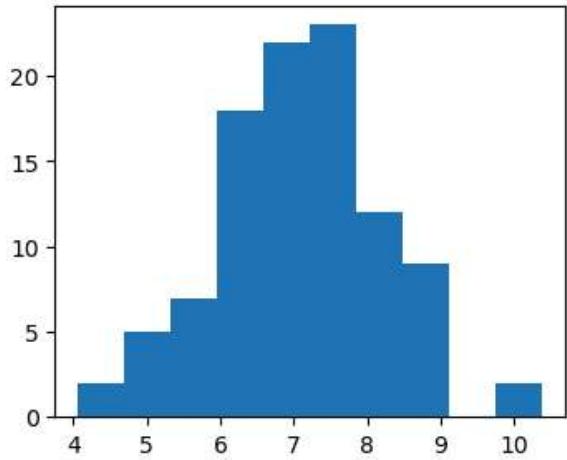
Uniforme: N = 13



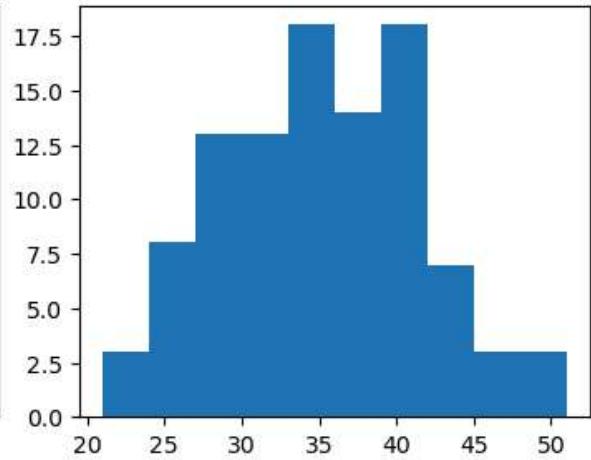
Bernoulli: N = 13



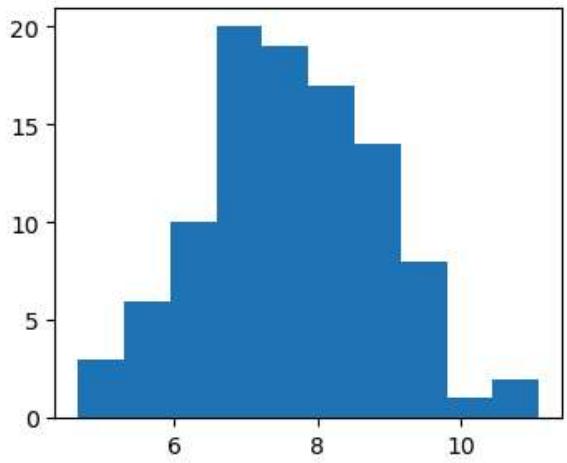
Uniforme: N = 14



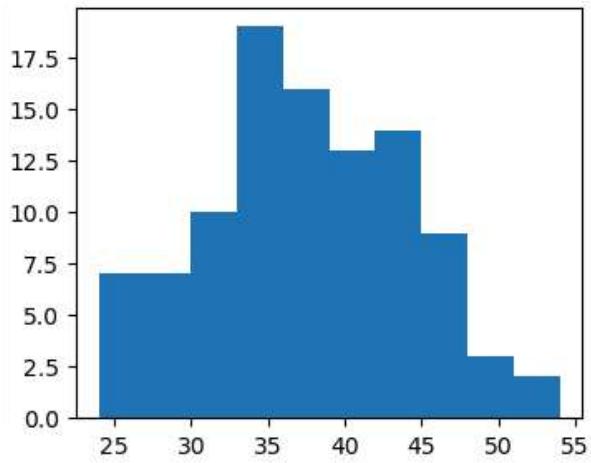
Bernoulli: N = 14



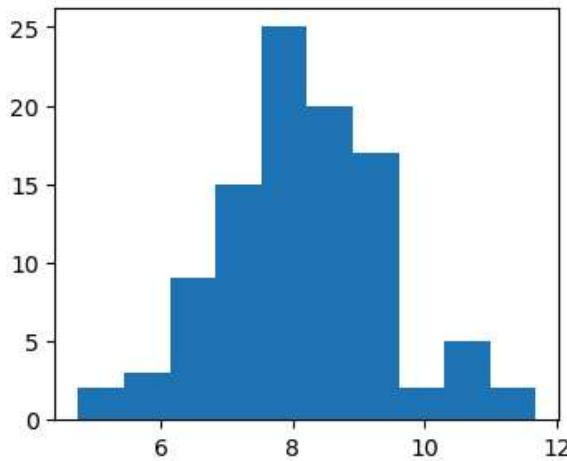
Uniforme: N = 15



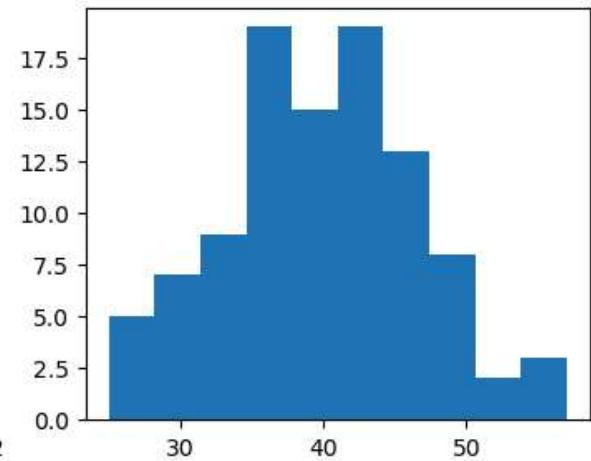
Bernoulli: N = 15

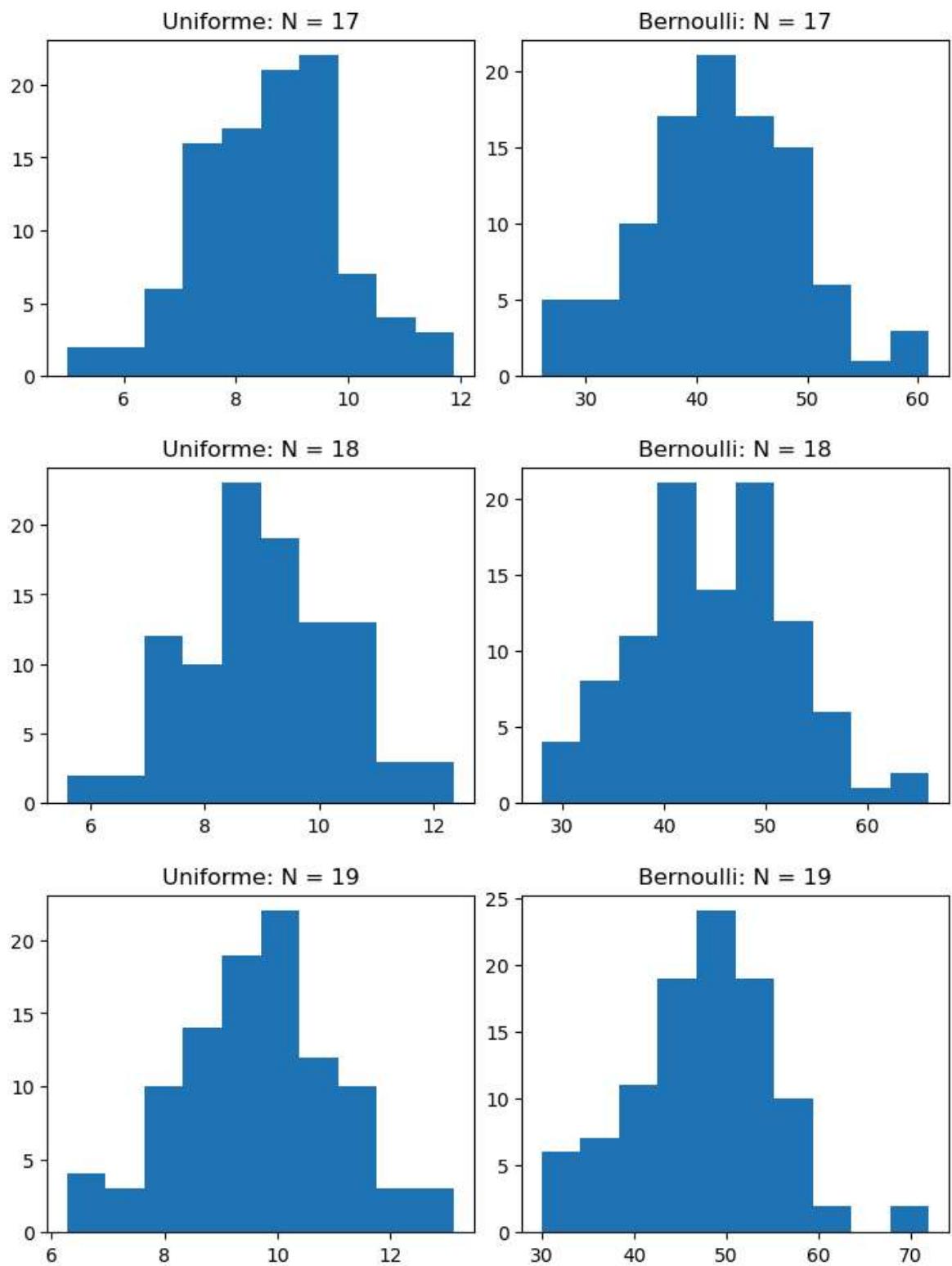


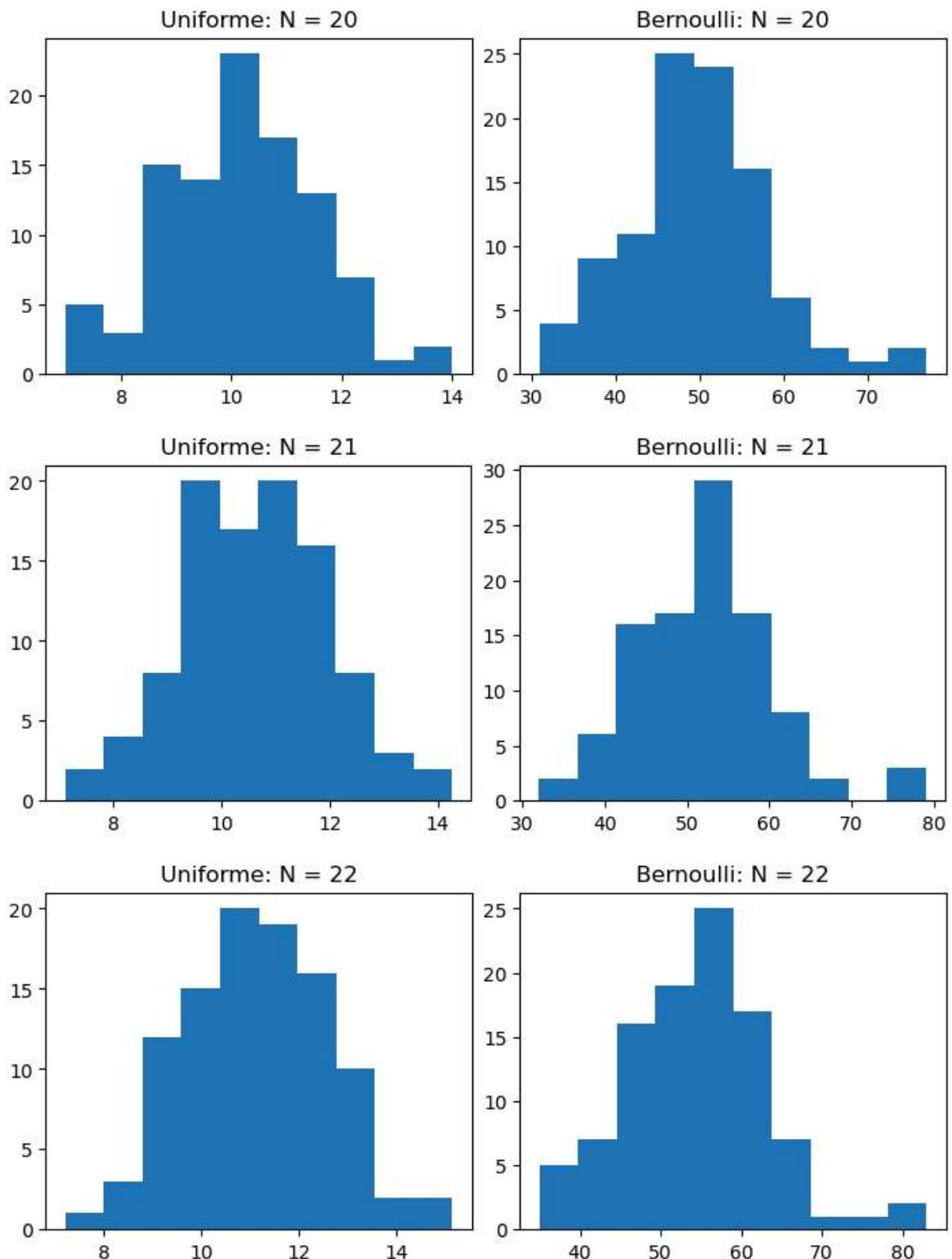
Uniforme: N = 16



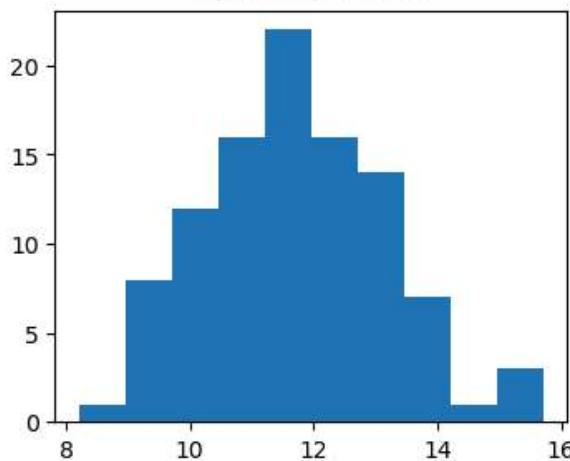
Bernoulli: N = 16



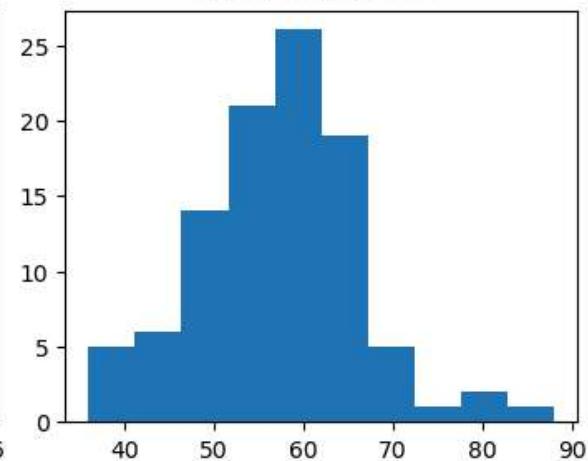




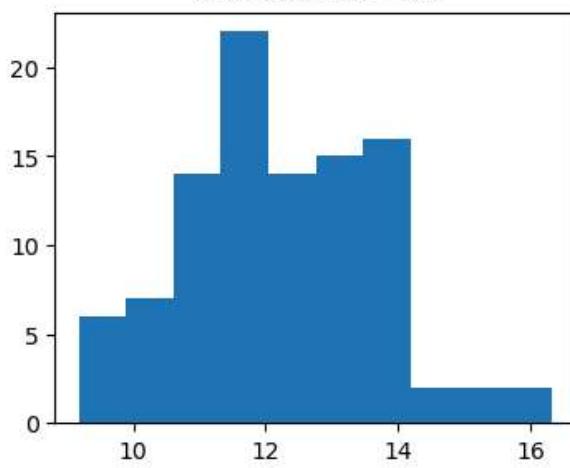
Uniforme: N = 23



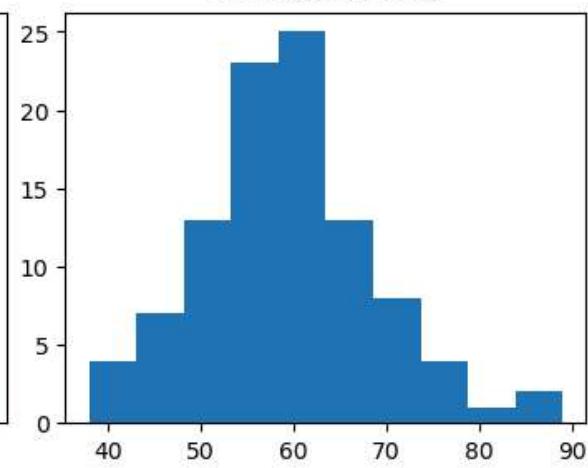
Bernoulli: N = 23



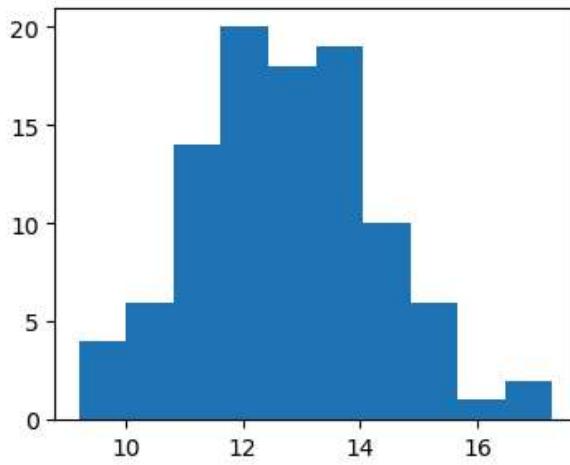
Uniforme: N = 24



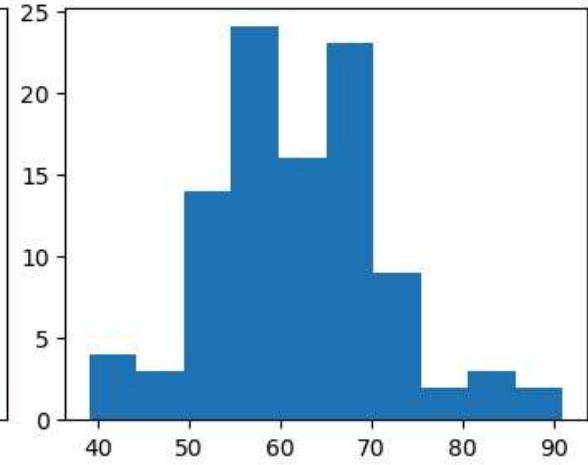
Bernoulli: N = 24

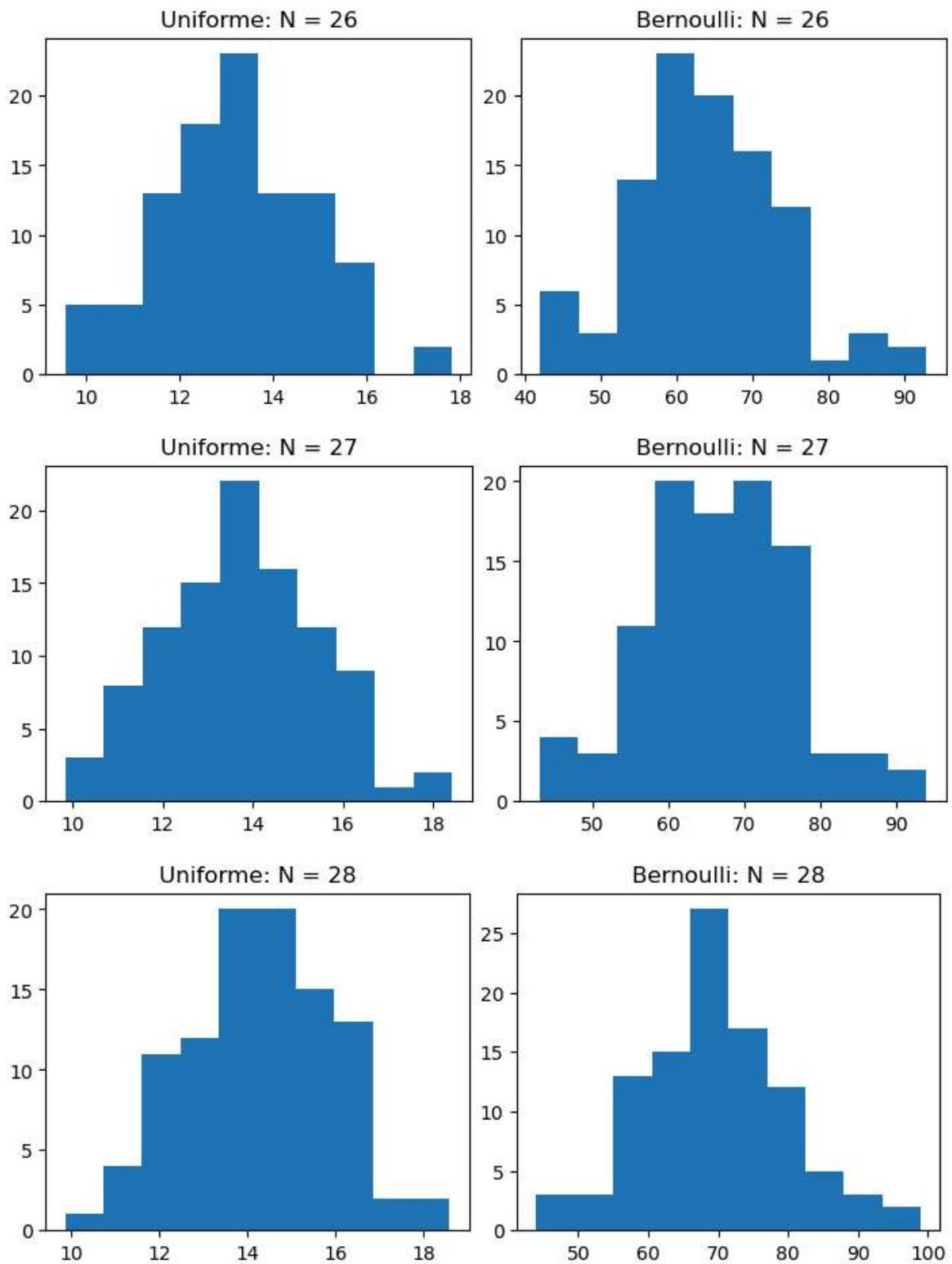


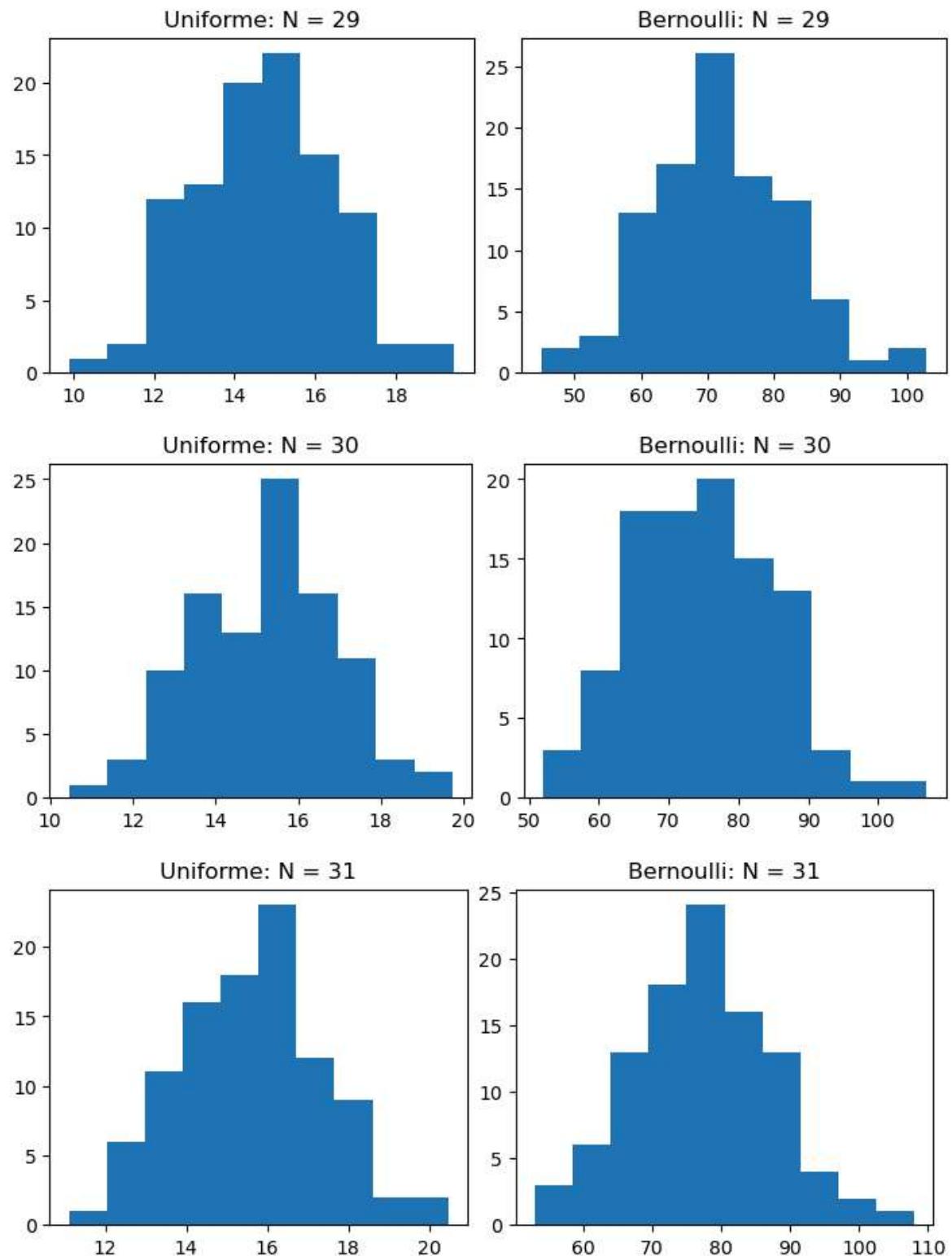
Uniforme: N = 25

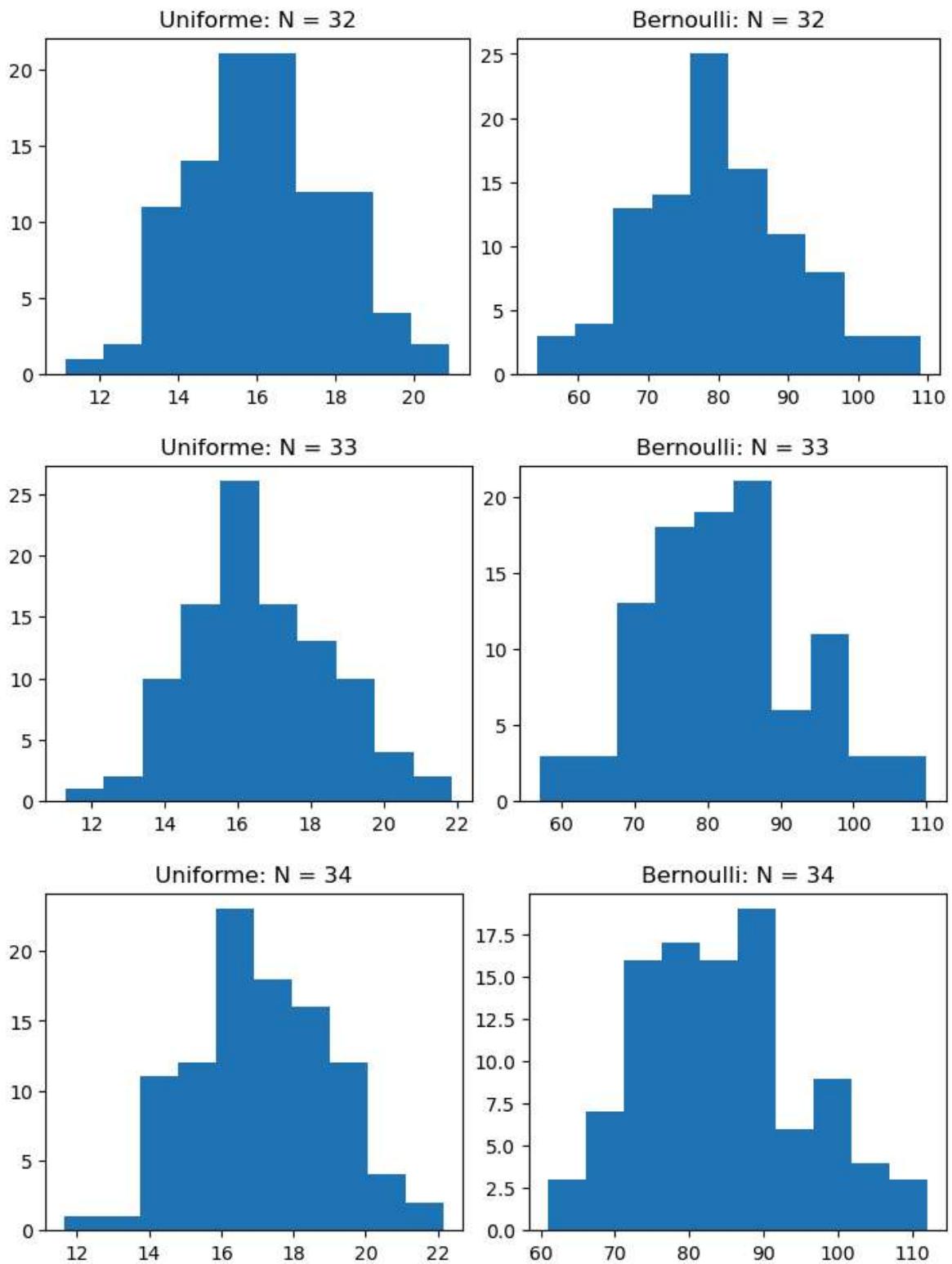


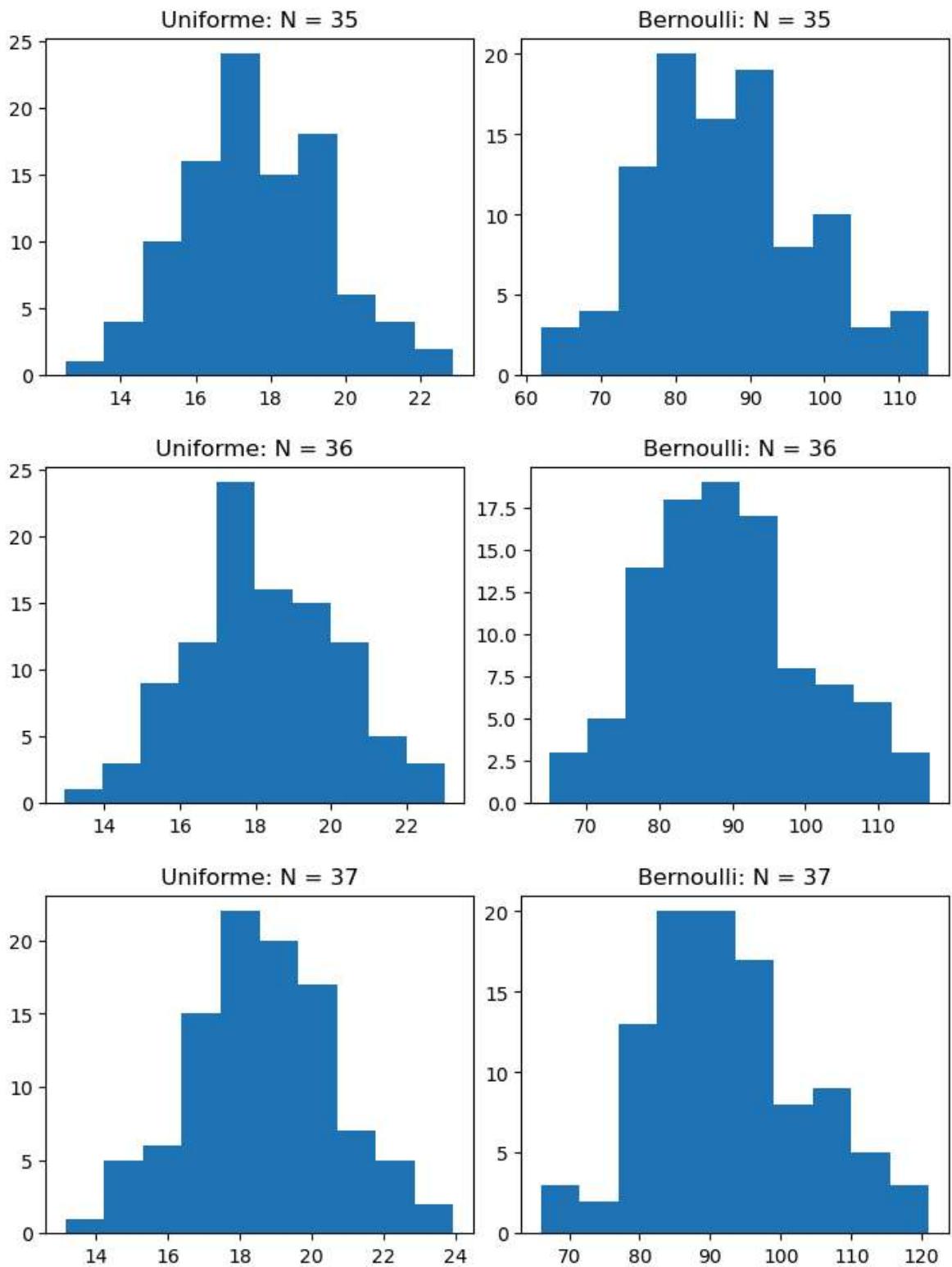
Bernoulli: N = 25

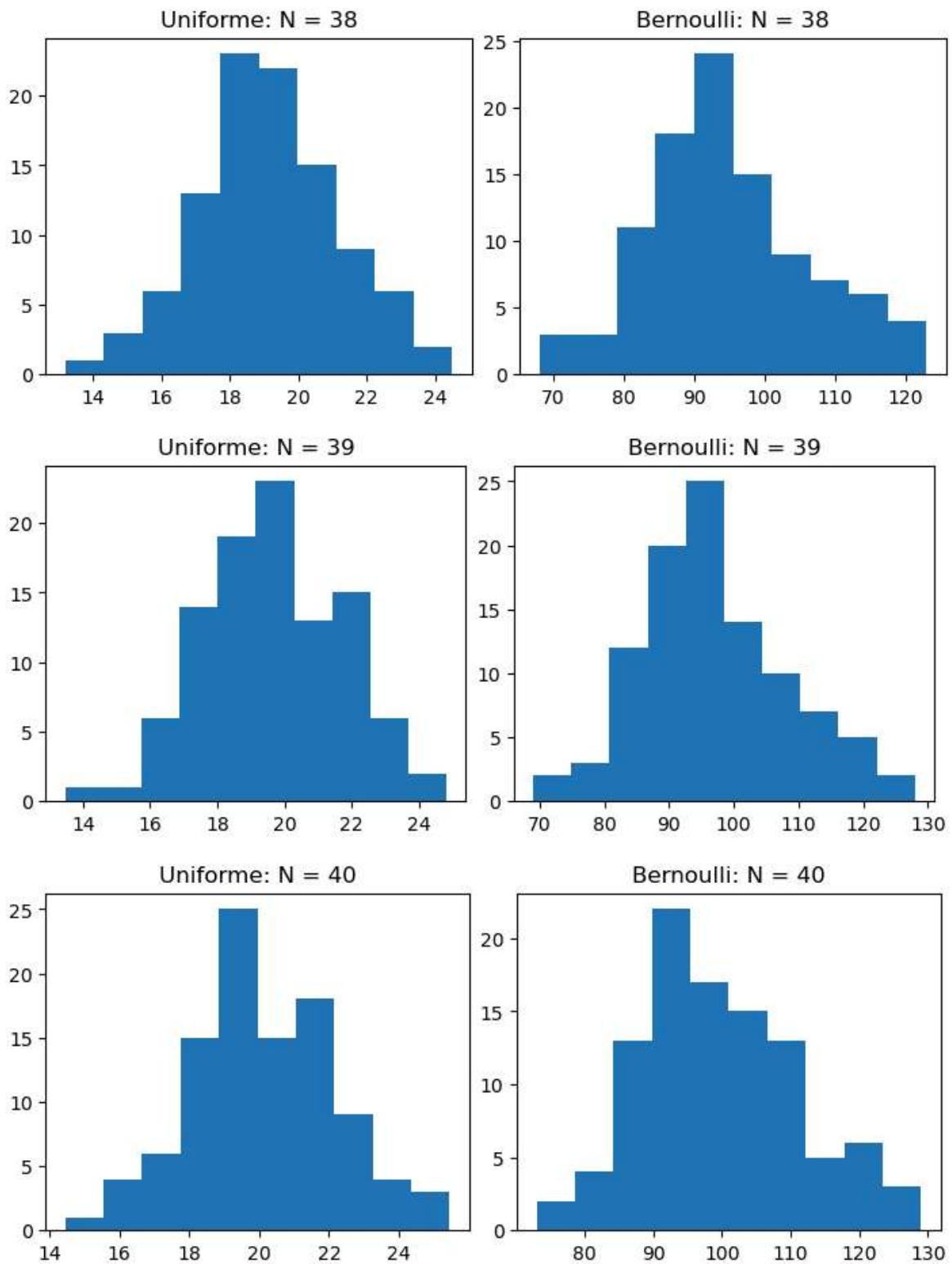




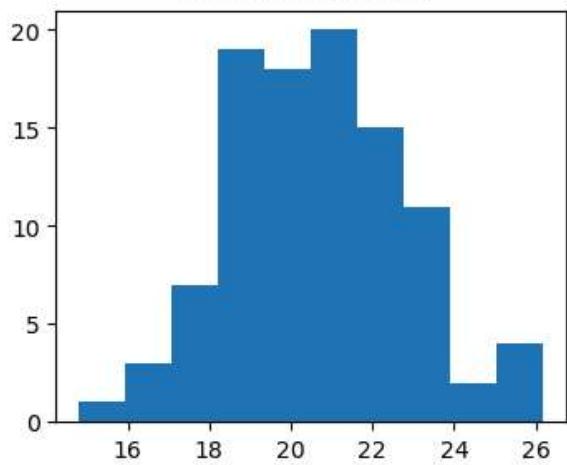




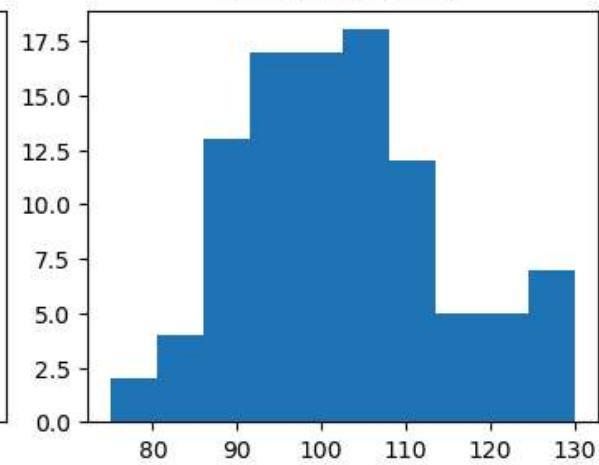




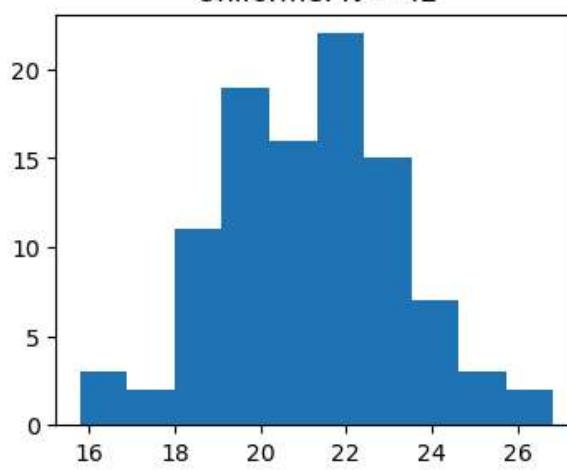
Uniforme: N = 41



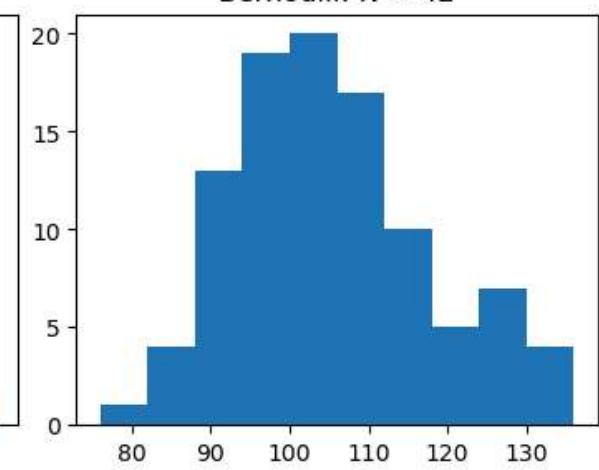
Bernoulli: N = 41



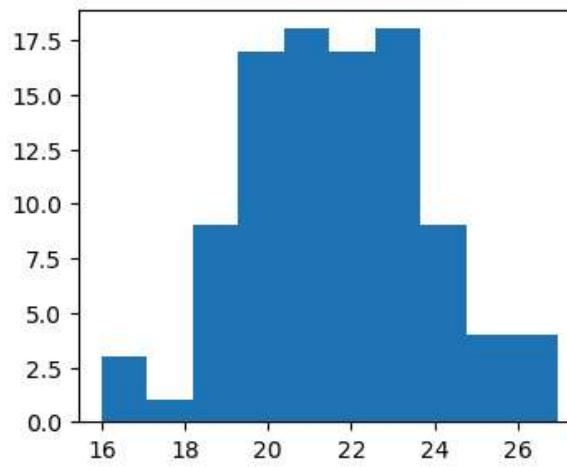
Uniforme: N = 42



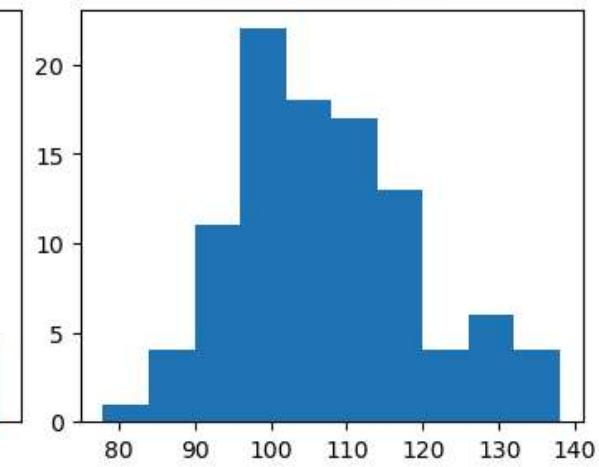
Bernoulli: N = 42

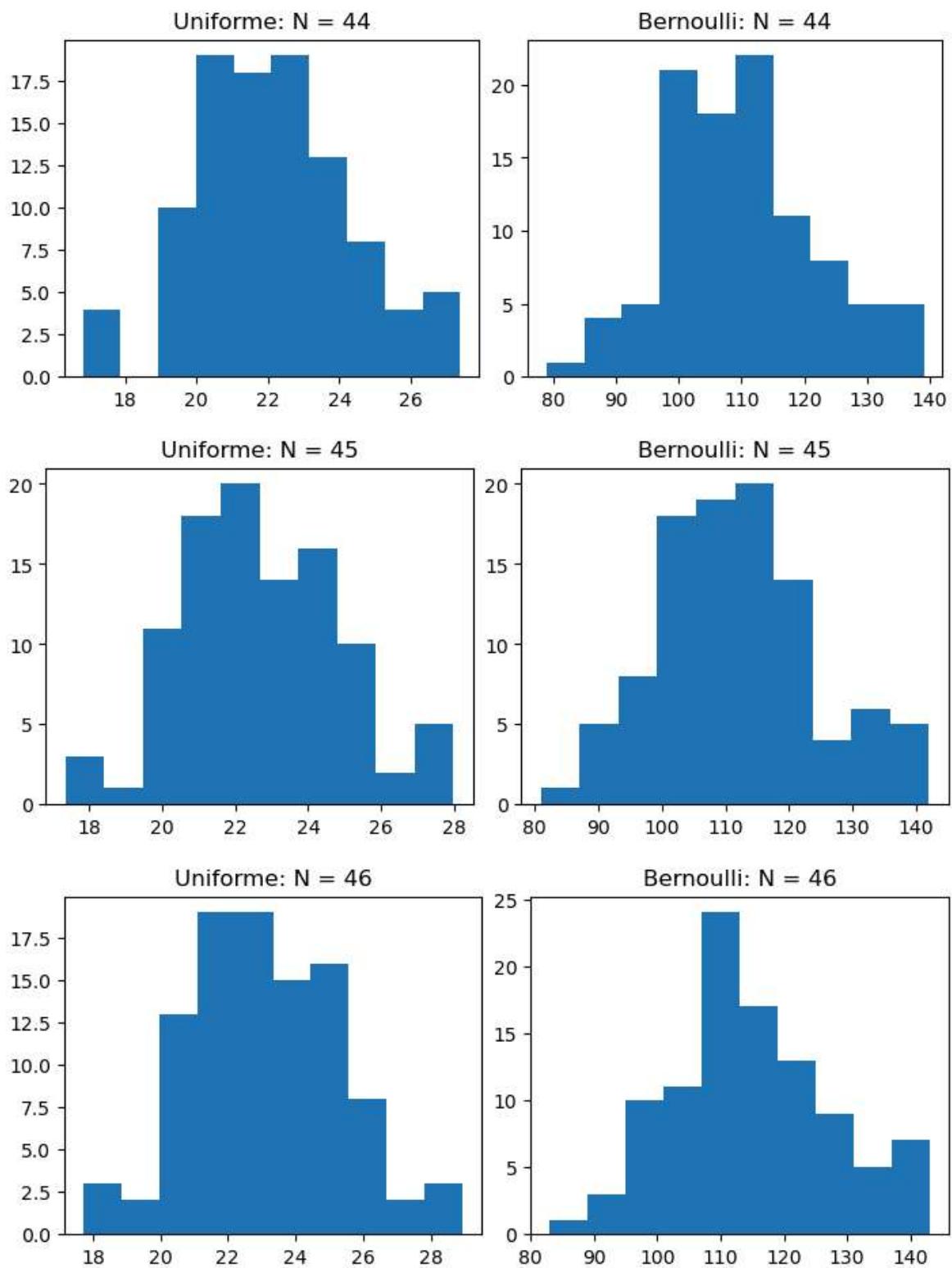


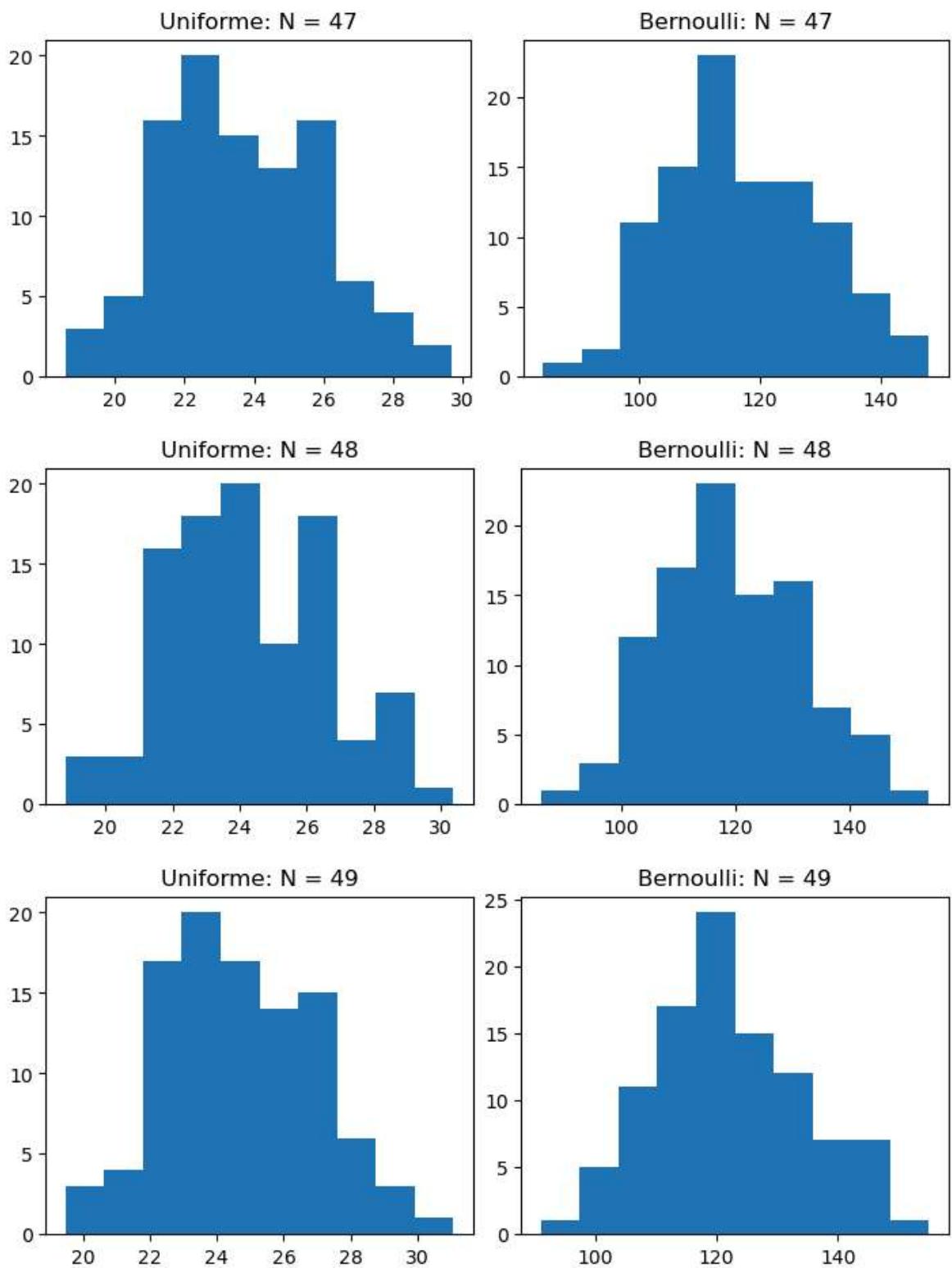
Uniforme: N = 43

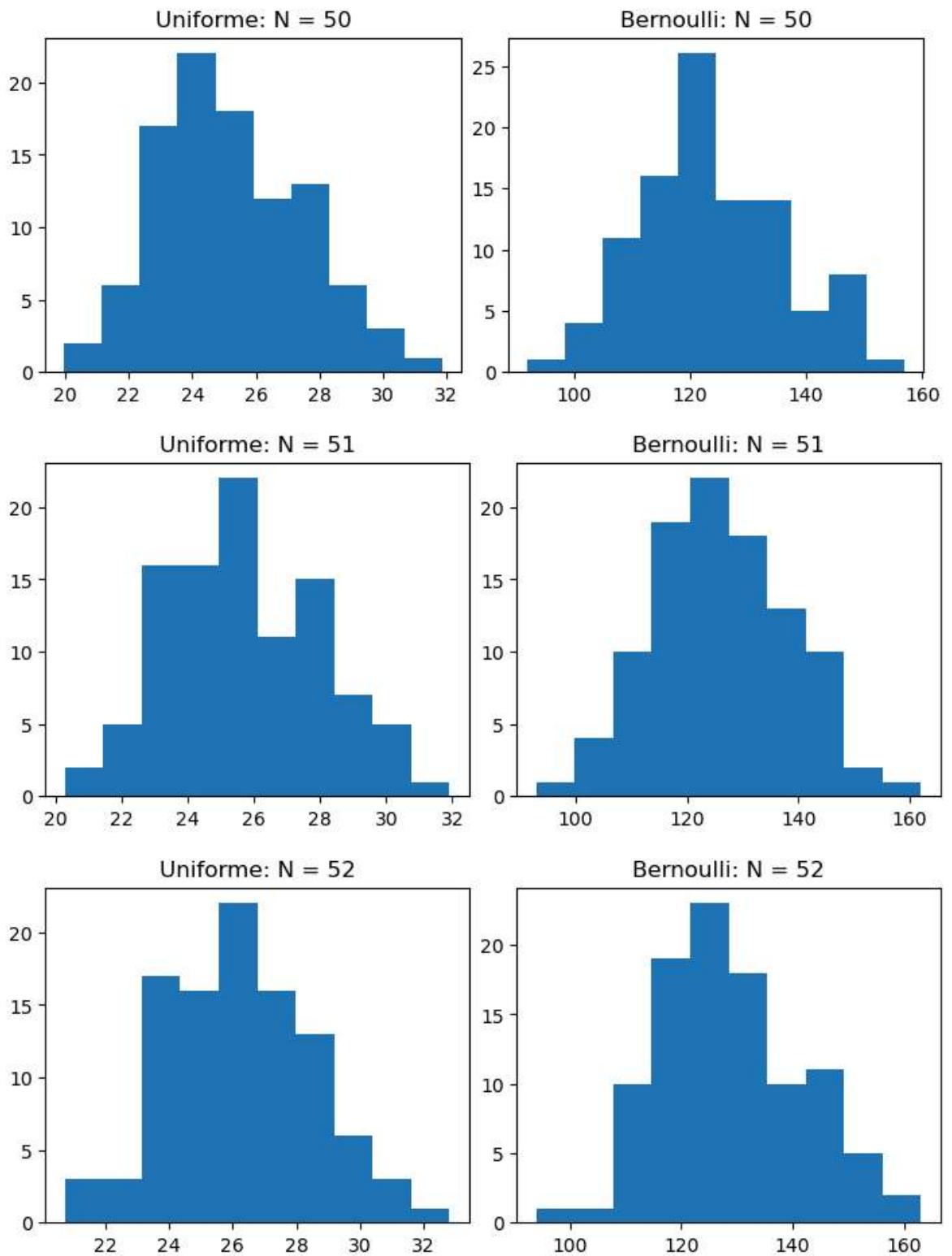


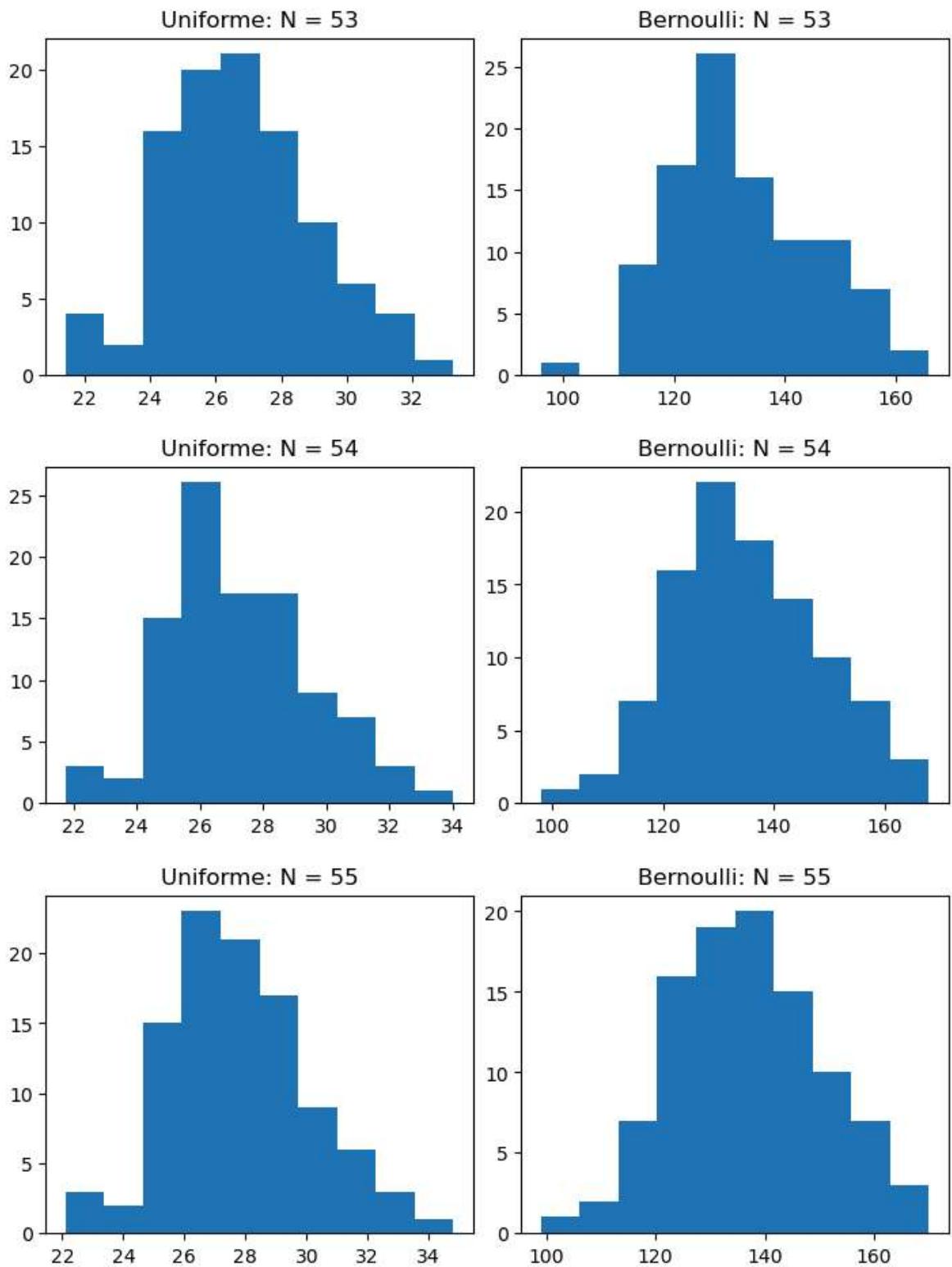
Bernoulli: N = 43

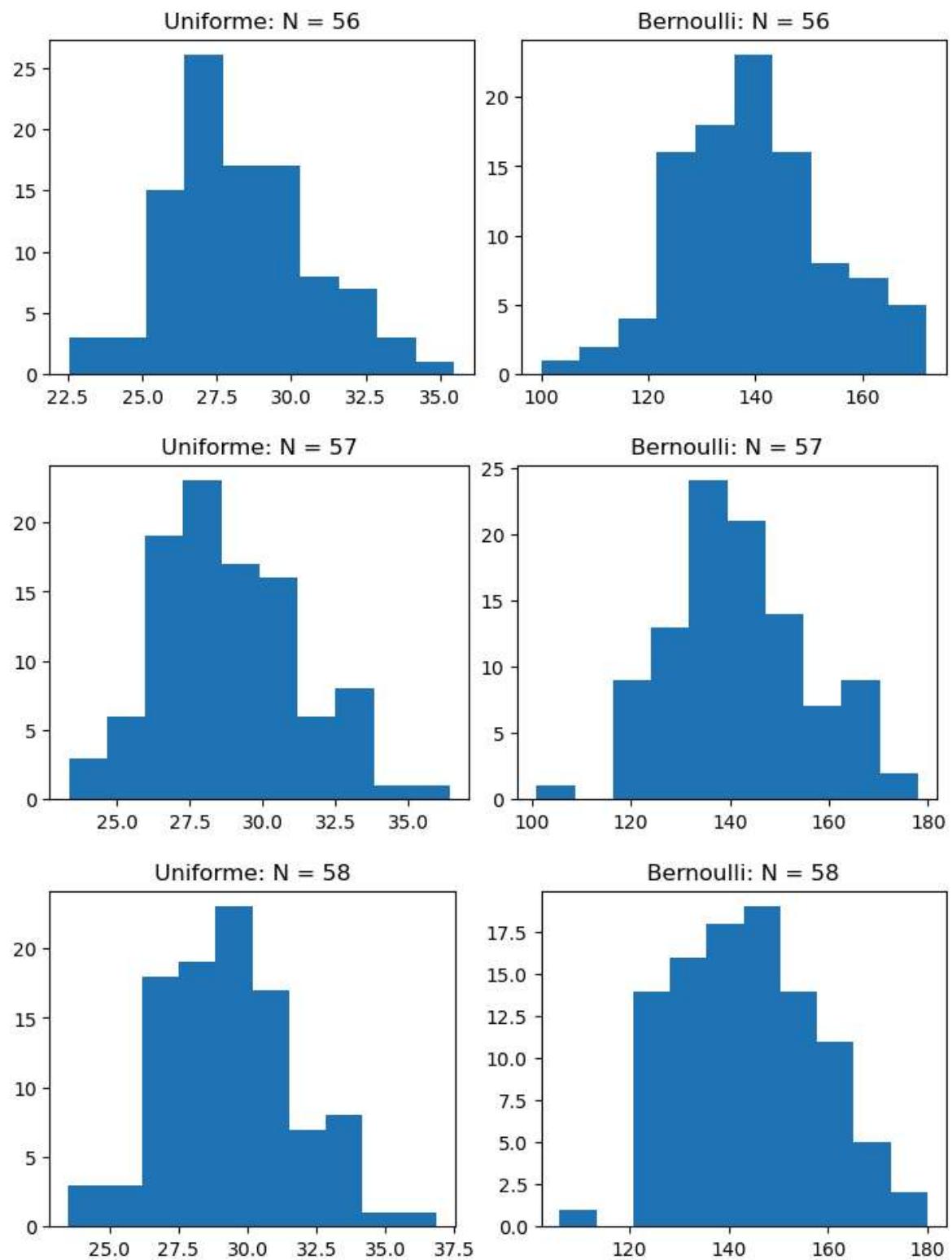


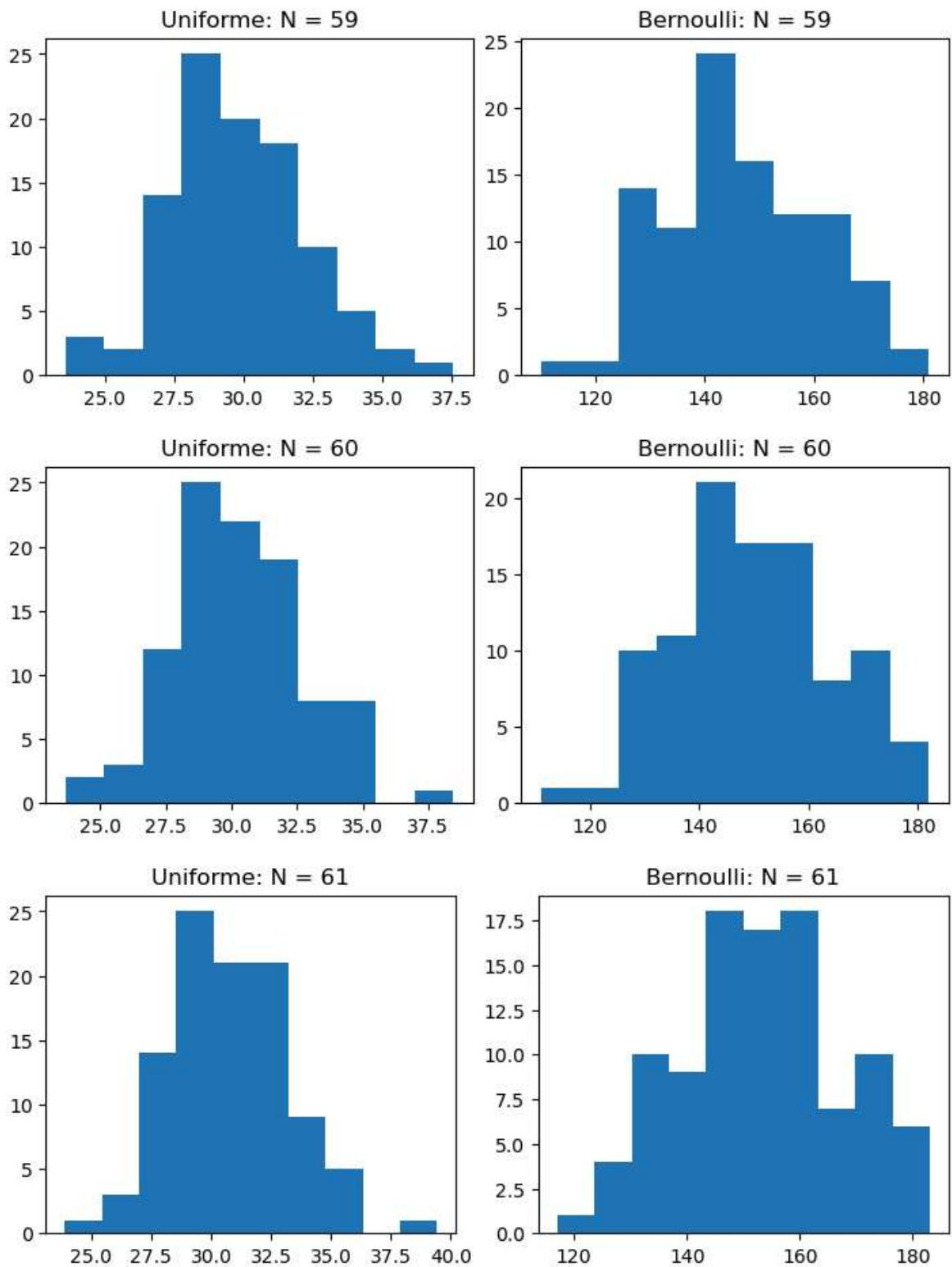




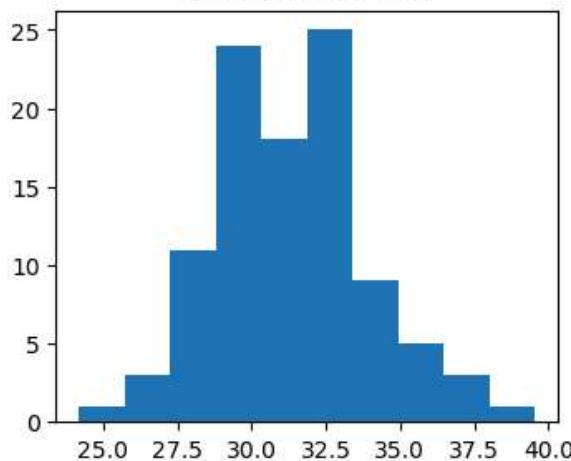




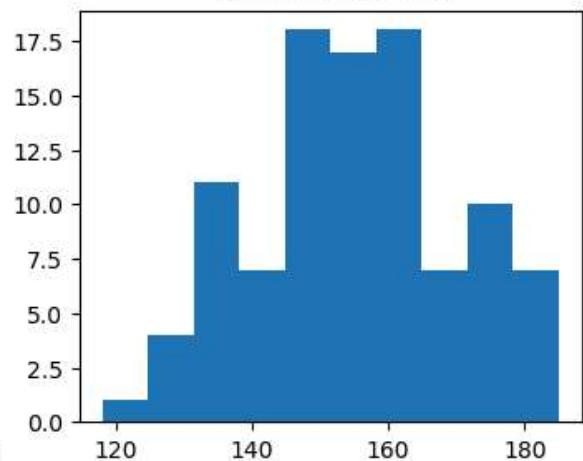




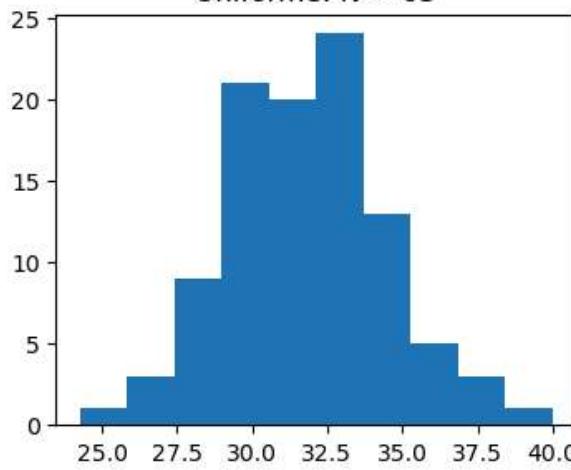
Uniforme: N = 62



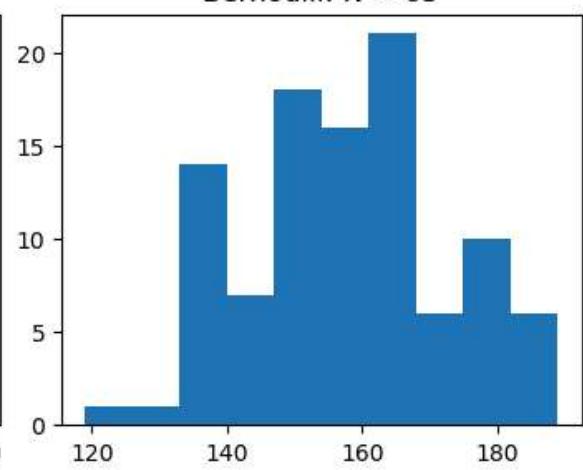
Bernoulli: N = 62



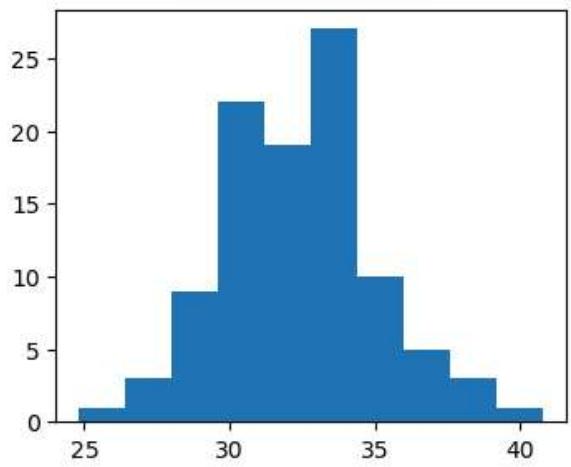
Uniforme: N = 63



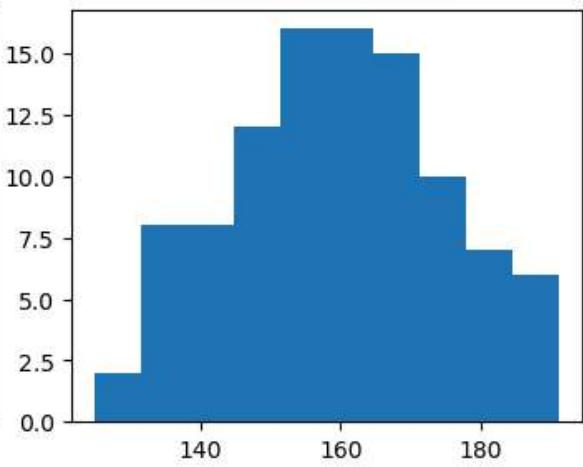
Bernoulli: N = 63



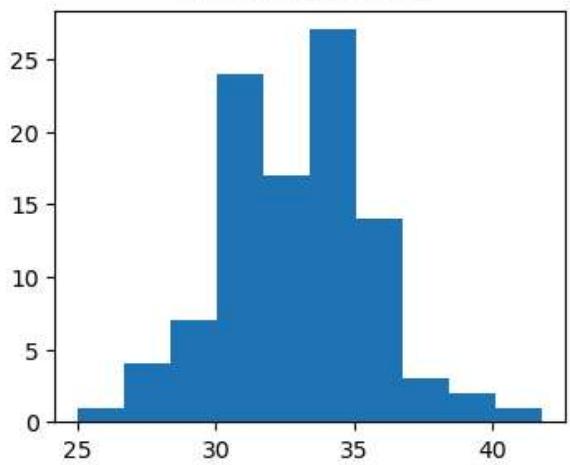
Uniforme: N = 64



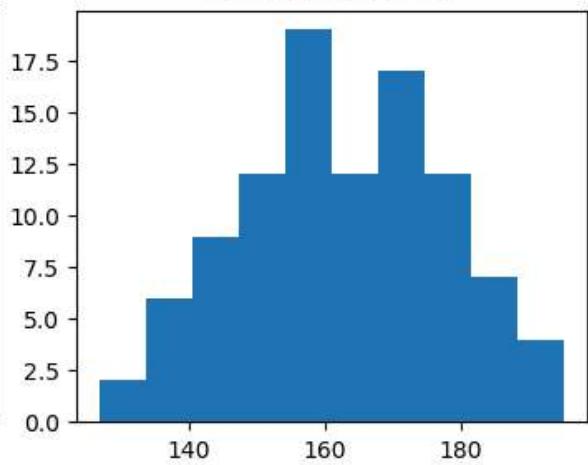
Bernoulli: N = 64



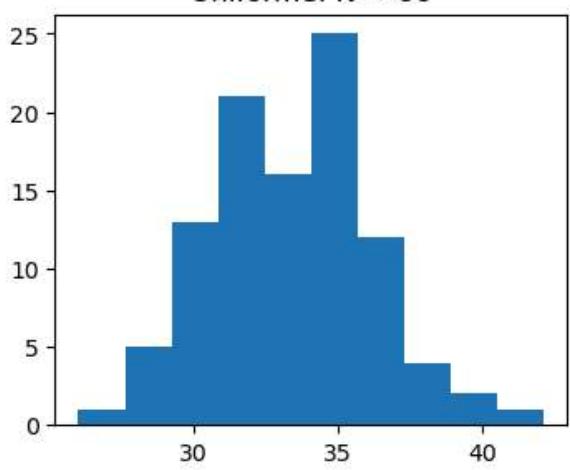
Uniforme: N = 65



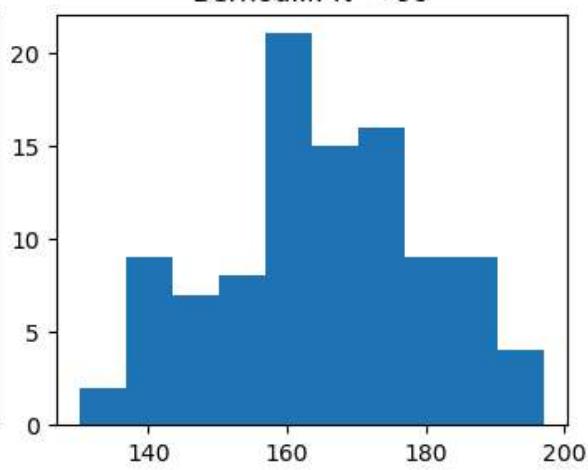
Bernoulli: N = 65



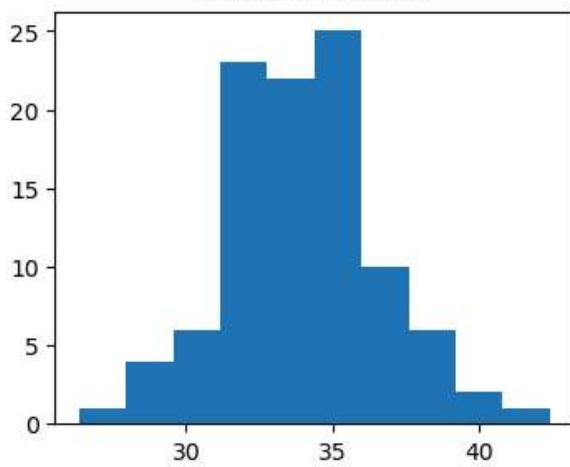
Uniforme: N = 66



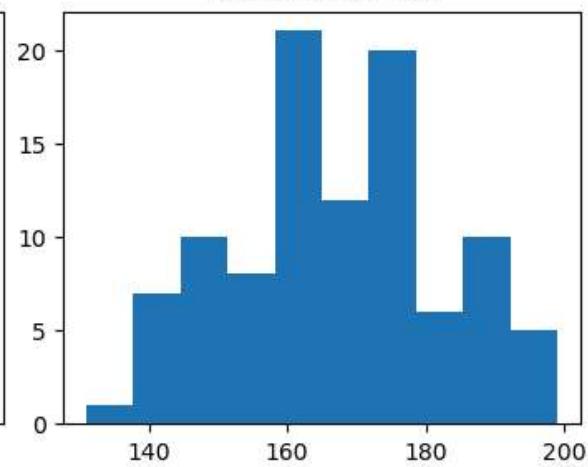
Bernoulli: N = 66

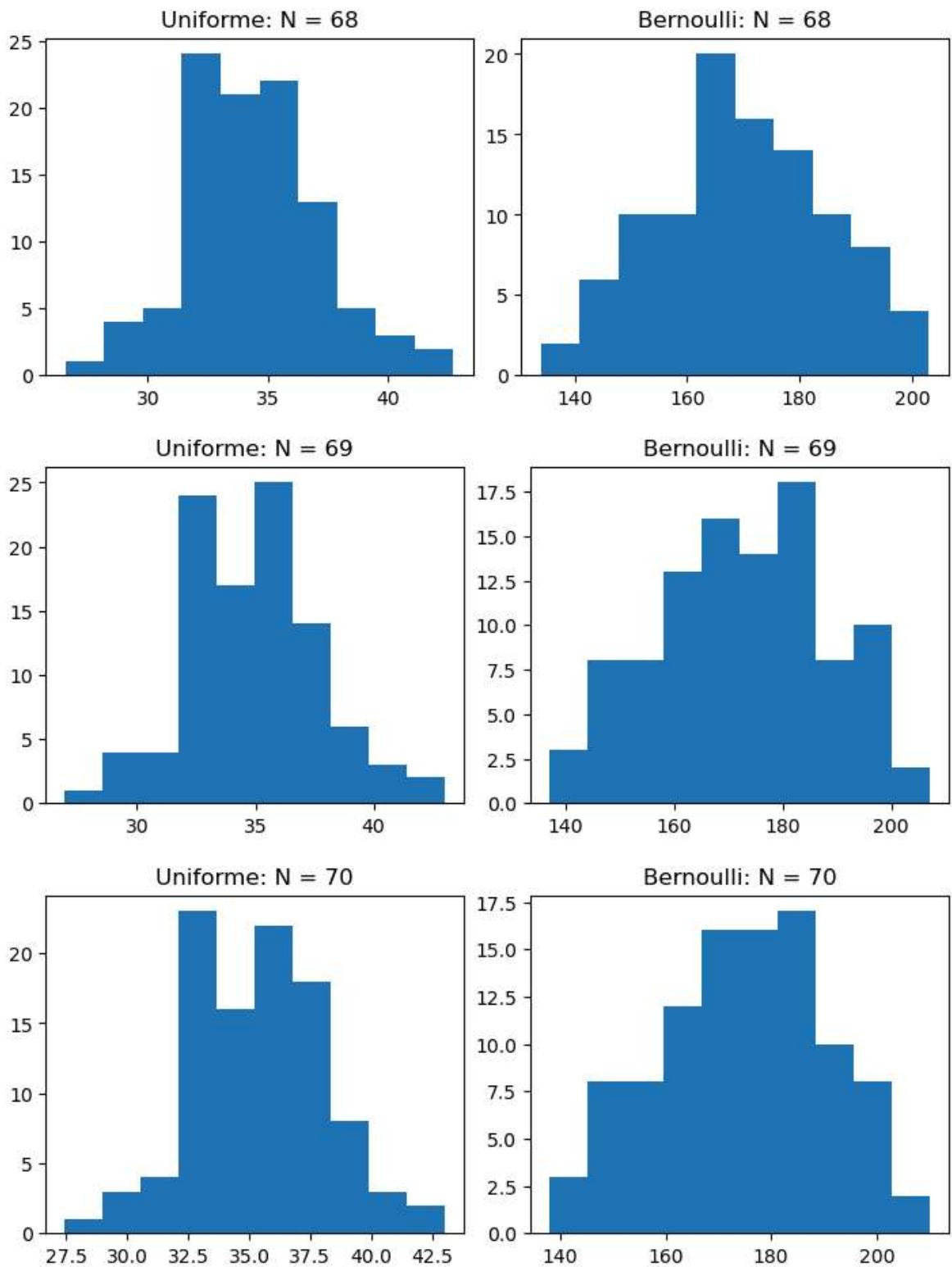


Uniforme: N = 67

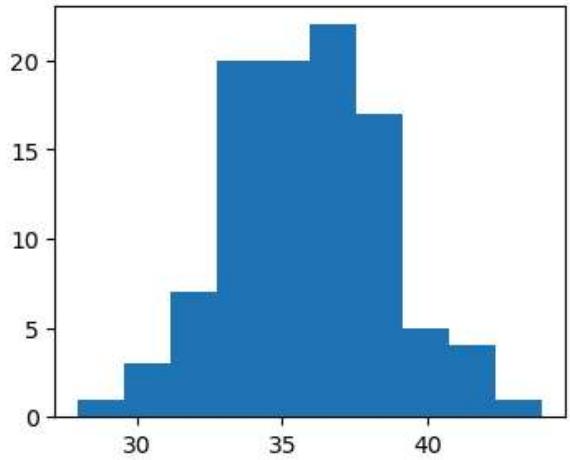


Bernoulli: N = 67

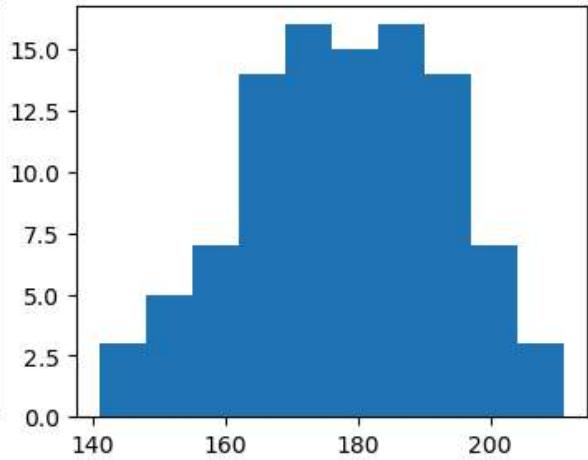




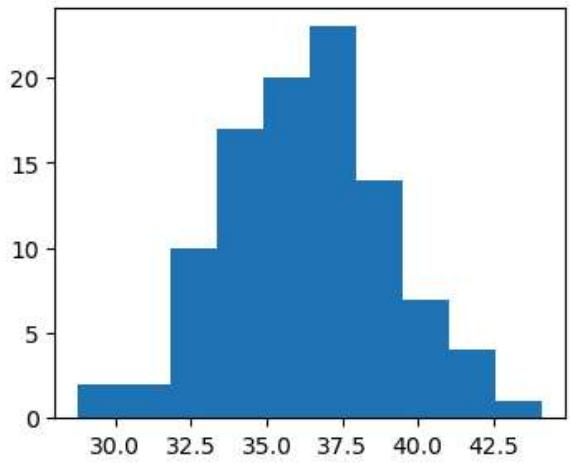
Uniforme: N = 71



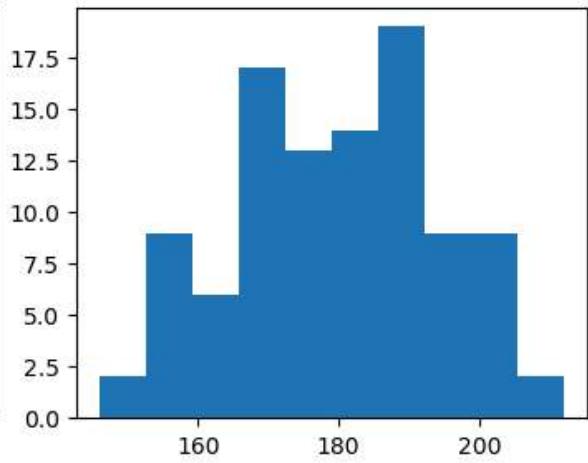
Bernoulli: N = 71



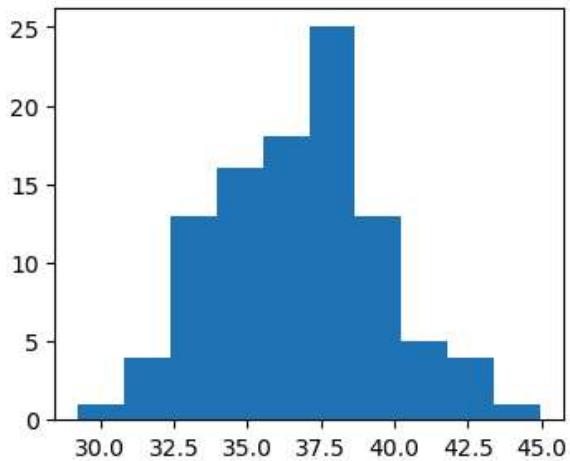
Uniforme: N = 72



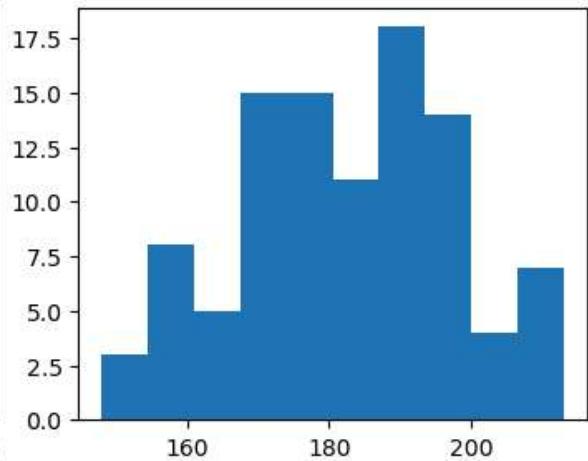
Bernoulli: N = 72

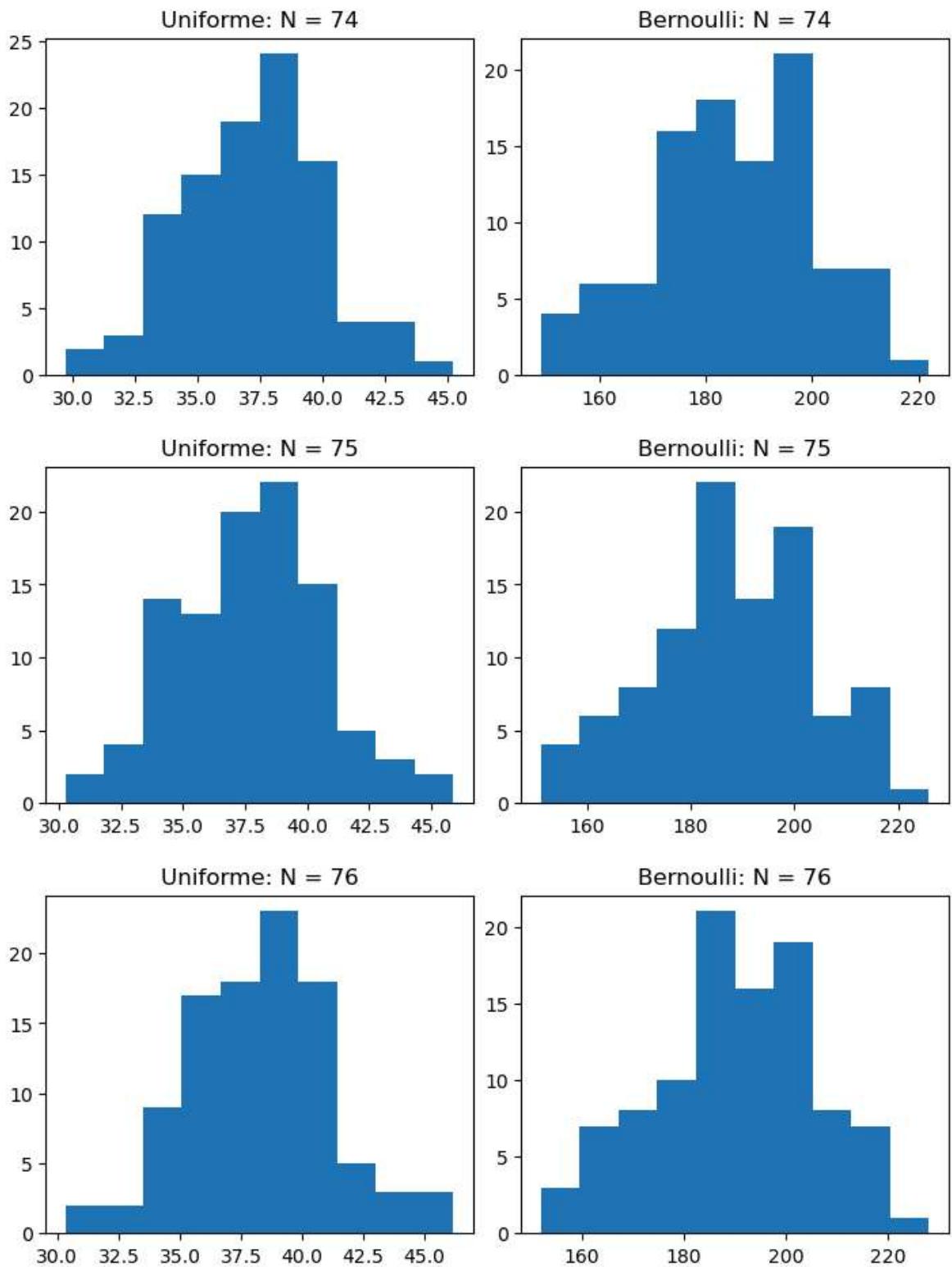


Uniforme: N = 73

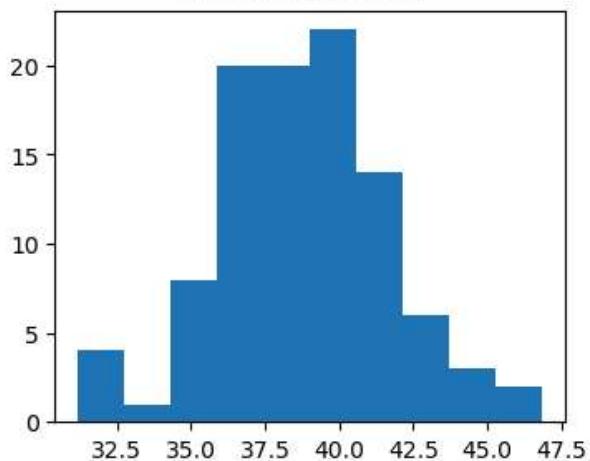


Bernoulli: N = 73

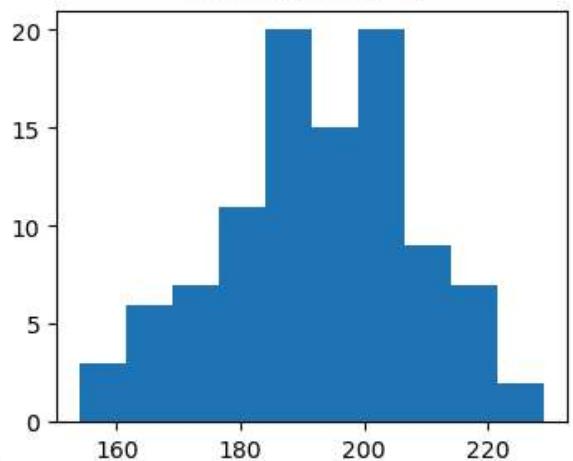




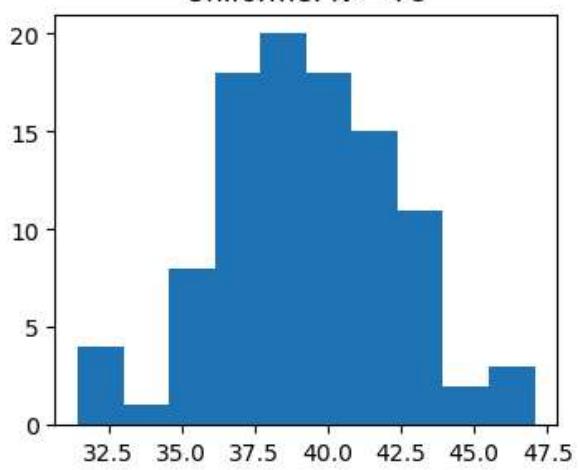
Uniforme: N = 77



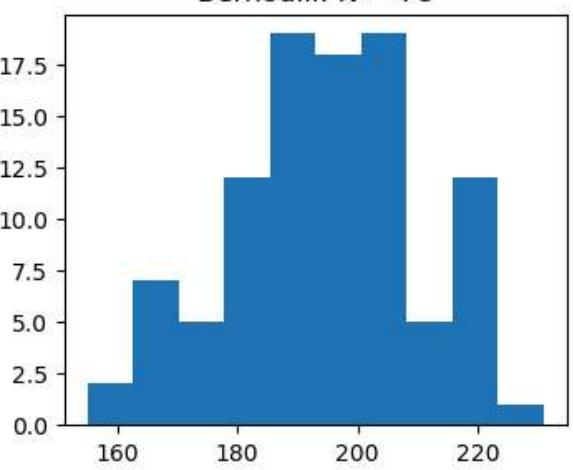
Bernoulli: N = 77



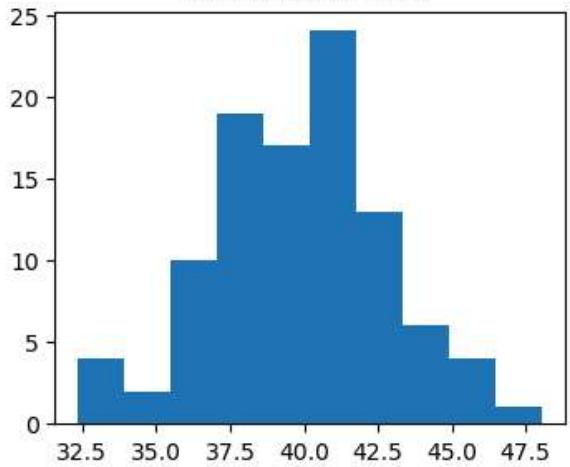
Uniforme: N = 78



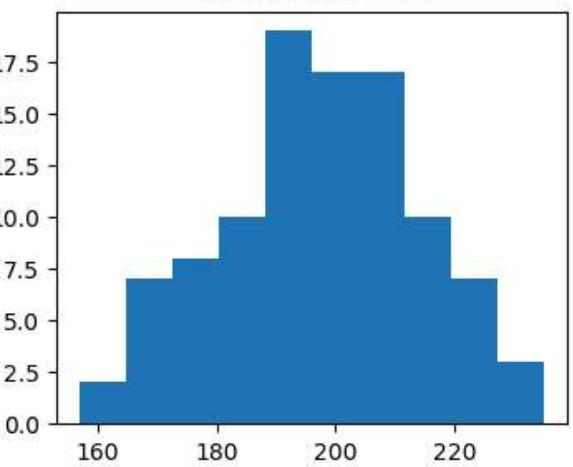
Bernoulli: N = 78

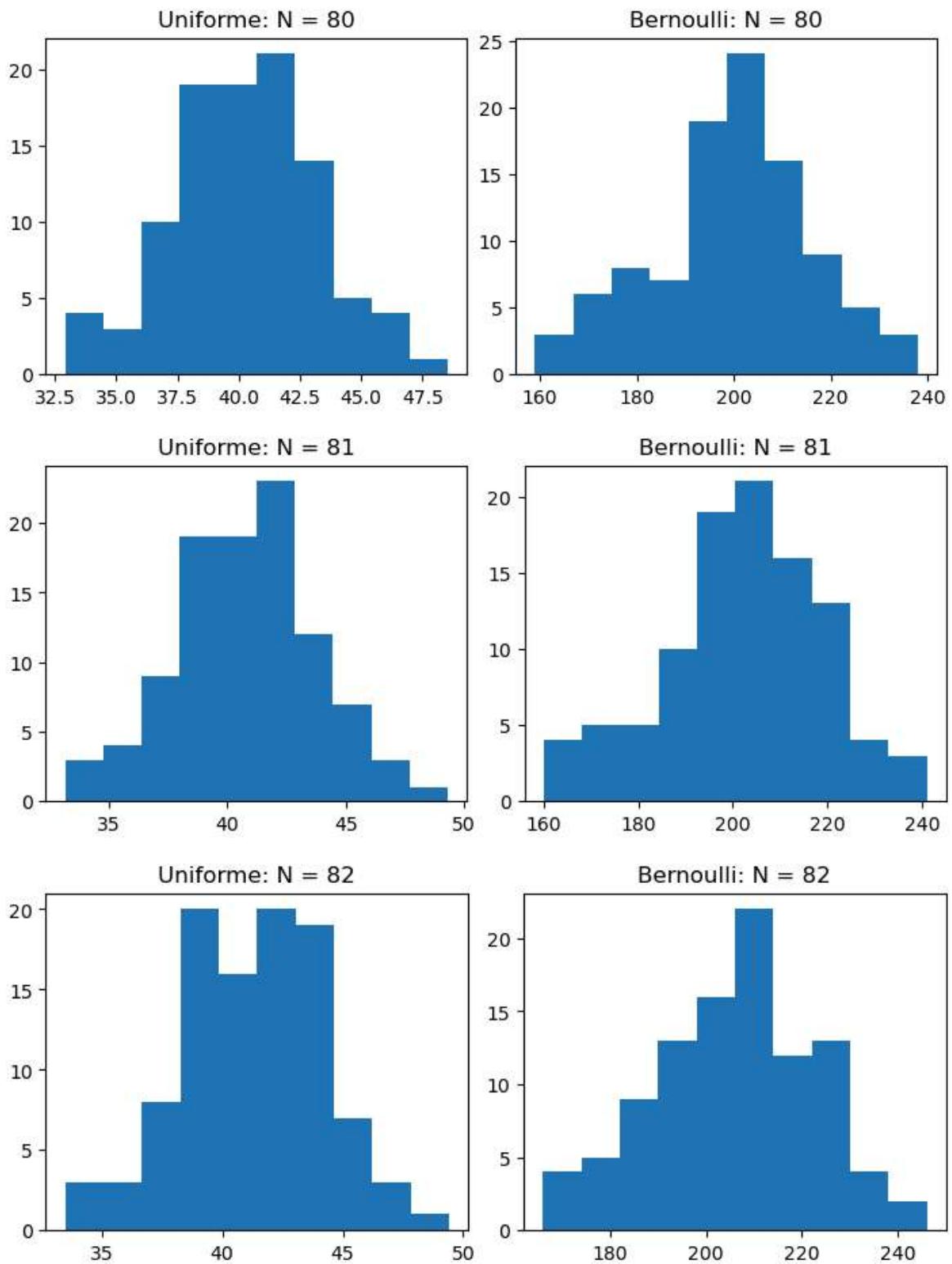


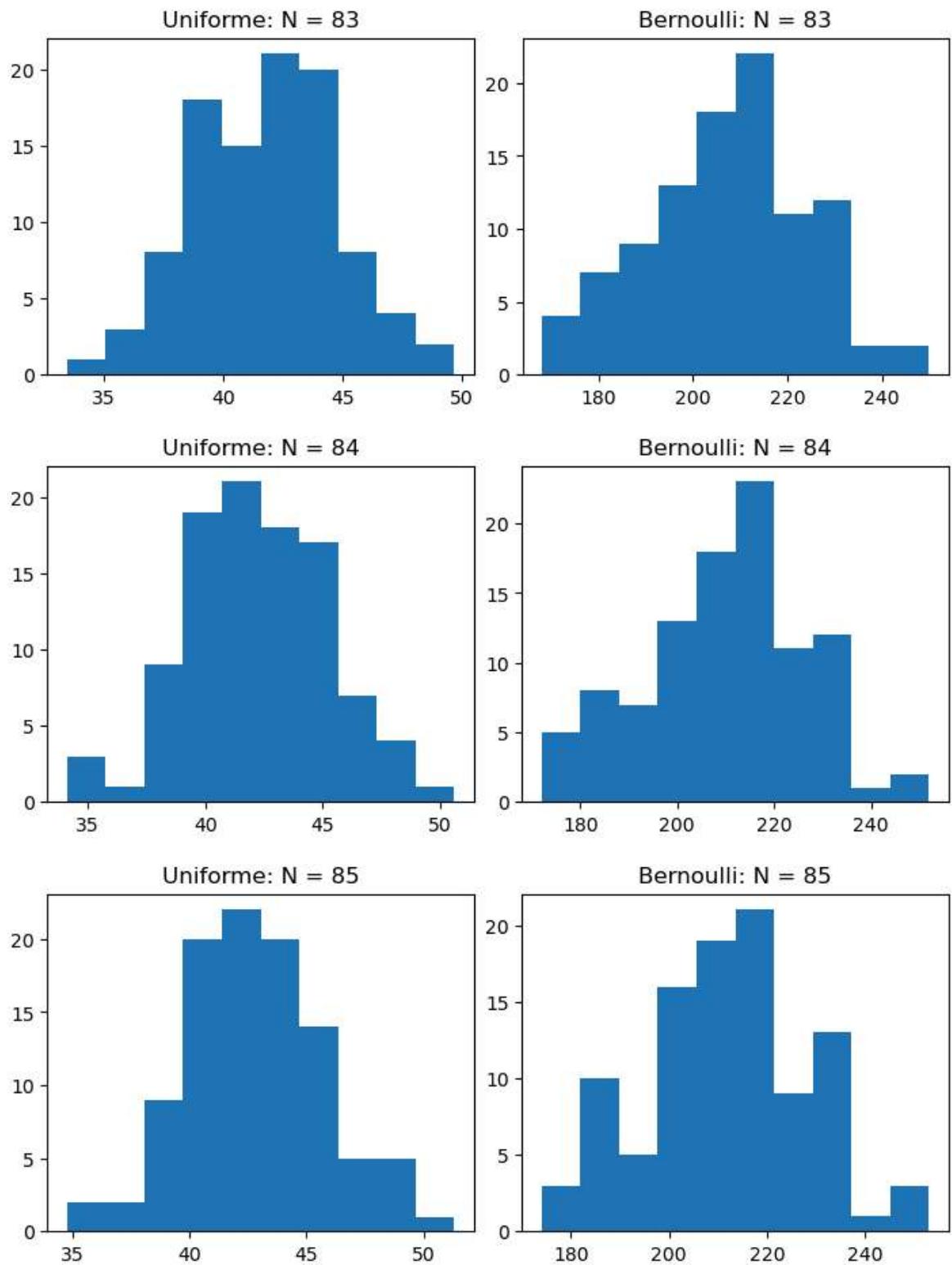
Uniforme: N = 79

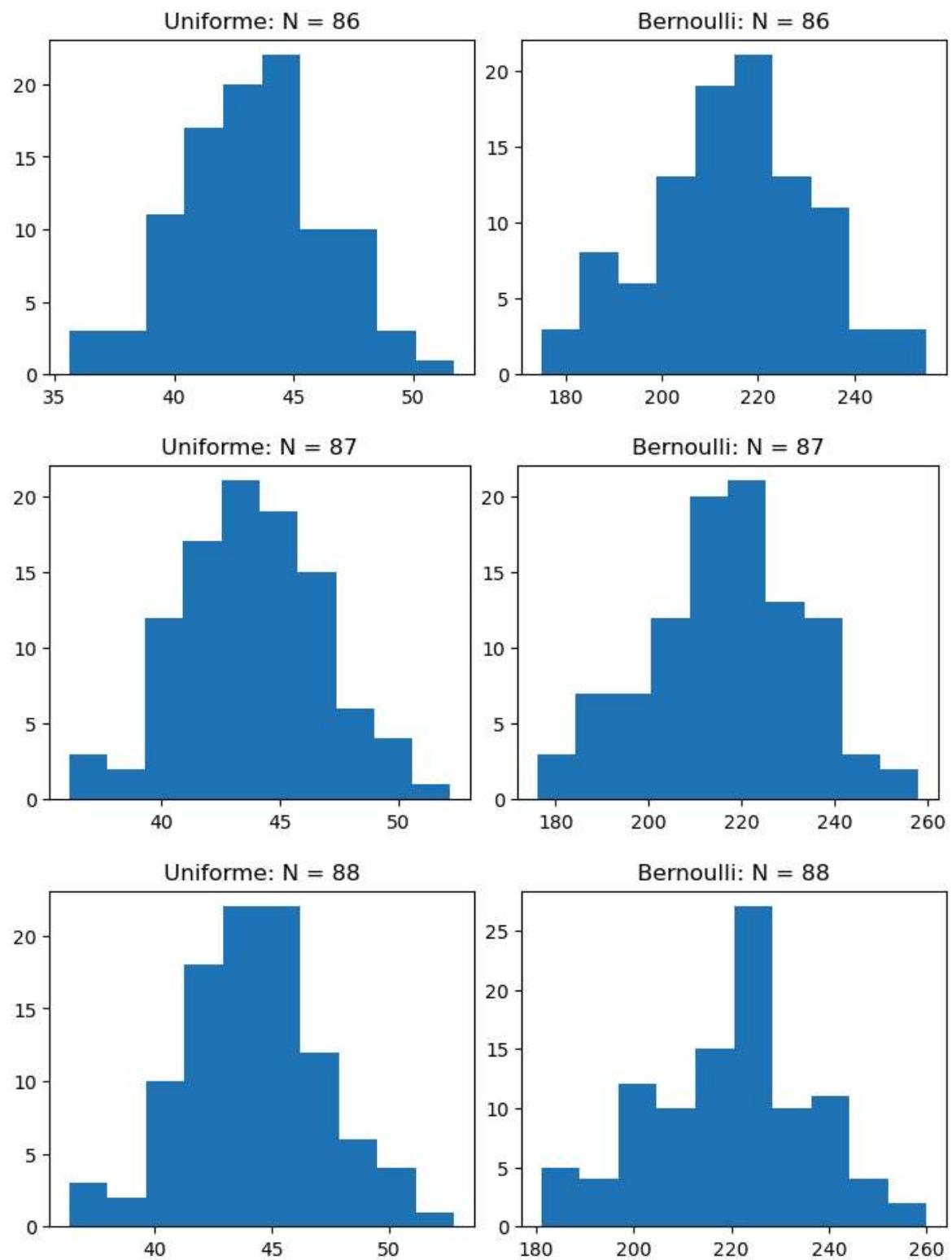


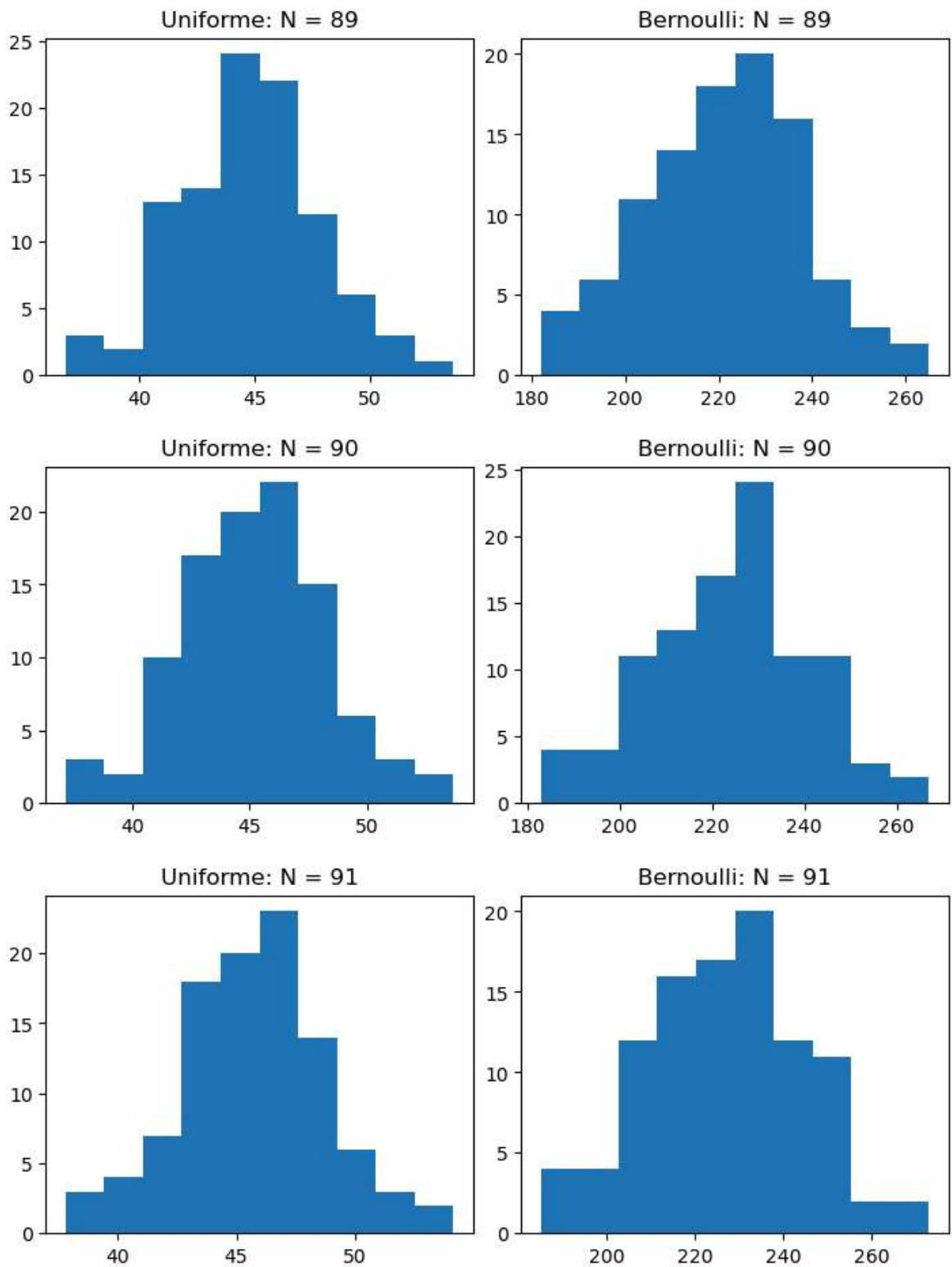
Bernoulli: N = 79

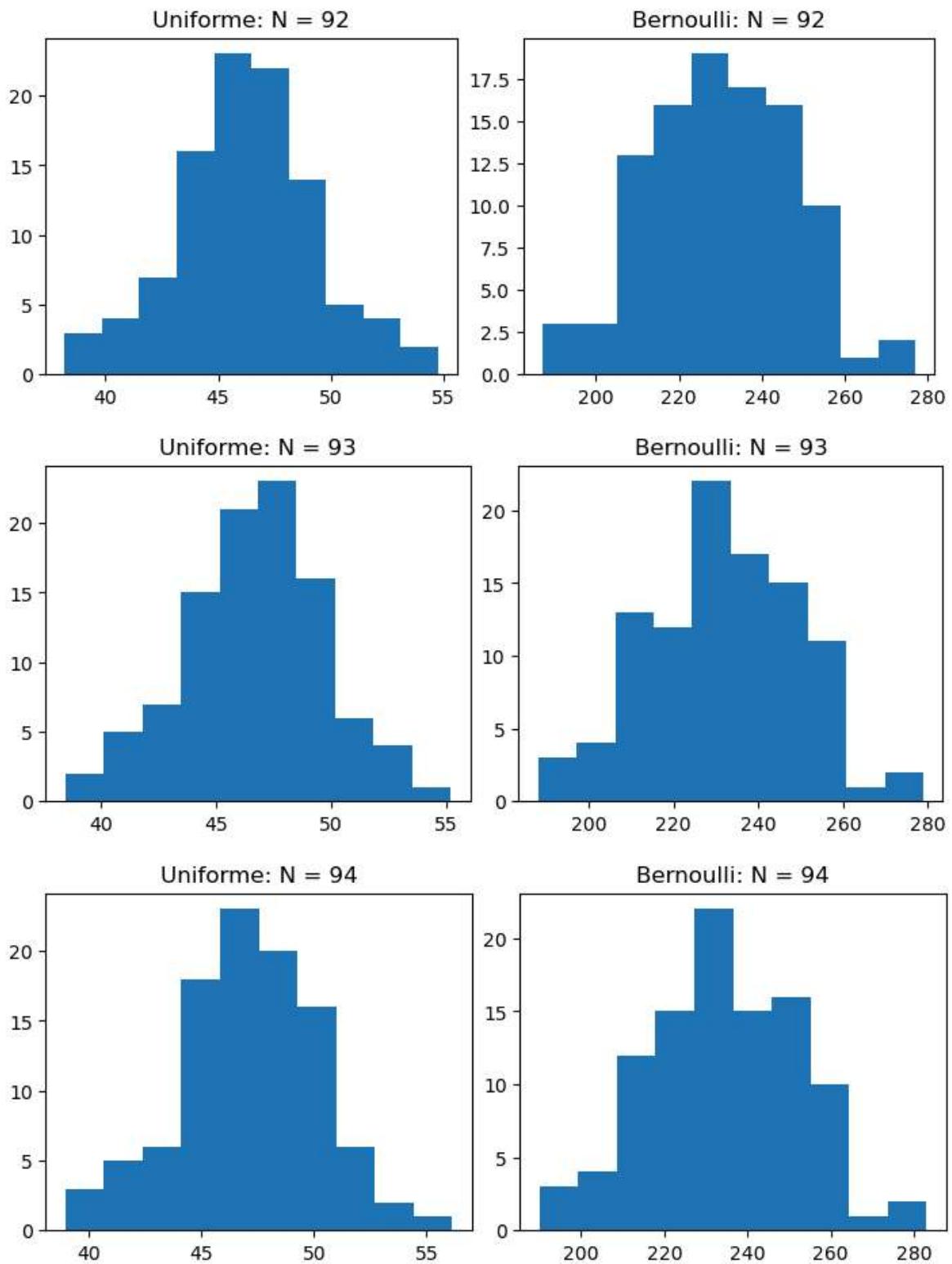




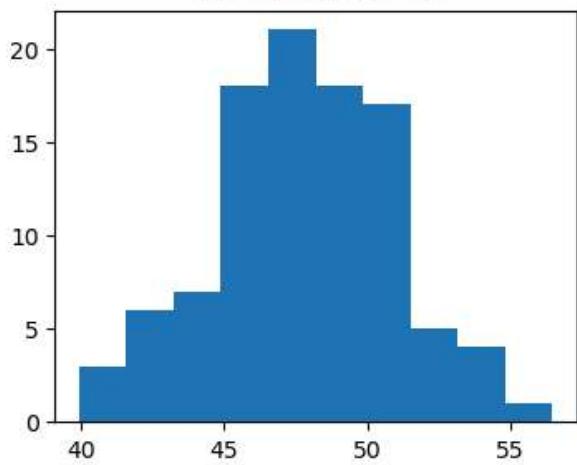




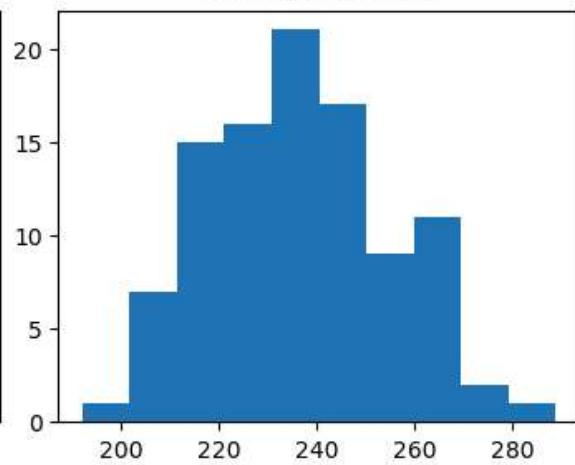




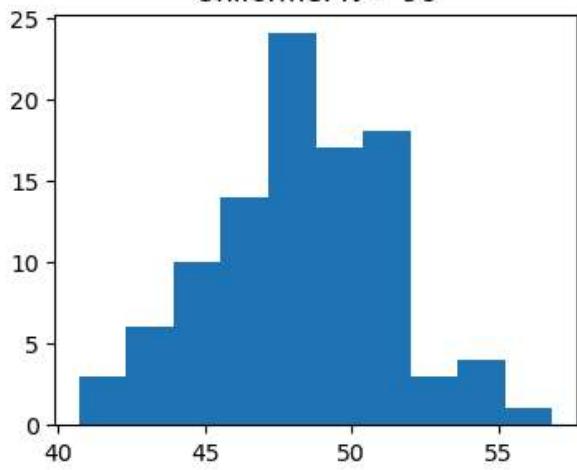
Uniforme: N = 95



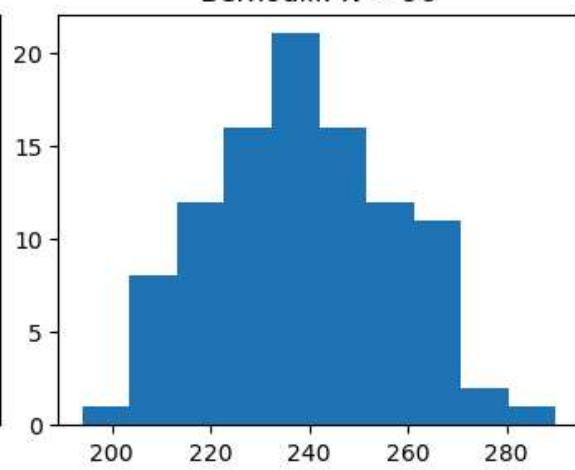
Bernoulli: N = 95



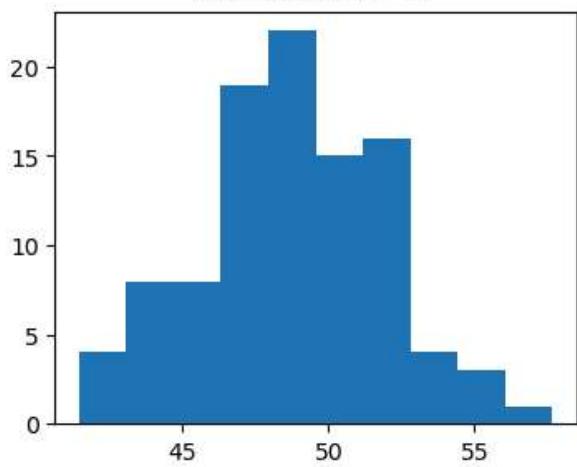
Uniforme: N = 96



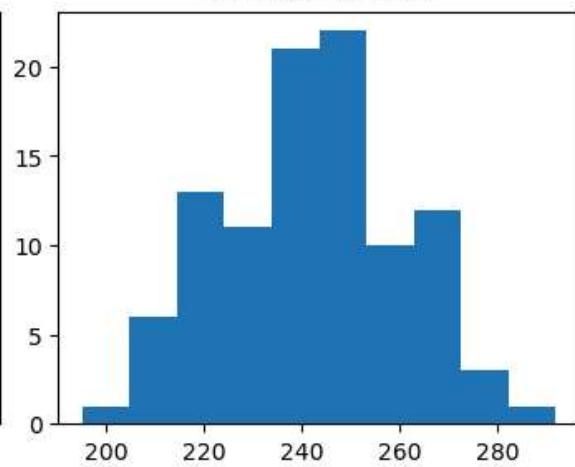
Bernoulli: N = 96

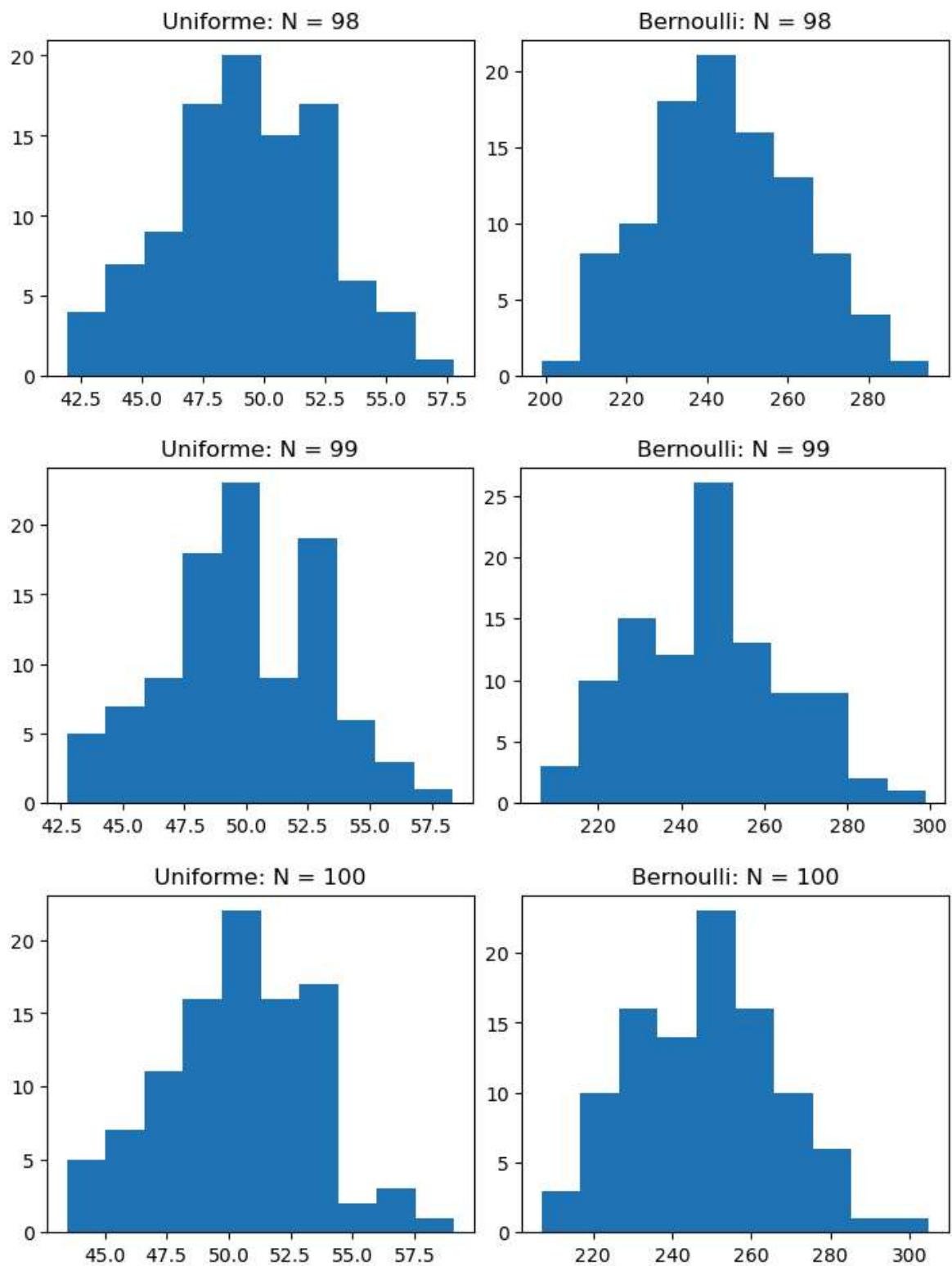


Uniforme: N = 97

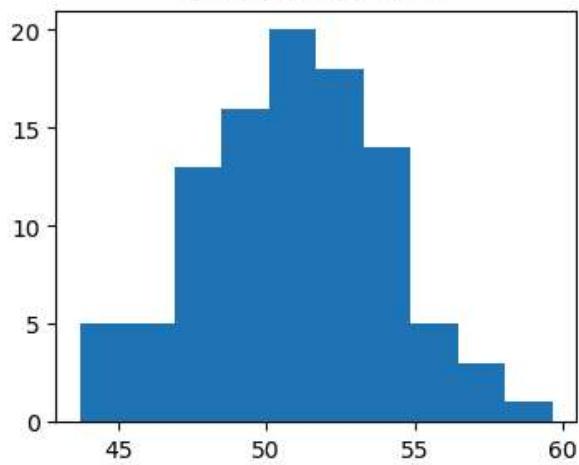


Bernoulli: N = 97

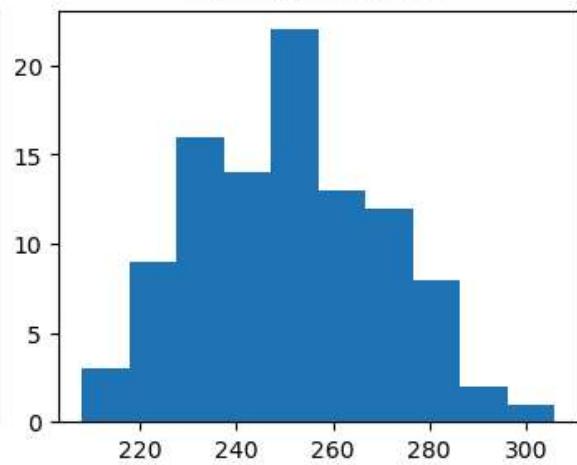




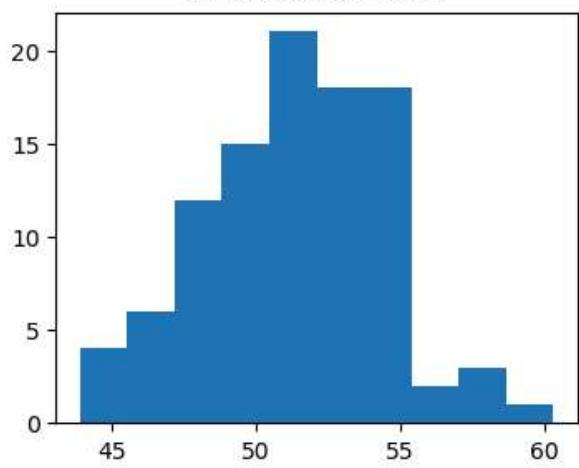
Uniforme: N = 101



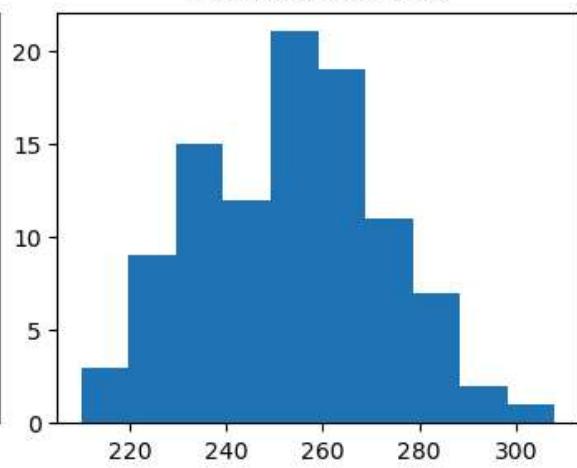
Bernoulli: N = 101



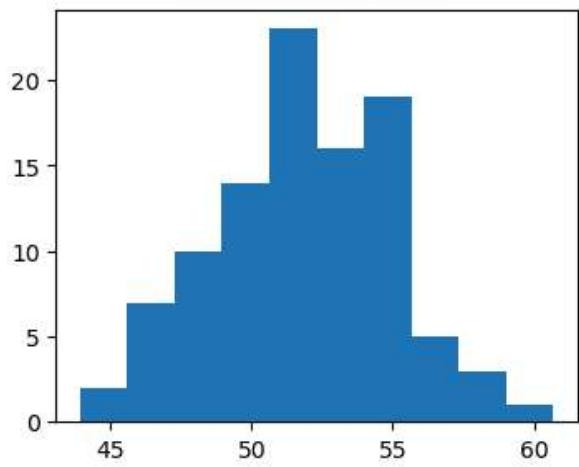
Uniforme: N = 102



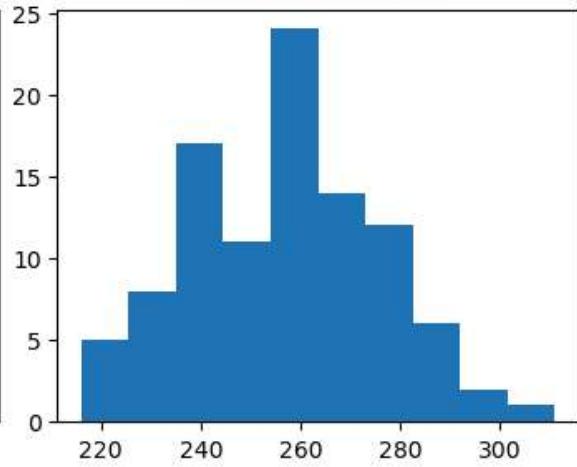
Bernoulli: N = 102

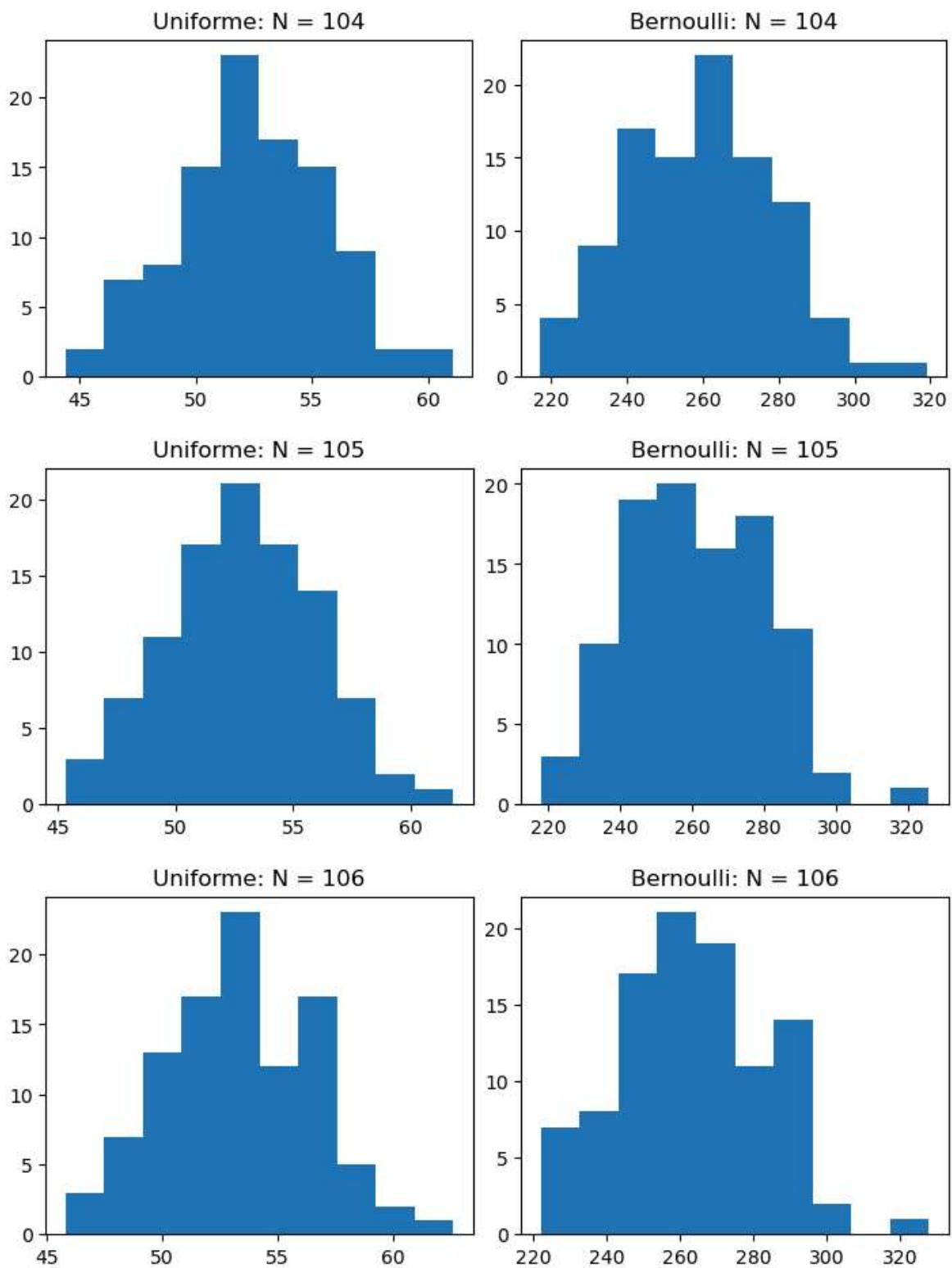


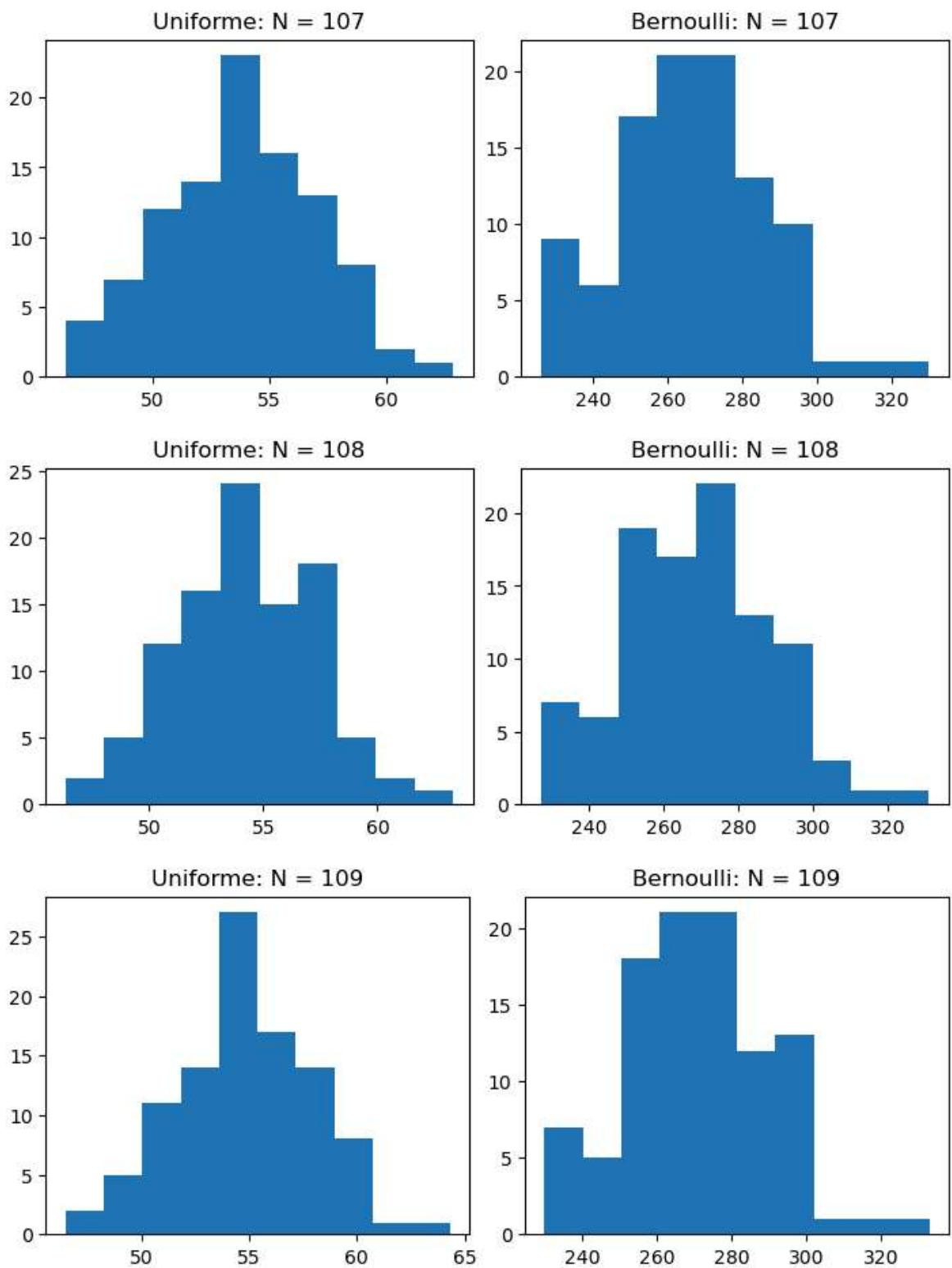
Uniforme: N = 103

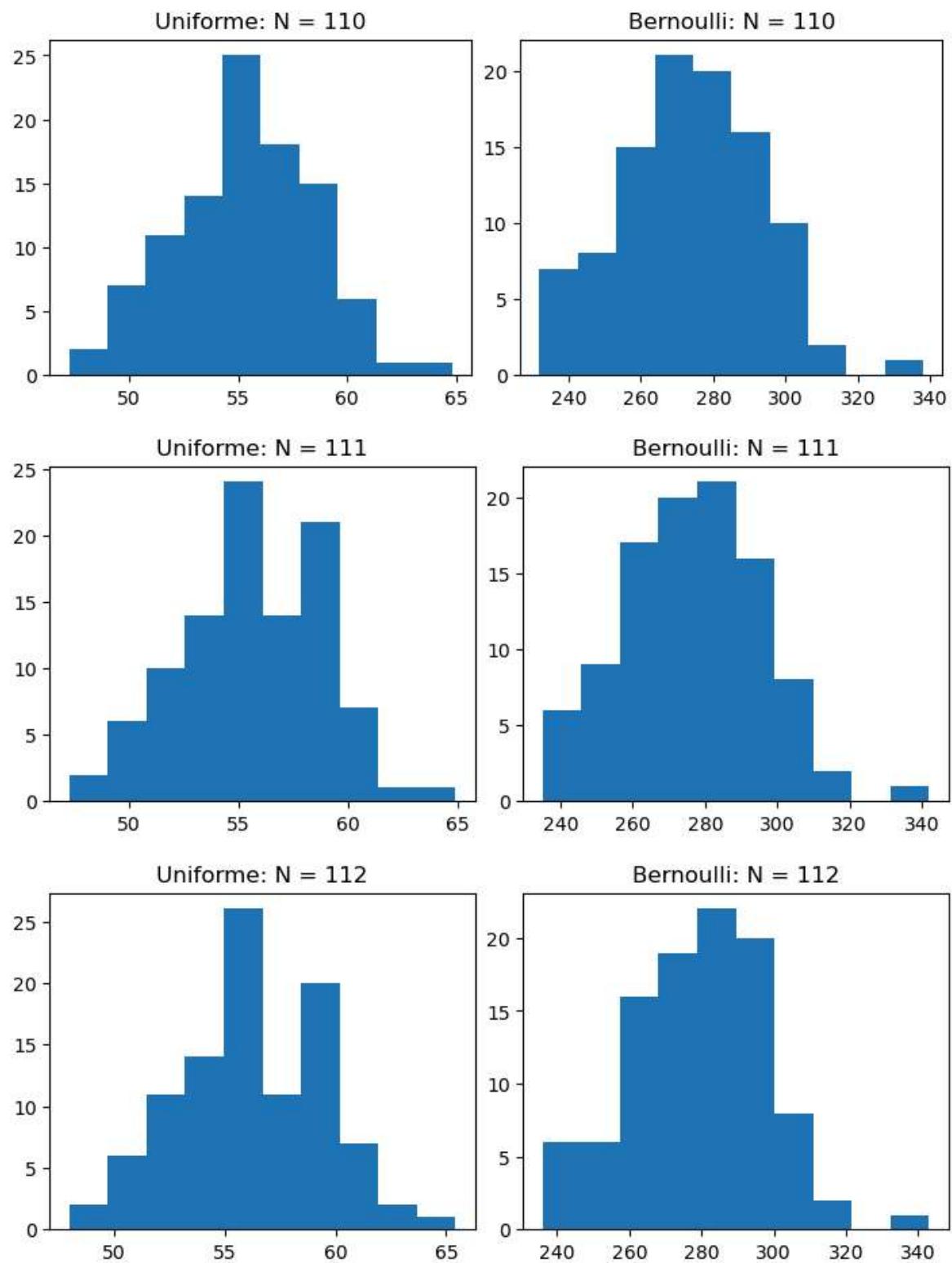


Bernoulli: N = 103

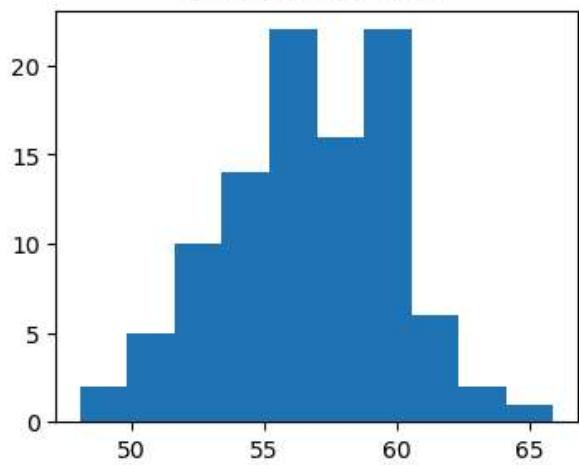




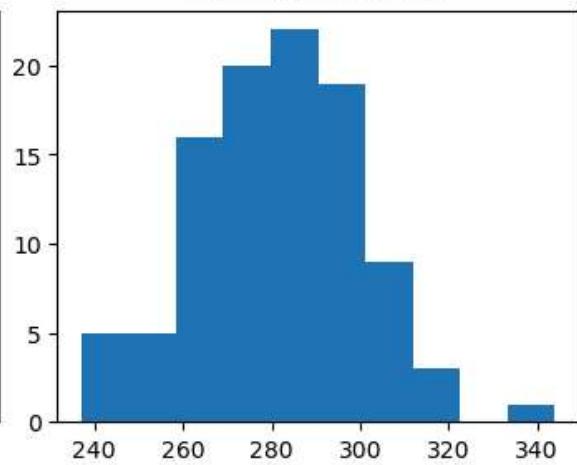




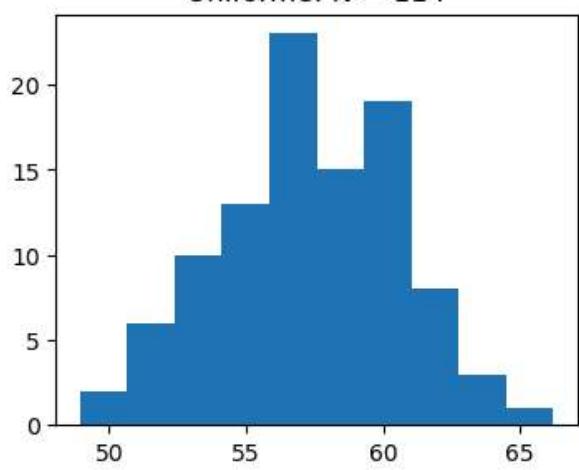
Uniforme: N = 113



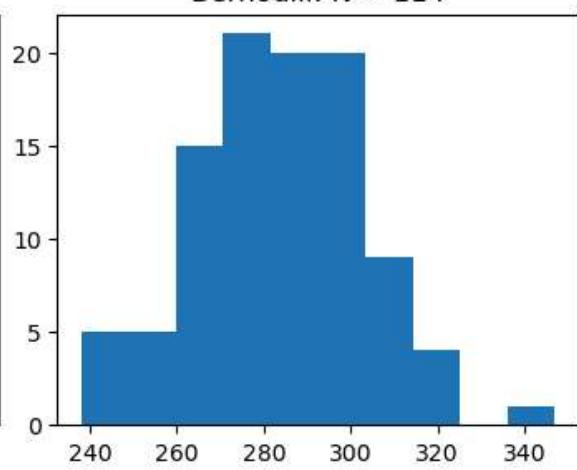
Bernoulli: N = 113



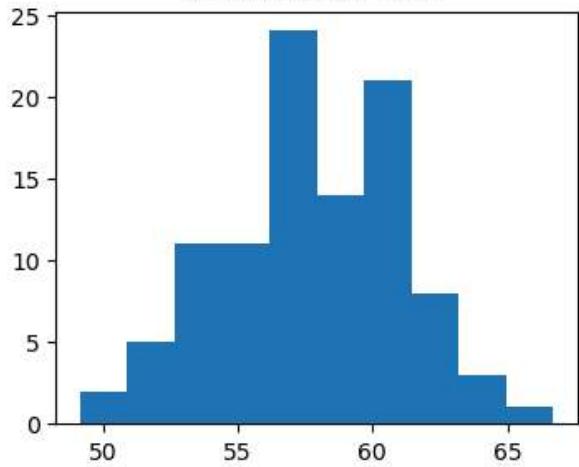
Uniforme: N = 114



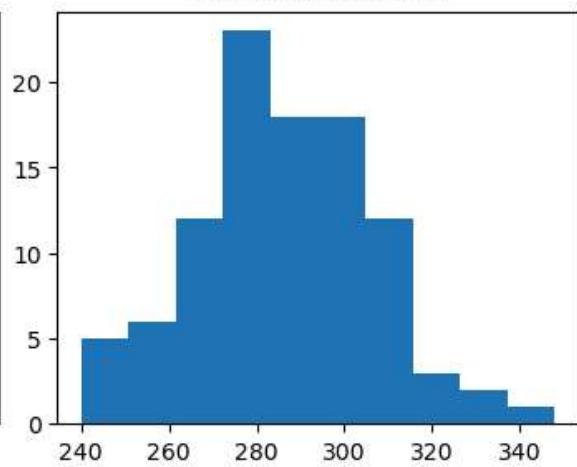
Bernoulli: N = 114



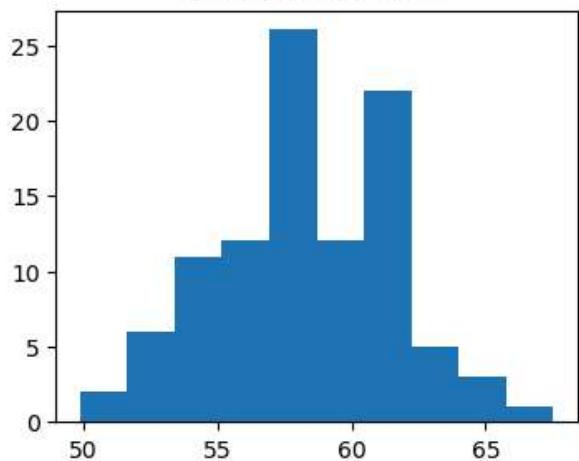
Uniforme: N = 115



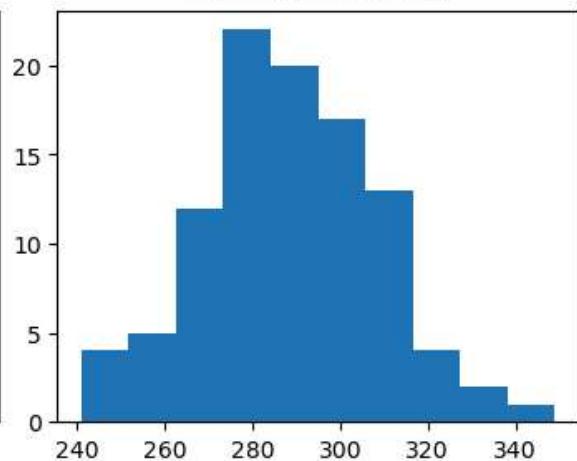
Bernoulli: N = 115



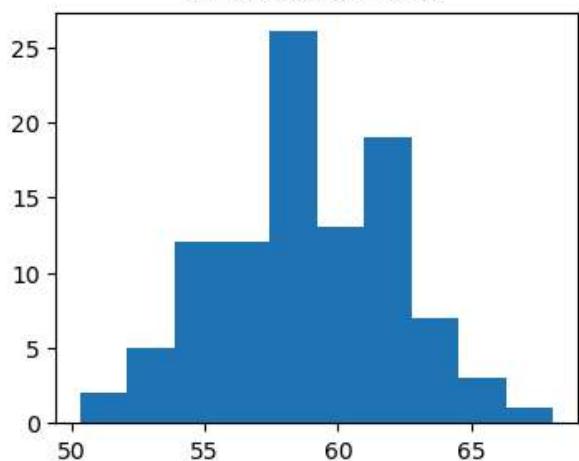
Uniforme: N = 116



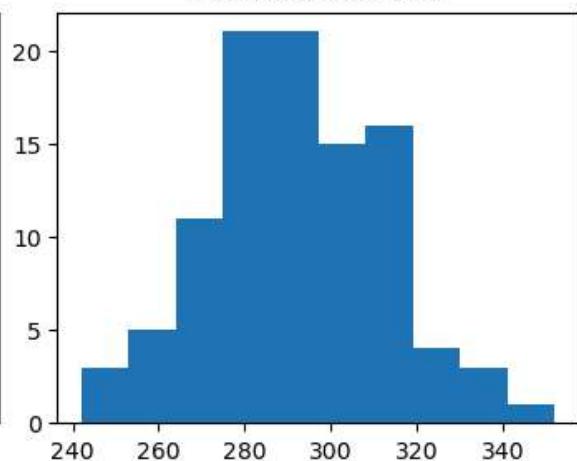
Bernoulli: N = 116



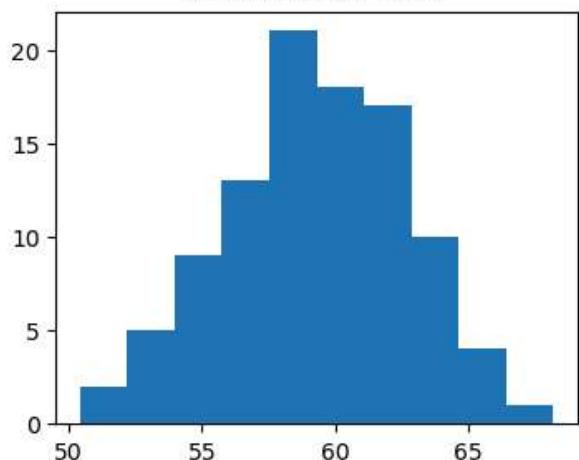
Uniforme: N = 117



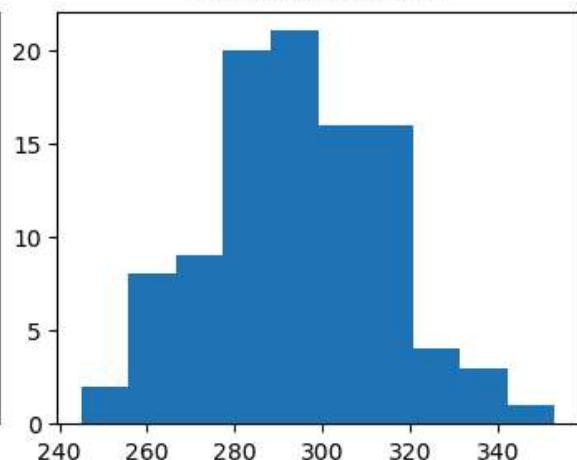
Bernoulli: N = 117

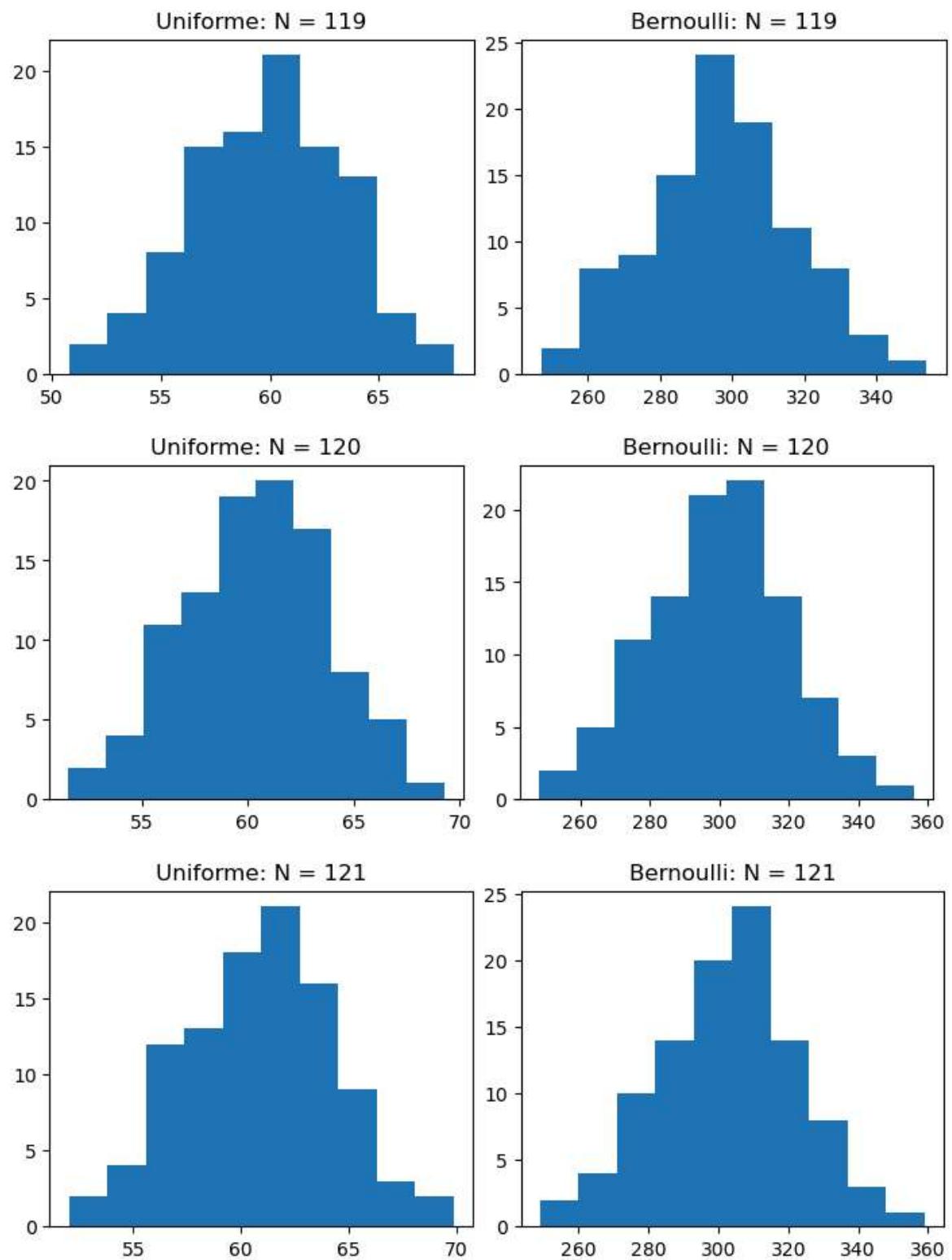


Uniforme: N = 118

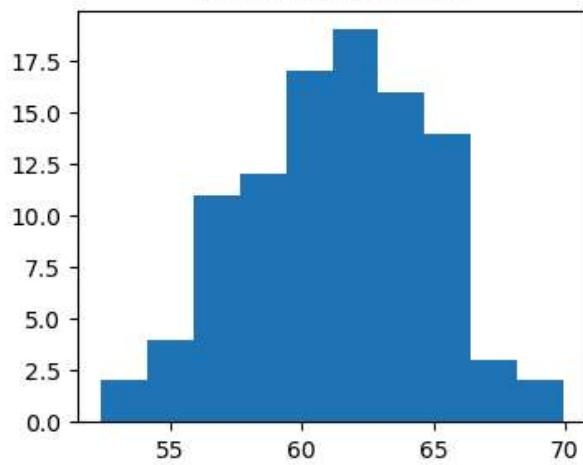


Bernoulli: N = 118

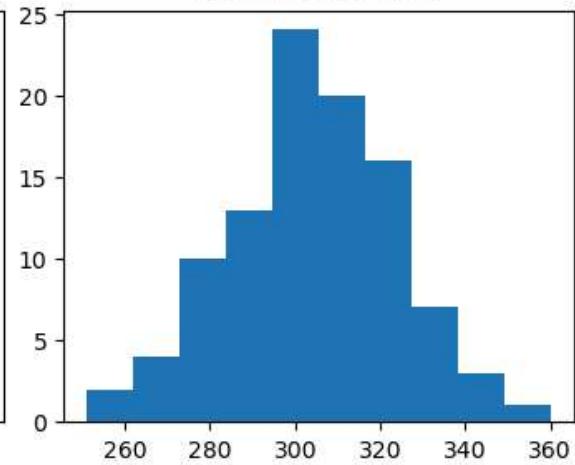




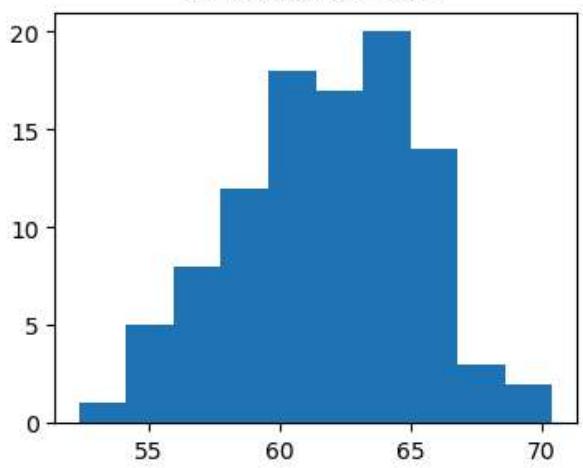
Uniforme: N = 122



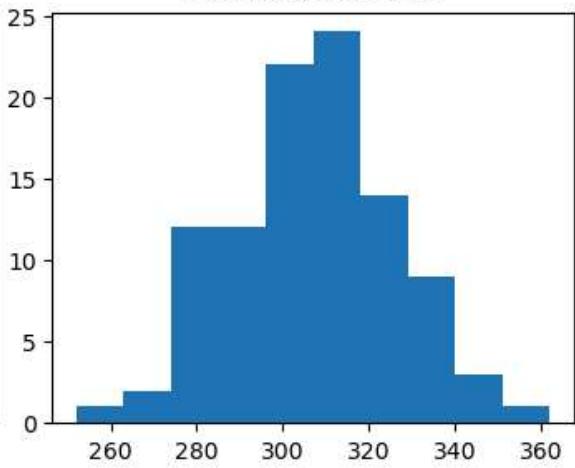
Bernoulli: N = 122



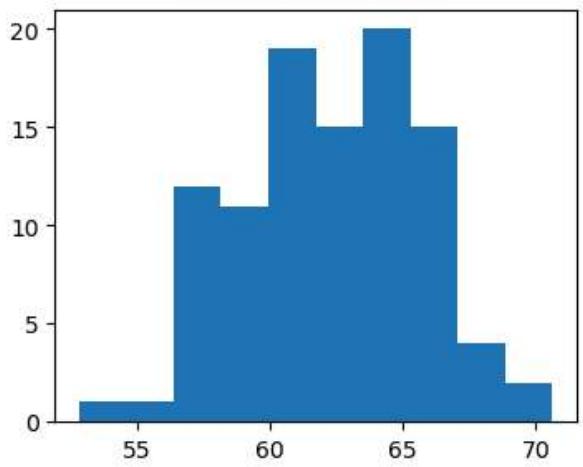
Uniforme: N = 123



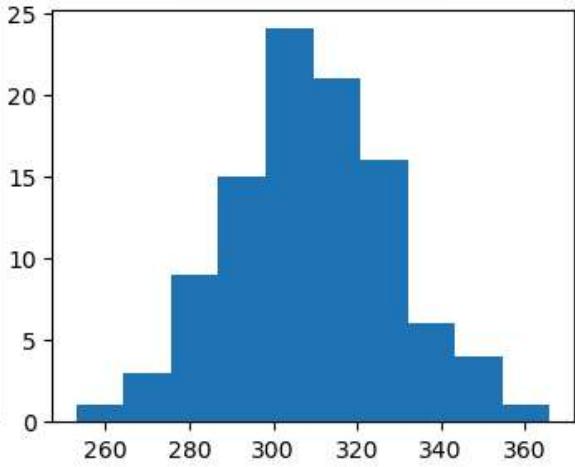
Bernoulli: N = 123



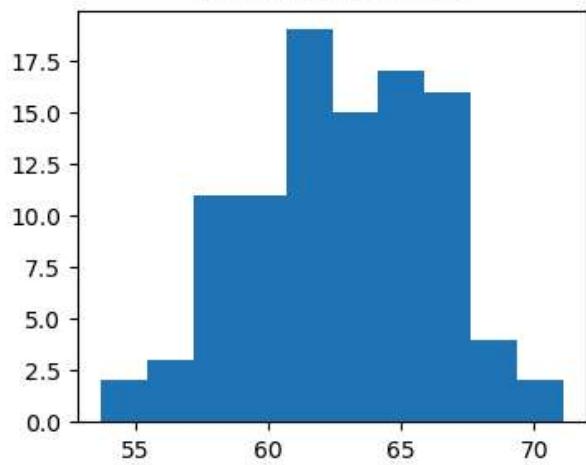
Uniforme: N = 124



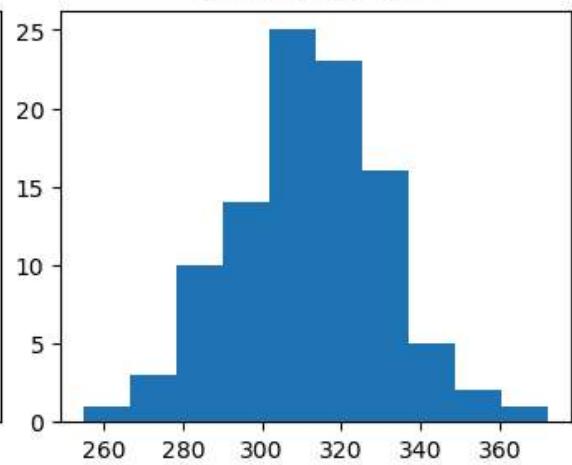
Bernoulli: N = 124



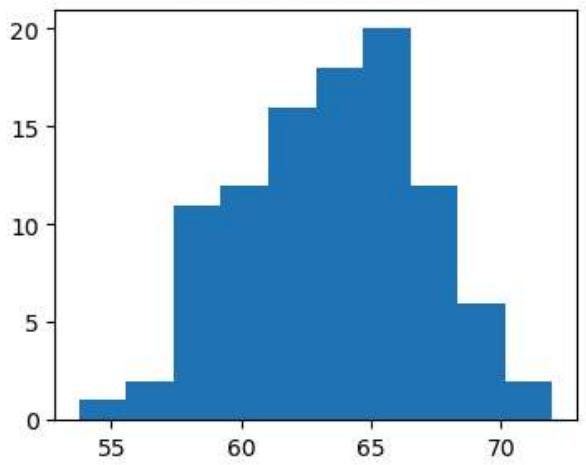
Uniforme: N = 125



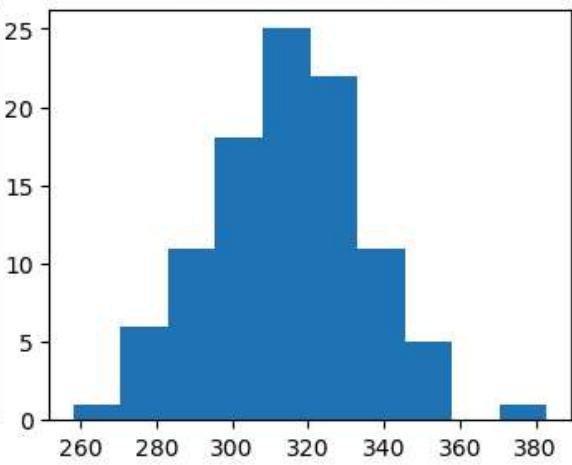
Bernoulli: N = 125



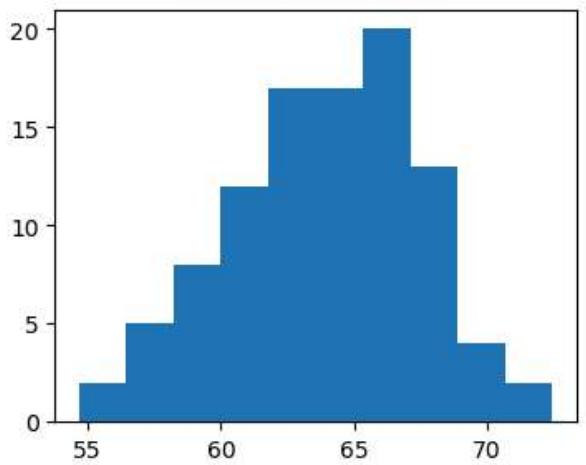
Uniforme: N = 126



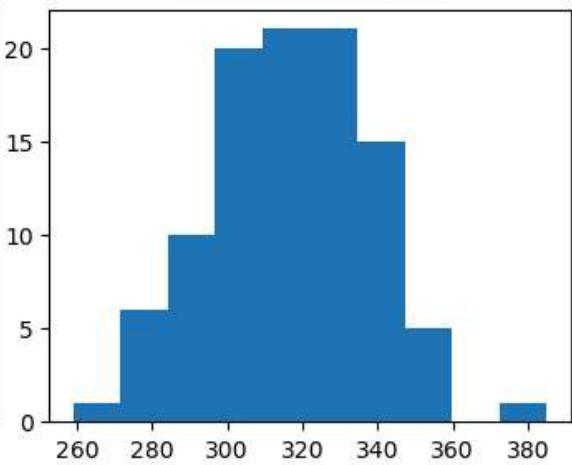
Bernoulli: N = 126



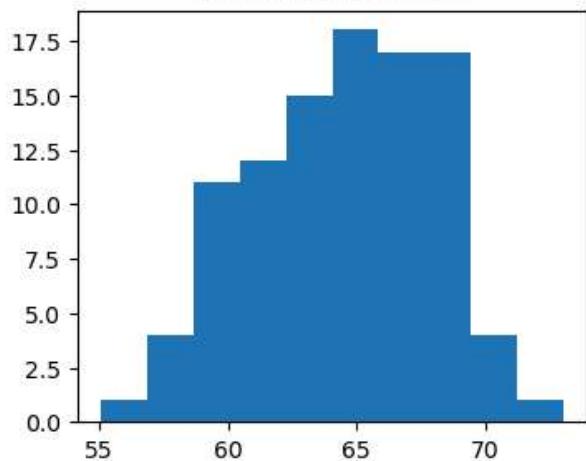
Uniforme: N = 127



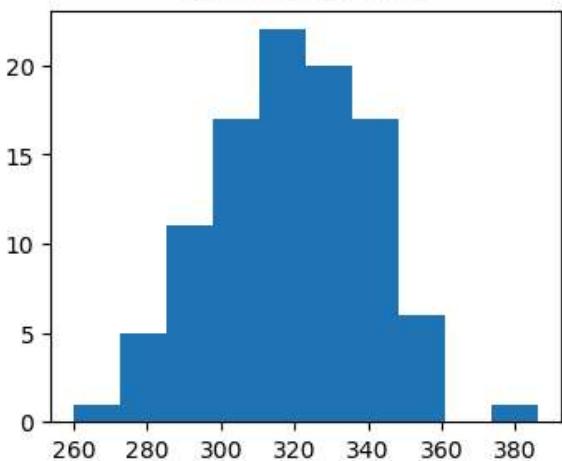
Bernoulli: N = 127



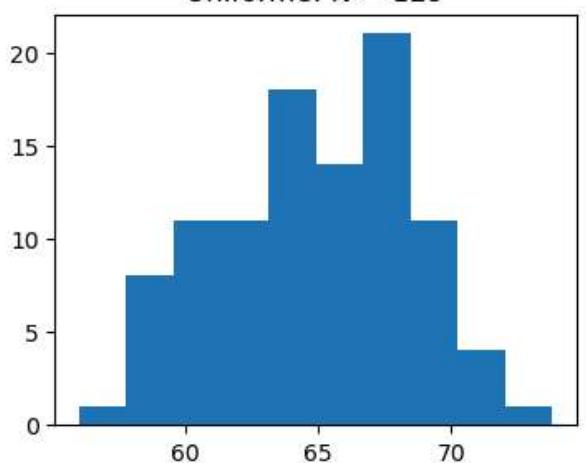
Uniforme: N = 128



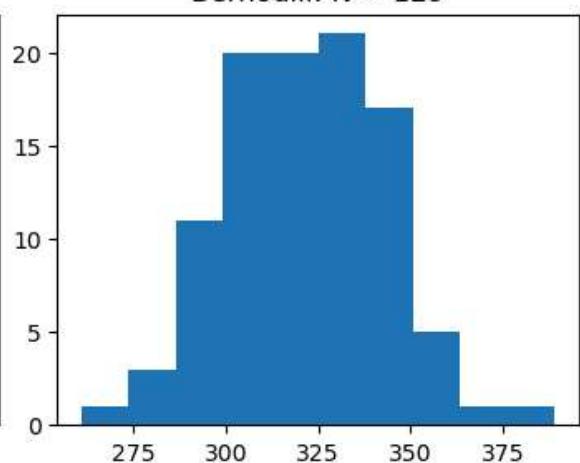
Bernoulli: N = 128



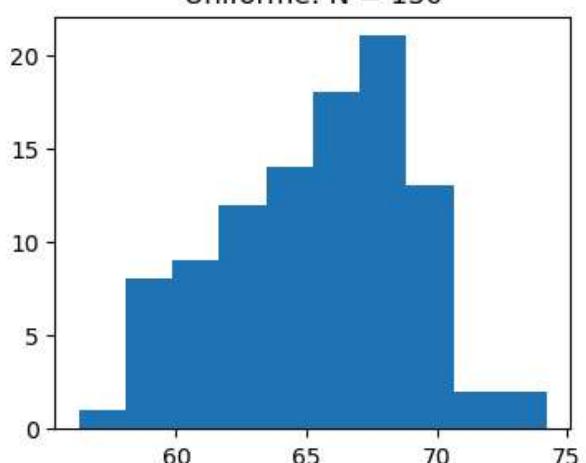
Uniforme: N = 129



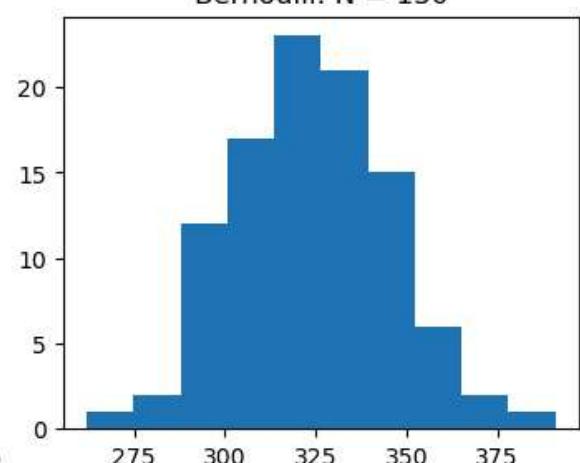
Bernoulli: N = 129

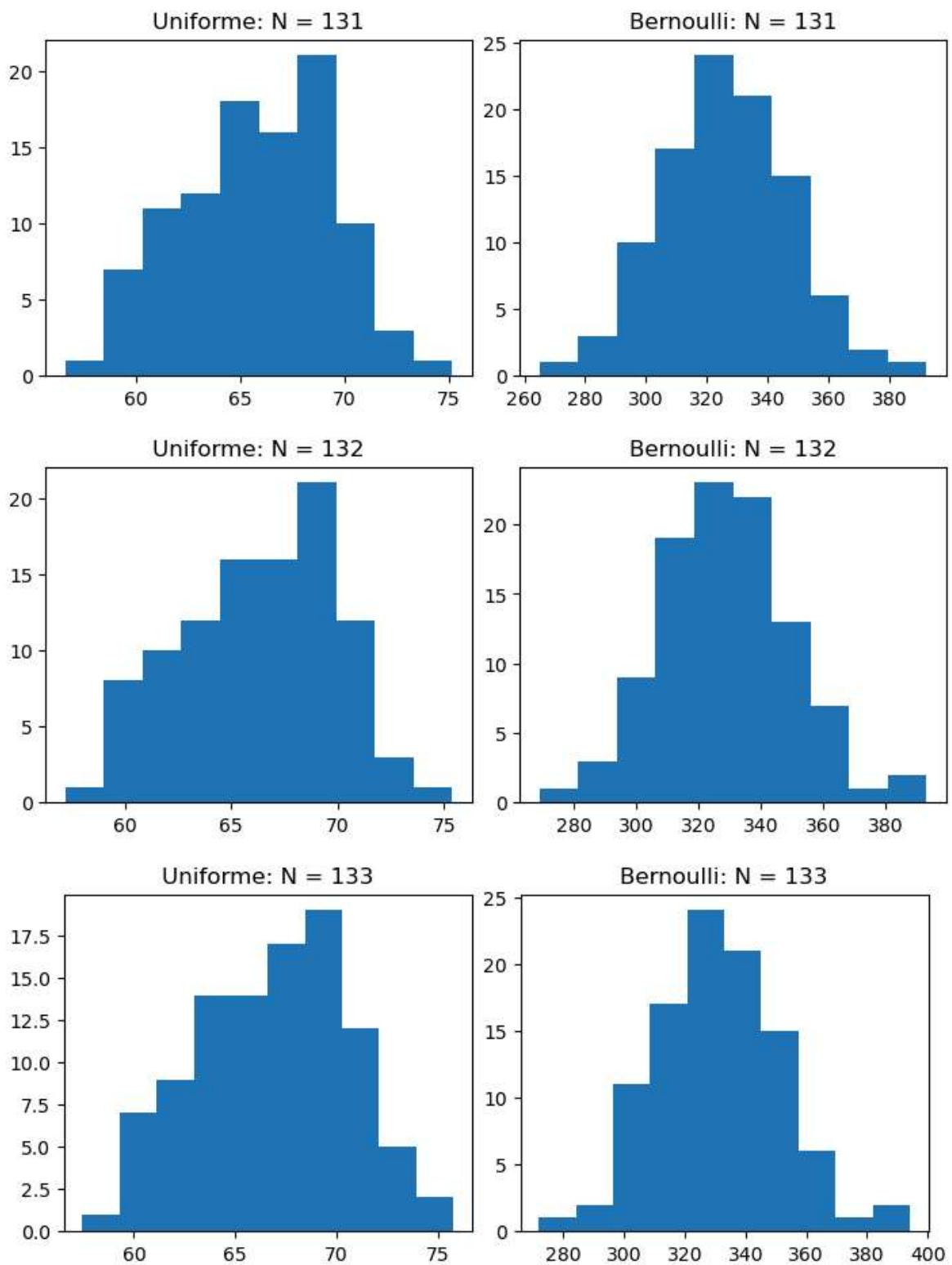


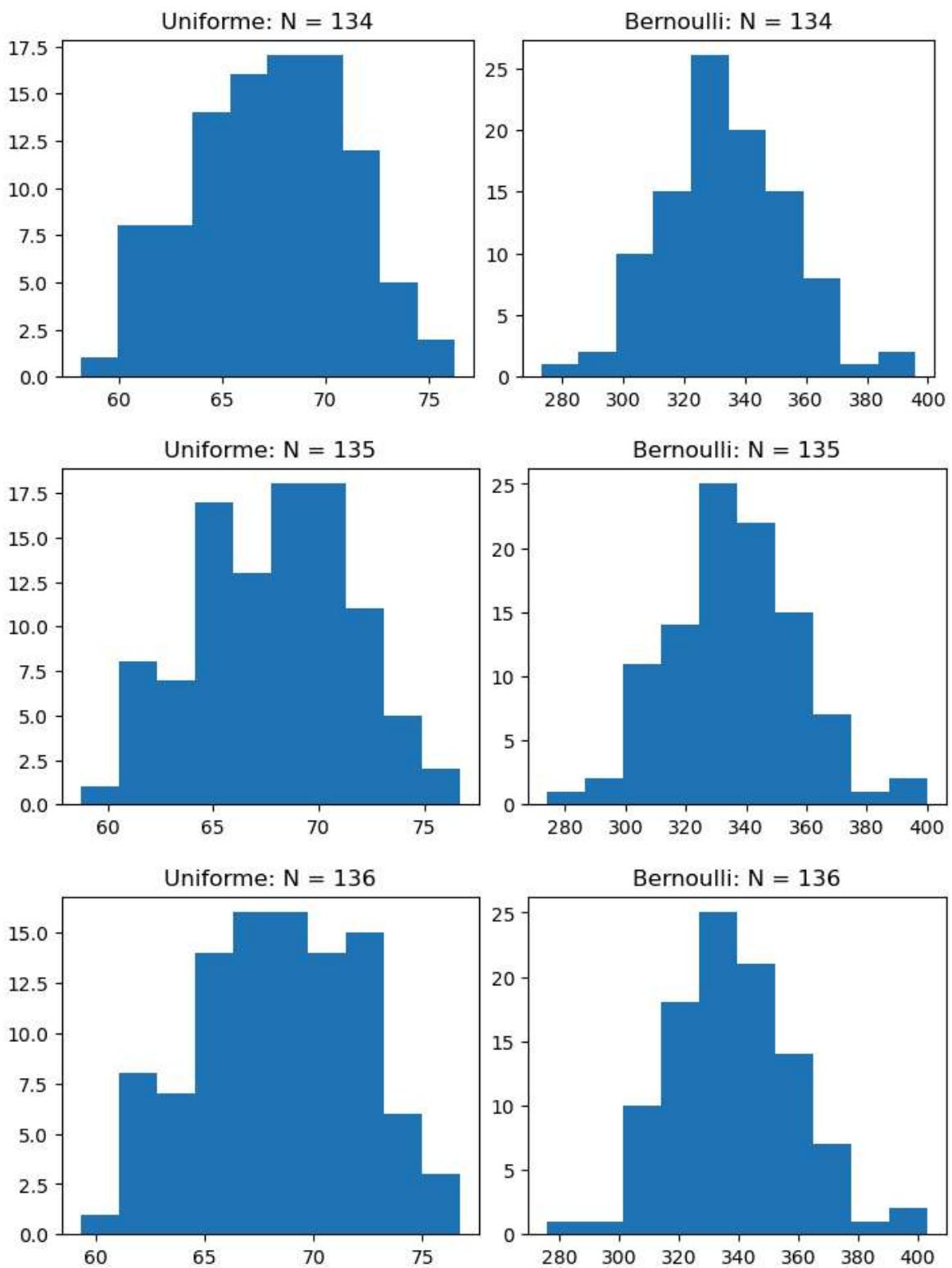
Uniforme: N = 130



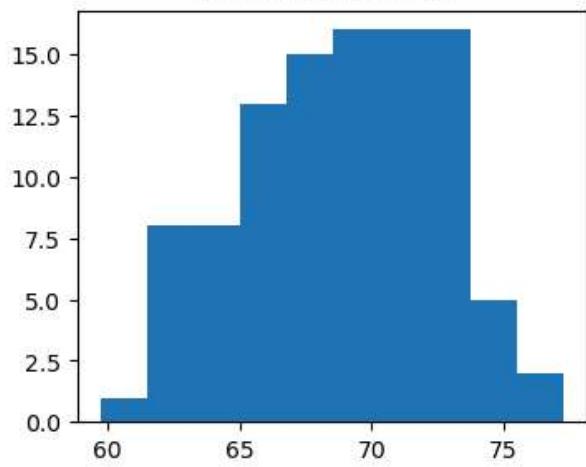
Bernoulli: N = 130



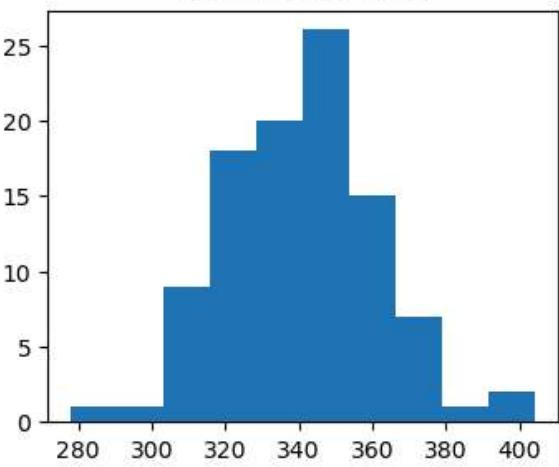




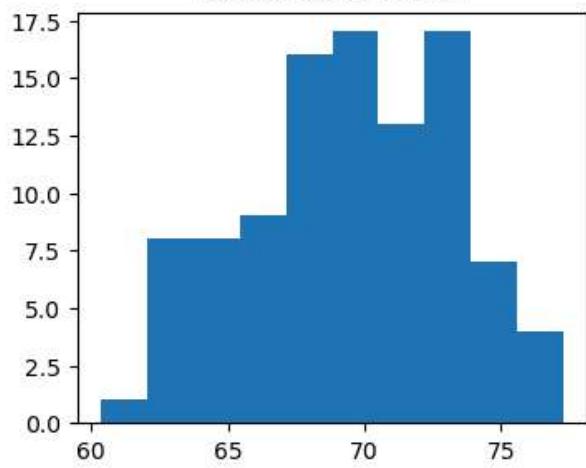
Uniforme: N = 137



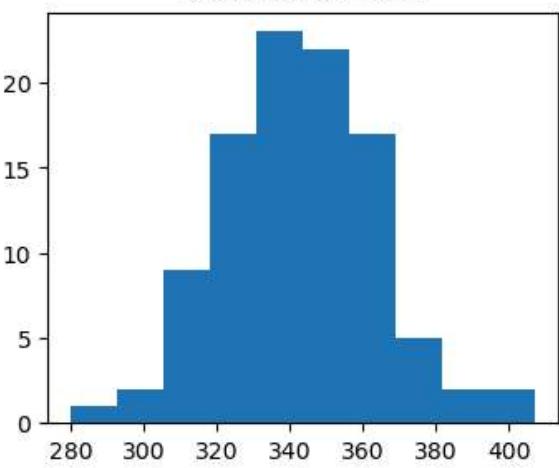
Bernoulli: N = 137



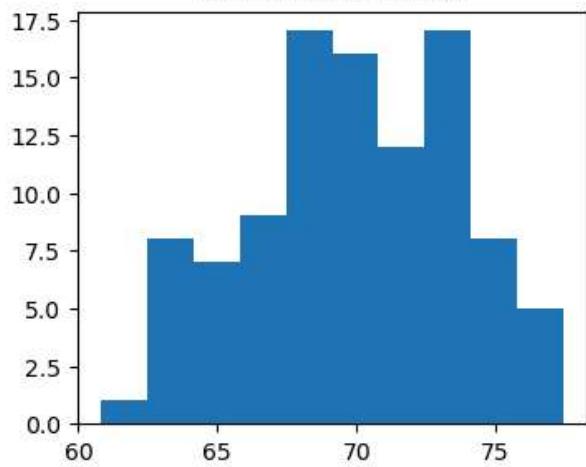
Uniforme: N = 138



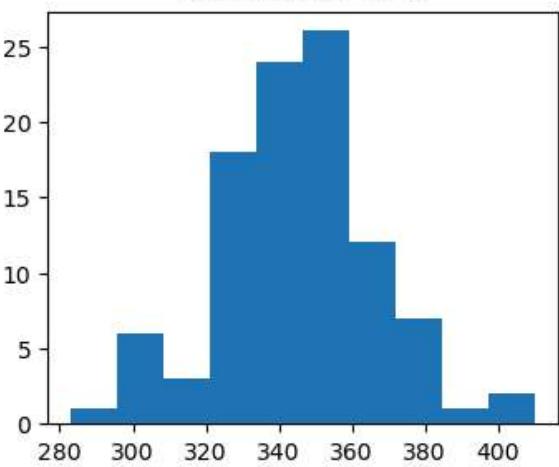
Bernoulli: N = 138

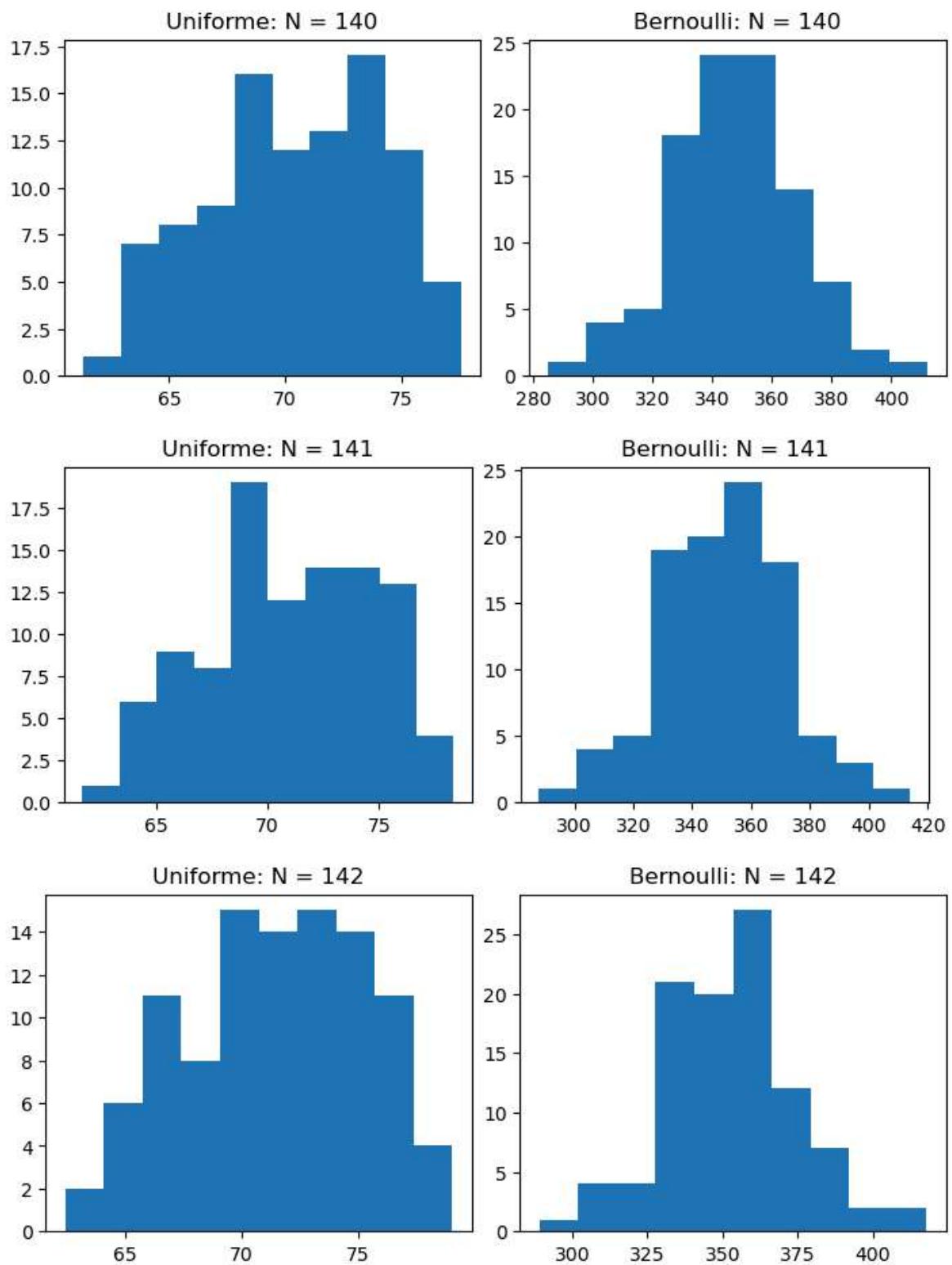


Uniforme: N = 139

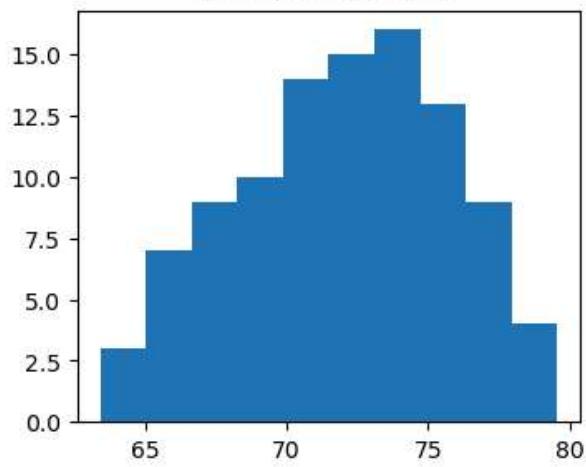


Bernoulli: N = 139

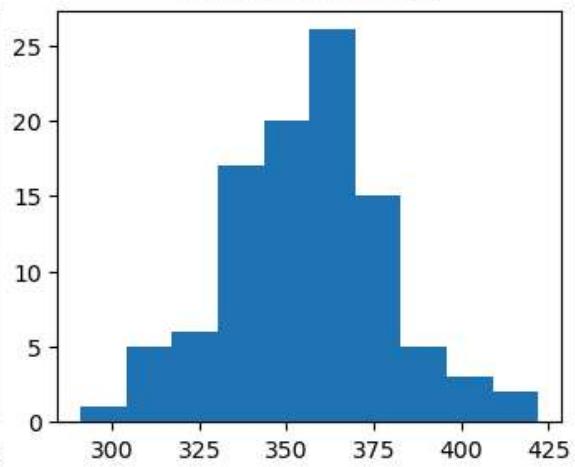




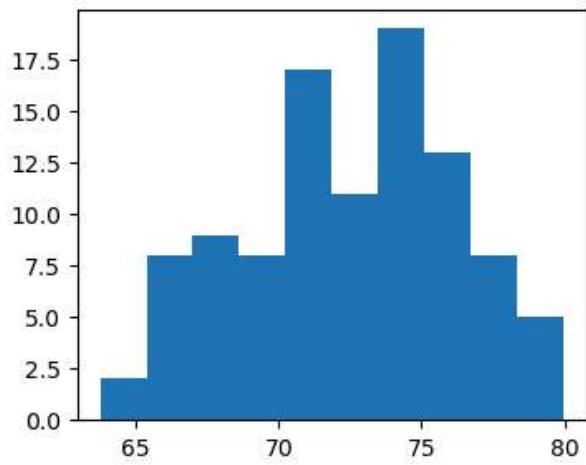
Uniforme: N = 143



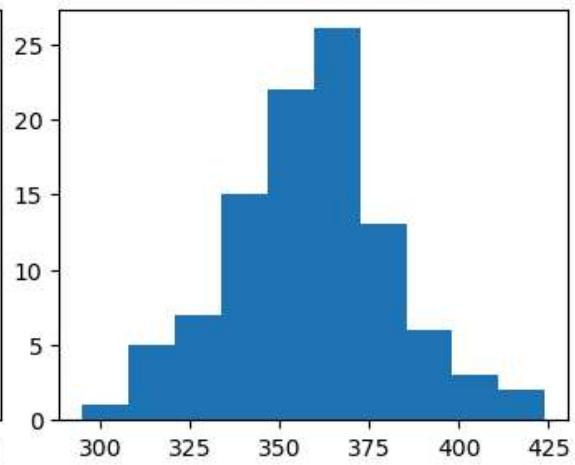
Bernoulli: N = 143



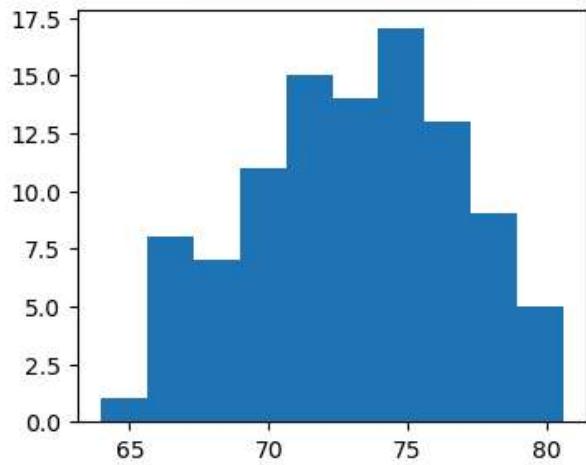
Uniforme: N = 144



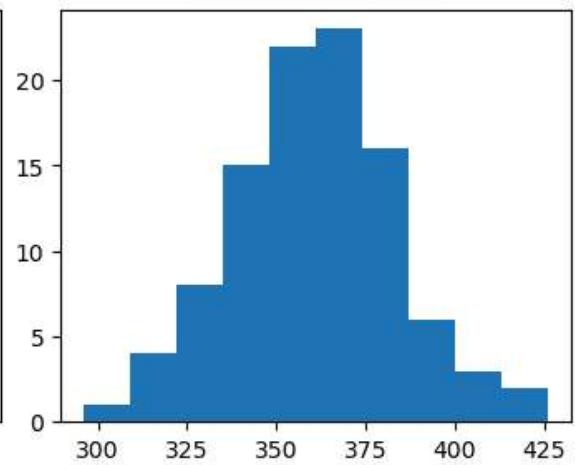
Bernoulli: N = 144

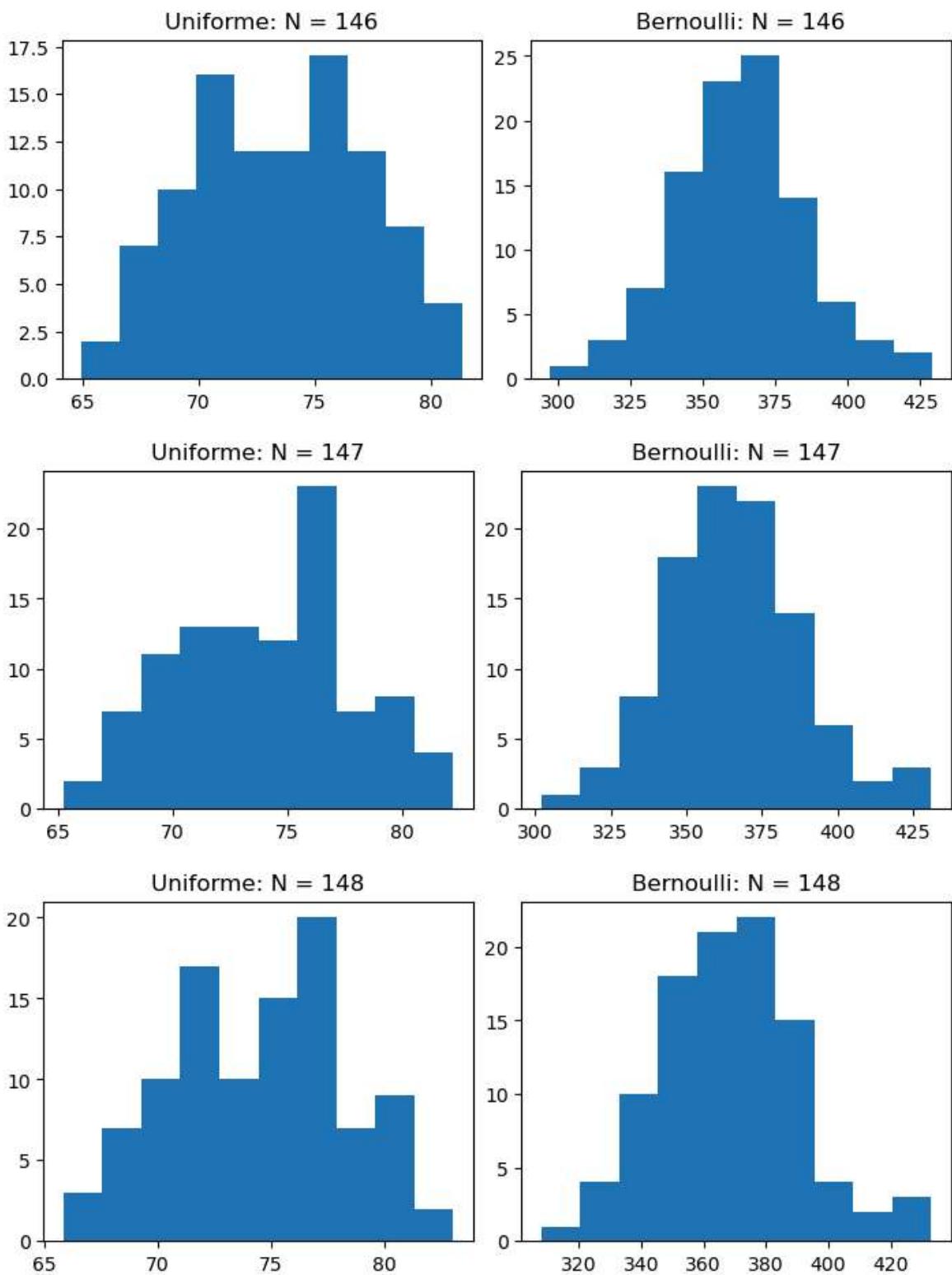


Uniforme: N = 145

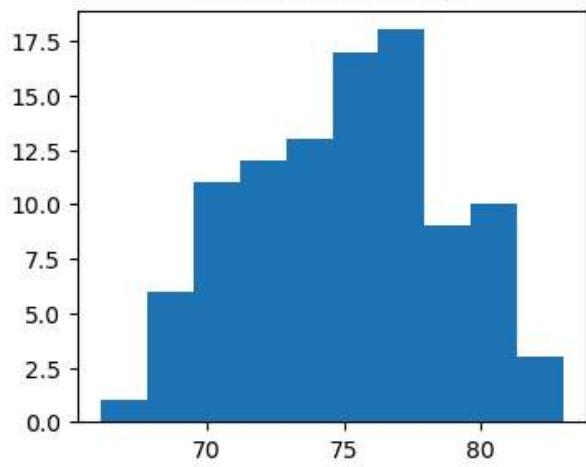


Bernoulli: N = 145

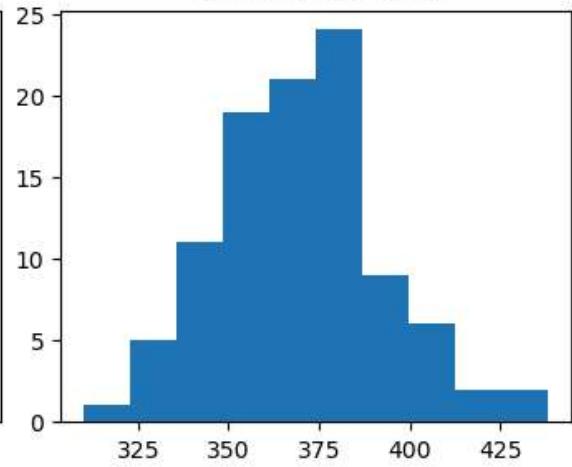




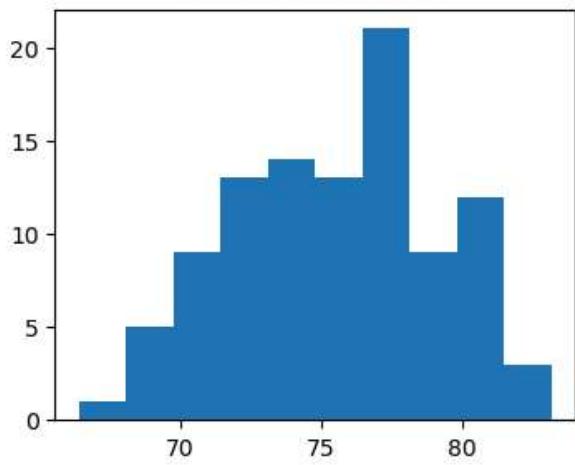
Uniforme: N = 149



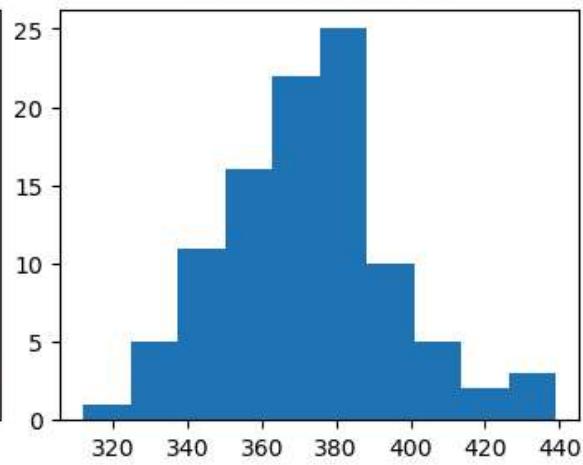
Bernoulli: N = 149



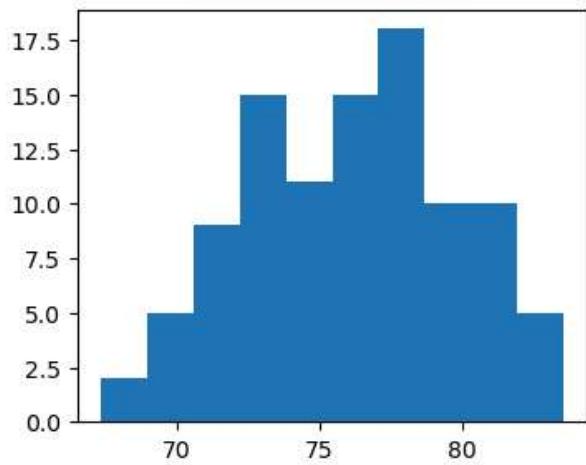
Uniforme: N = 150



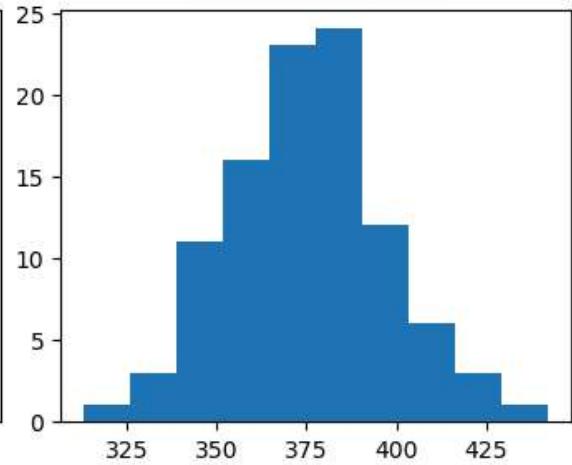
Bernoulli: N = 150



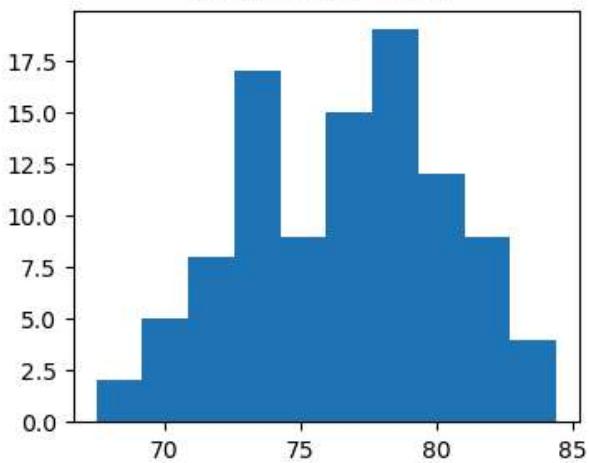
Uniforme: N = 151



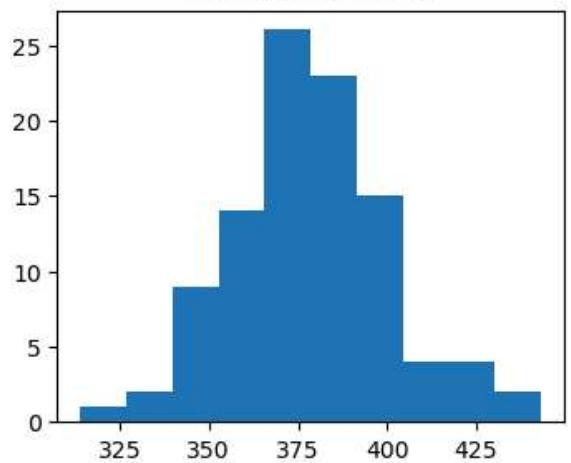
Bernoulli: N = 151



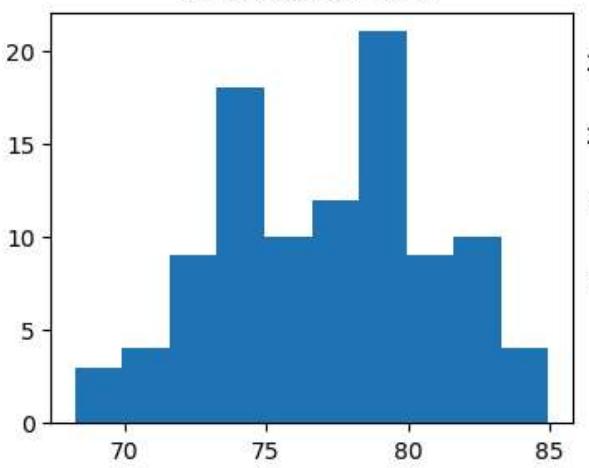
Uniforme: N = 152



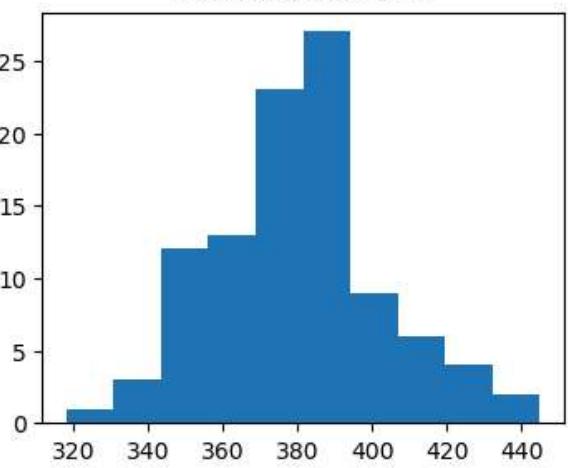
Bernoulli: N = 152



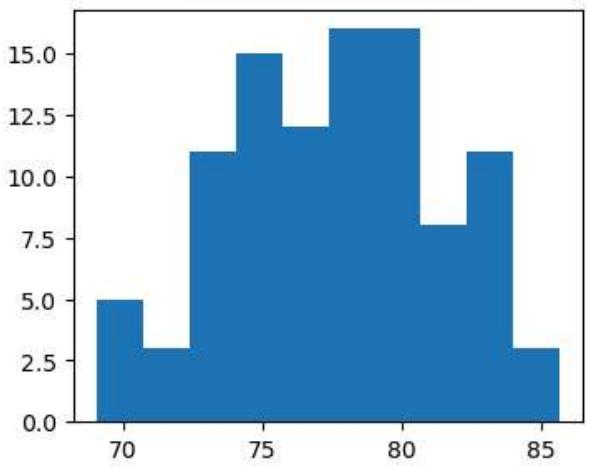
Uniforme: N = 153



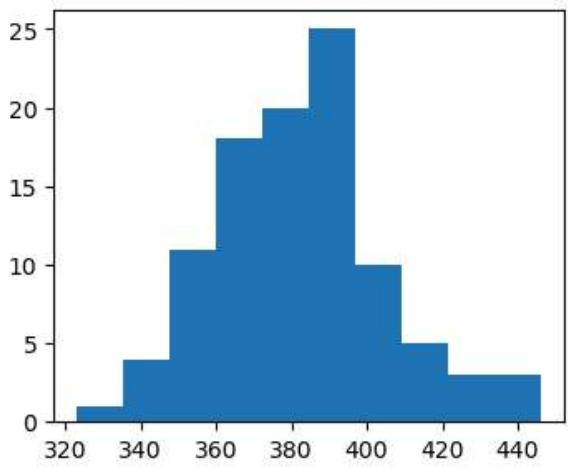
Bernoulli: N = 153

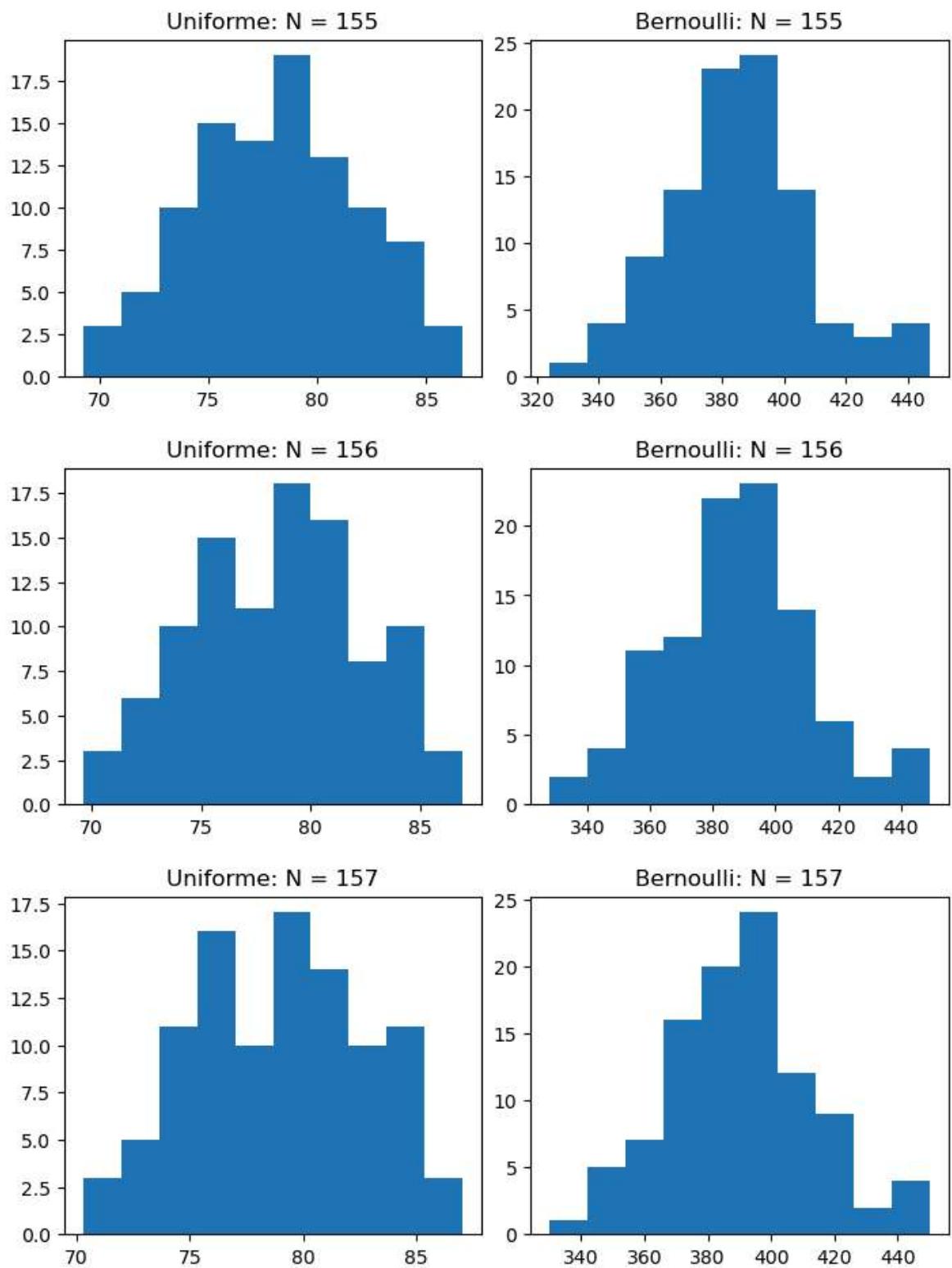


Uniforme: N = 154

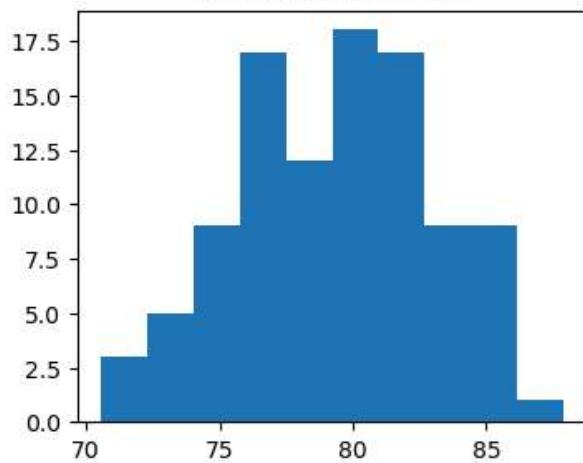


Bernoulli: N = 154

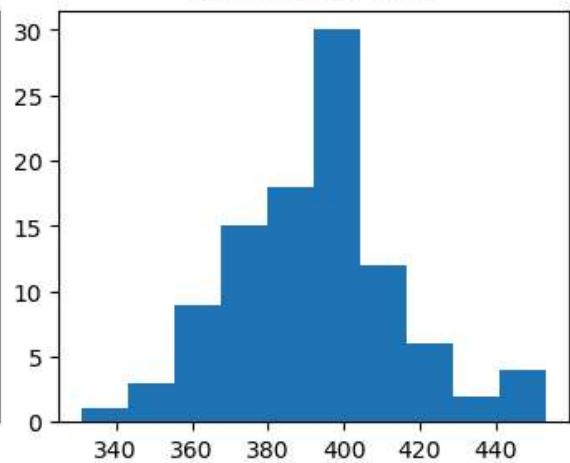




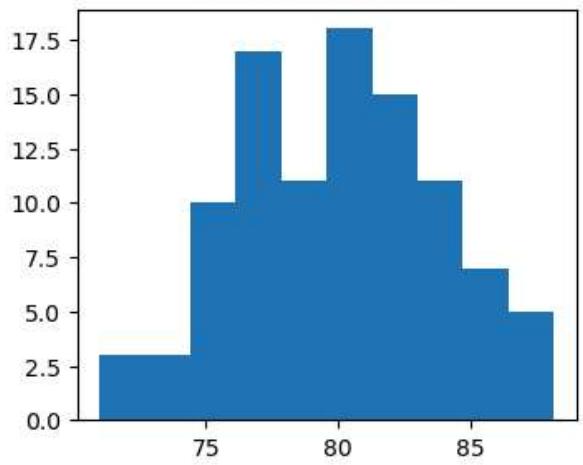
Uniforme: N = 158



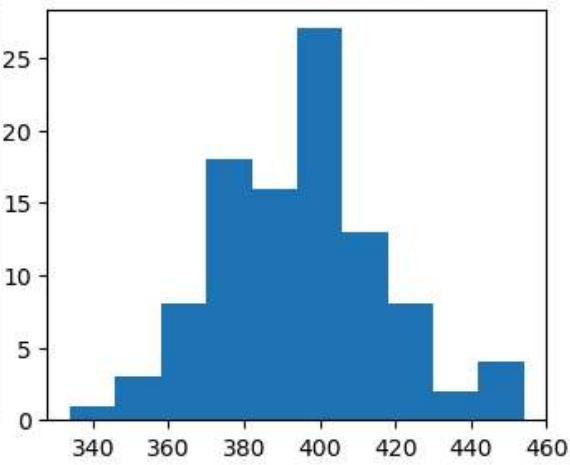
Bernoulli: N = 158



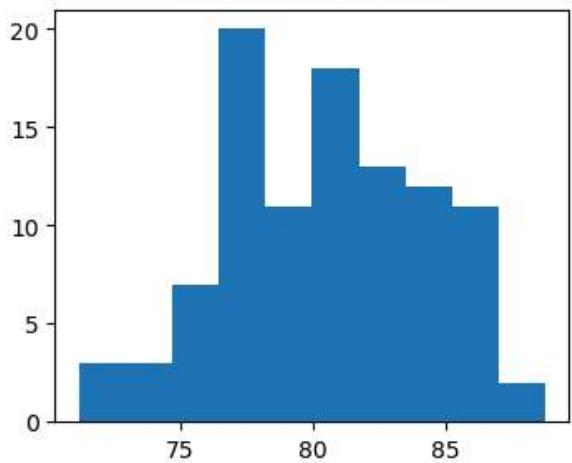
Uniforme: N = 159



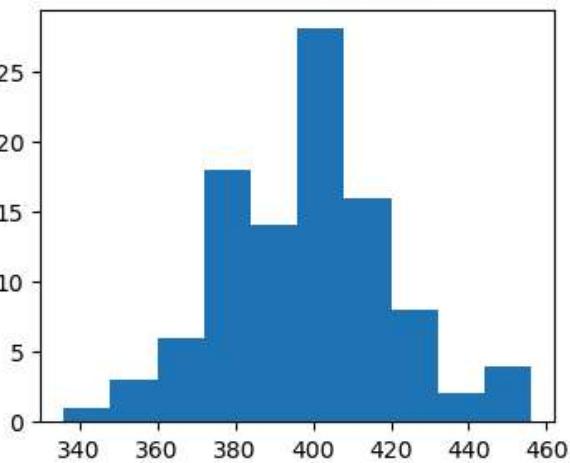
Bernoulli: N = 159



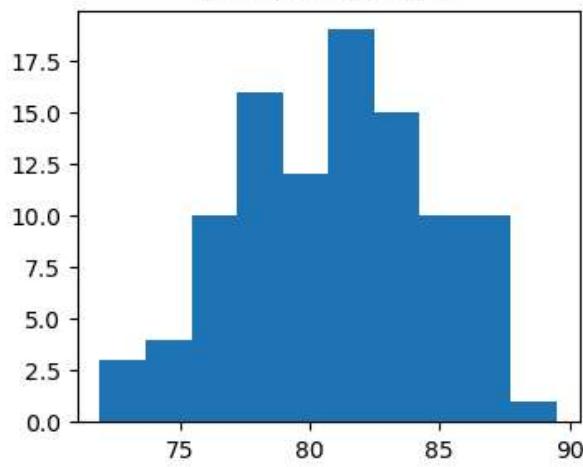
Uniforme: N = 160



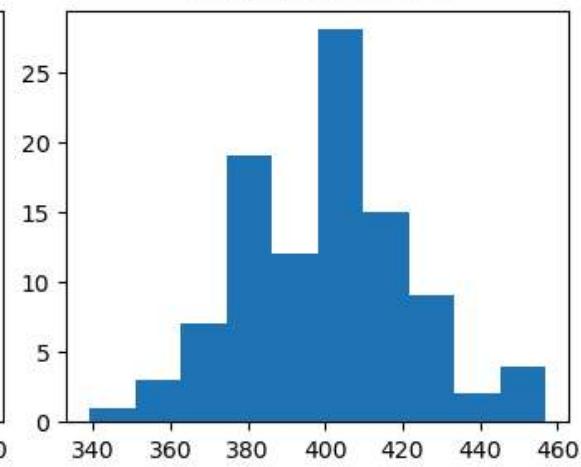
Bernoulli: N = 160



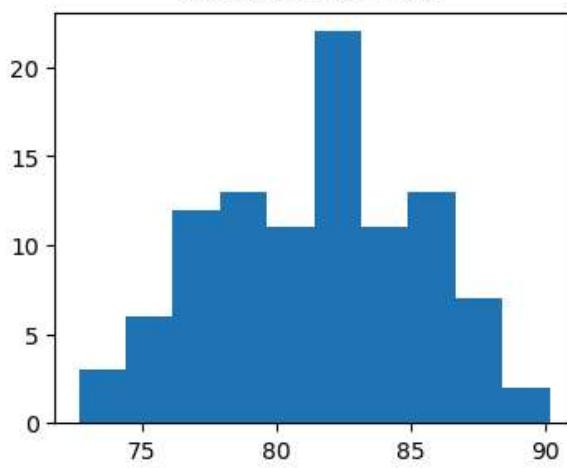
Uniforme: N = 161



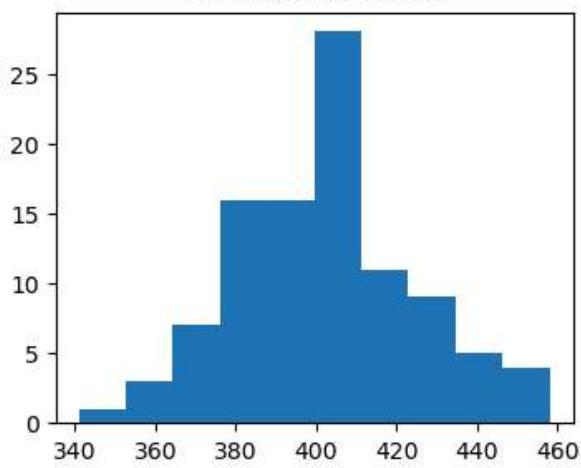
Bernoulli: N = 161



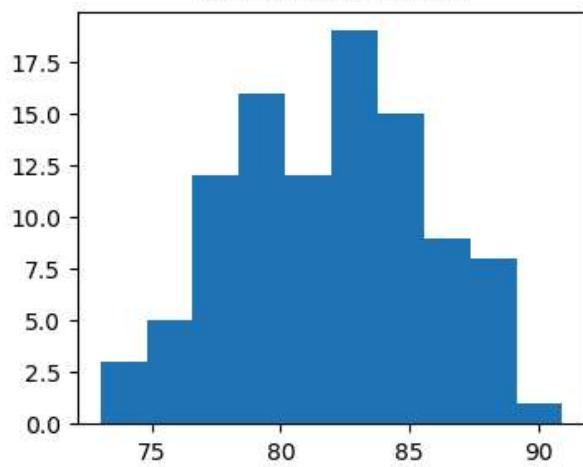
Uniforme: N = 162



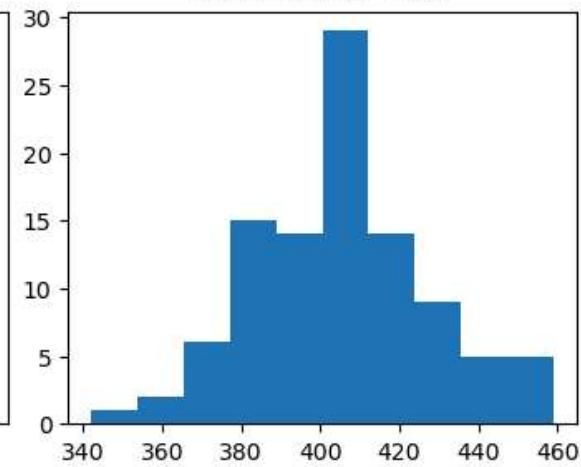
Bernoulli: N = 162



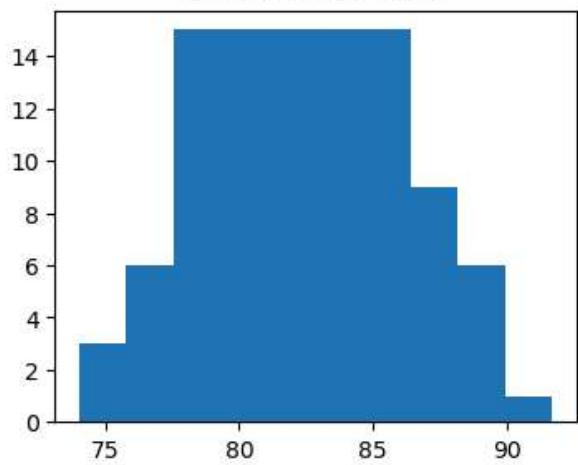
Uniforme: N = 163



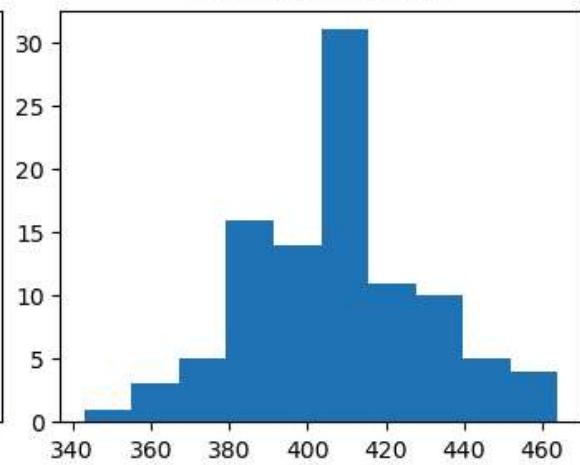
Bernoulli: N = 163



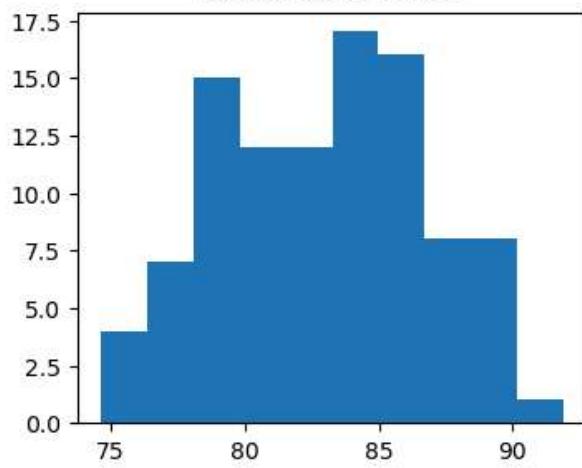
Uniforme: N = 164



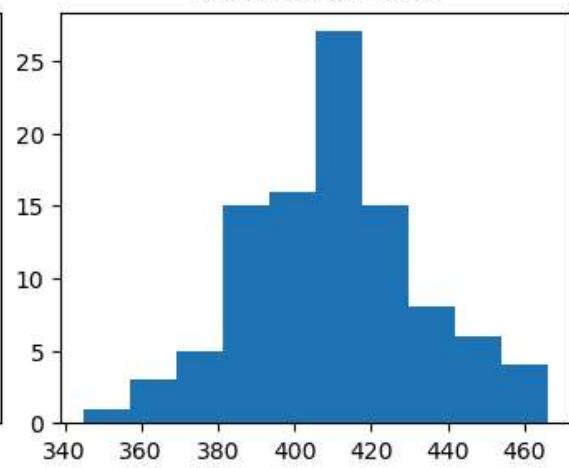
Bernoulli: N = 164



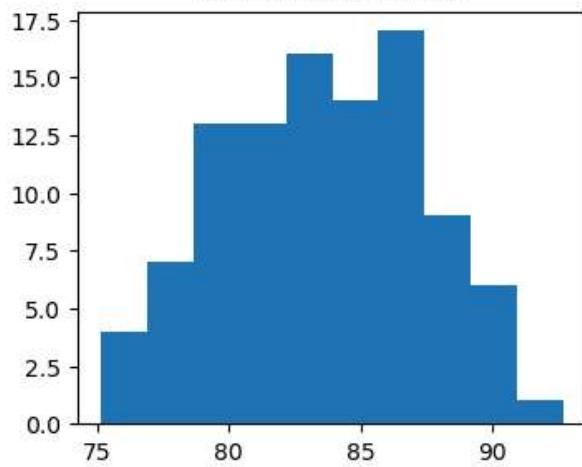
Uniforme: N = 165



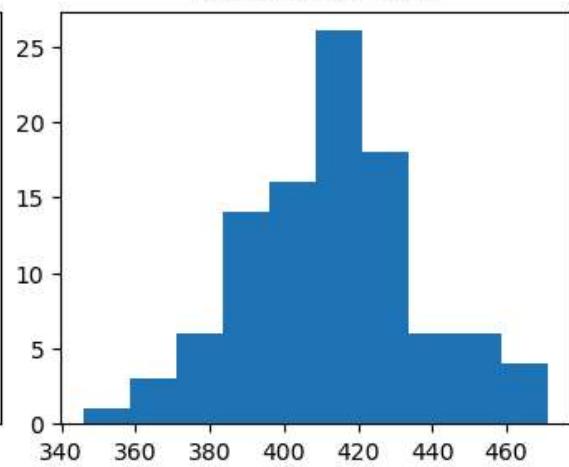
Bernoulli: N = 165

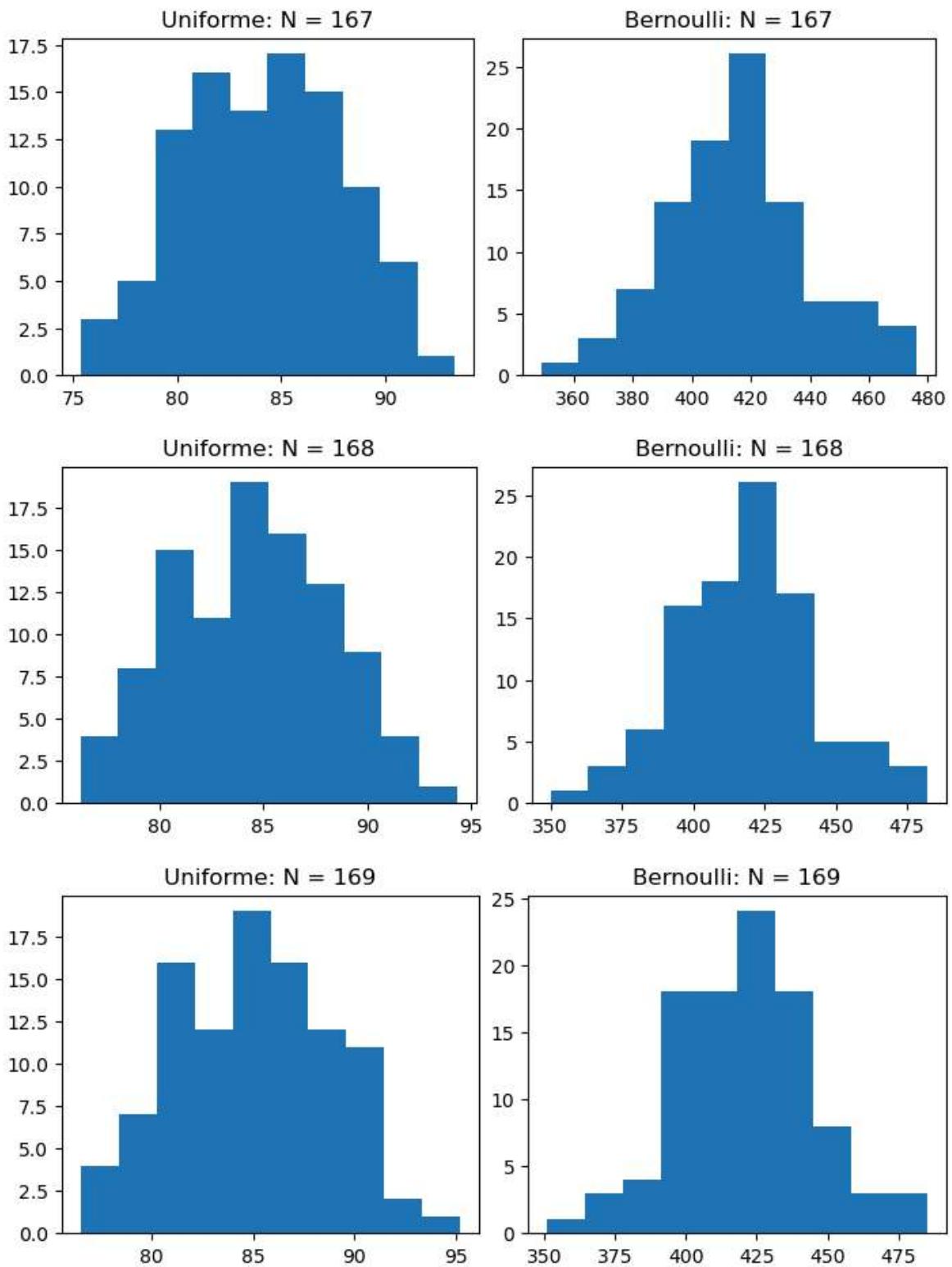


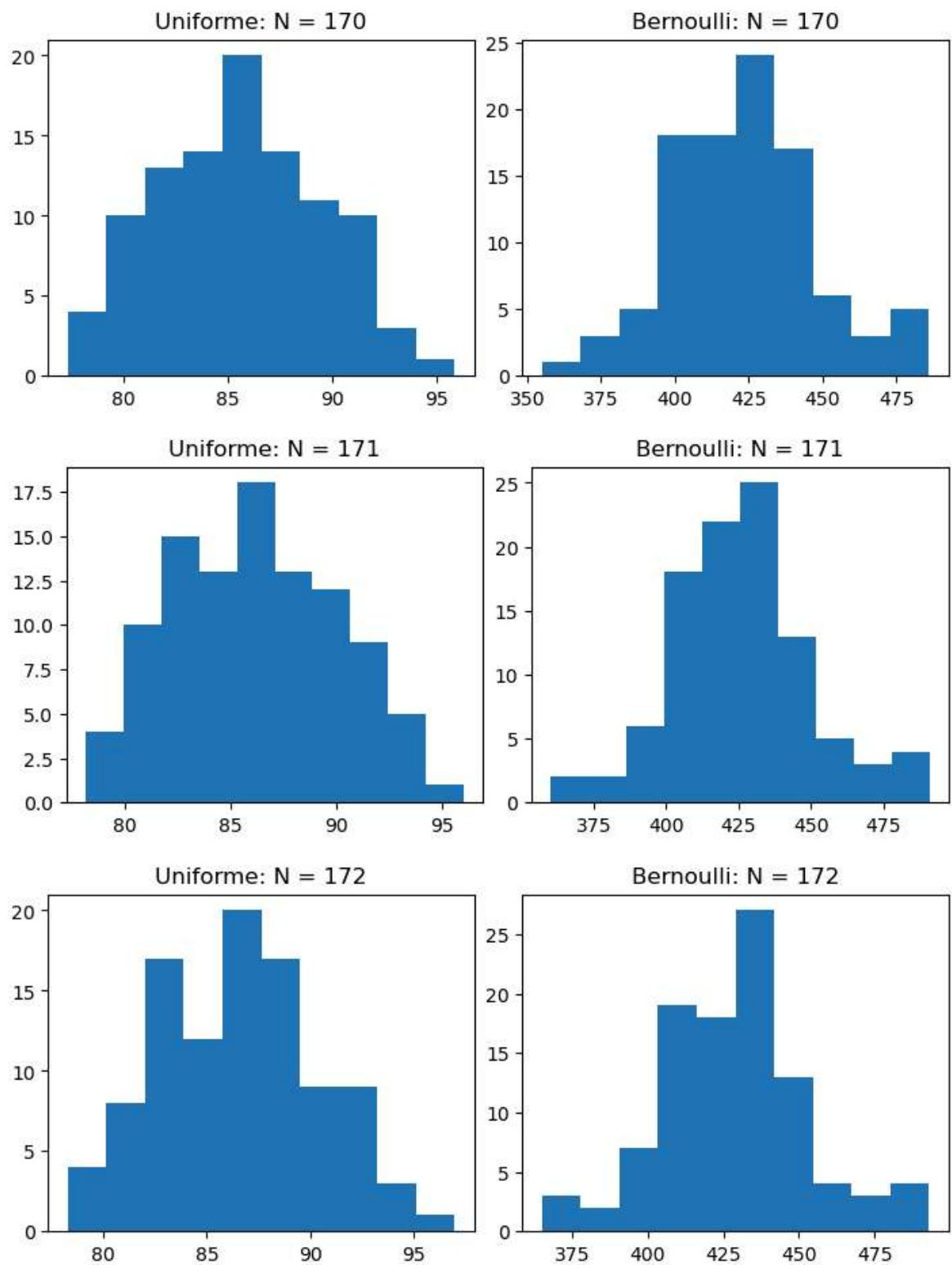
Uniforme: N = 166



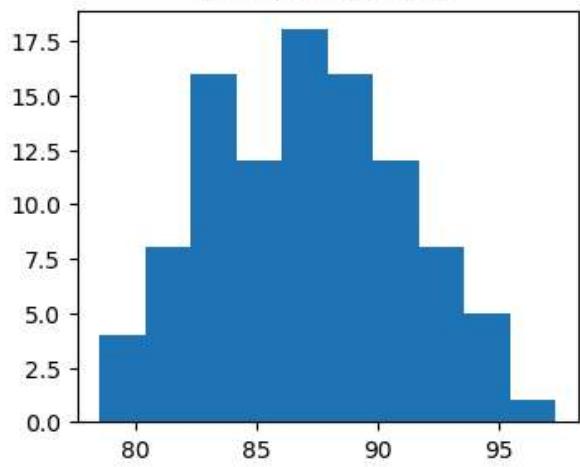
Bernoulli: N = 166



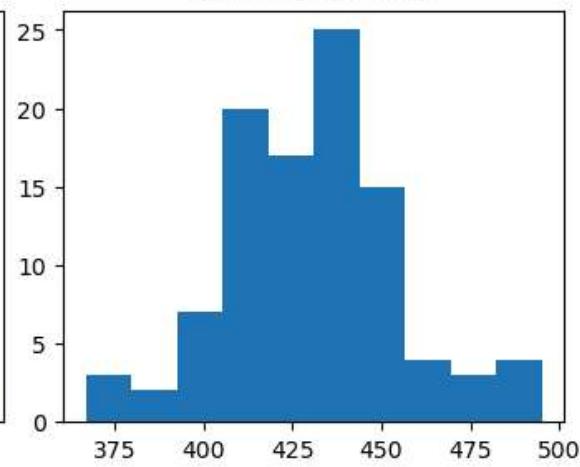




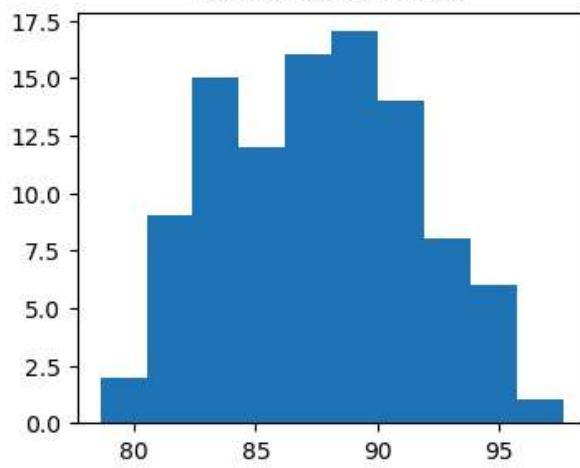
Uniforme: N = 173



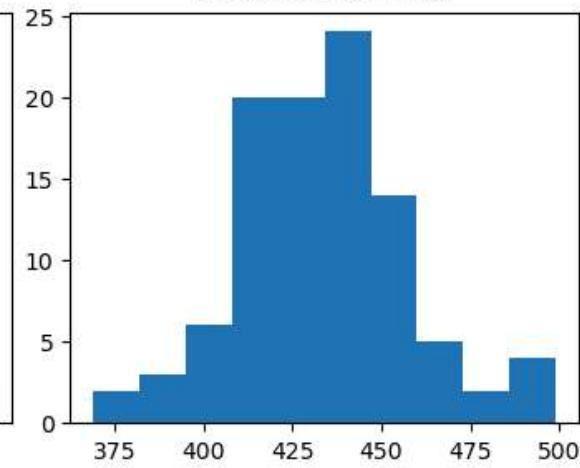
Bernoulli: N = 173



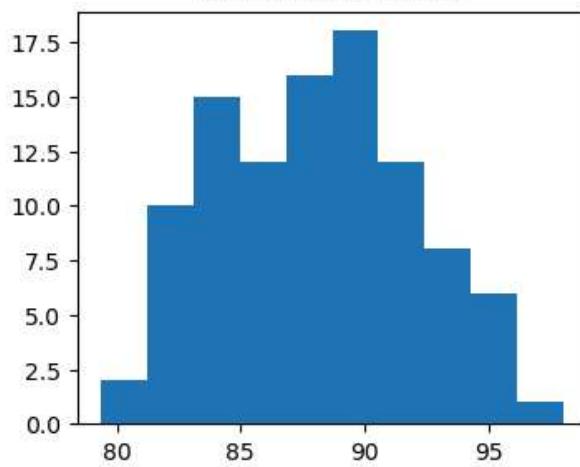
Uniforme: N = 174



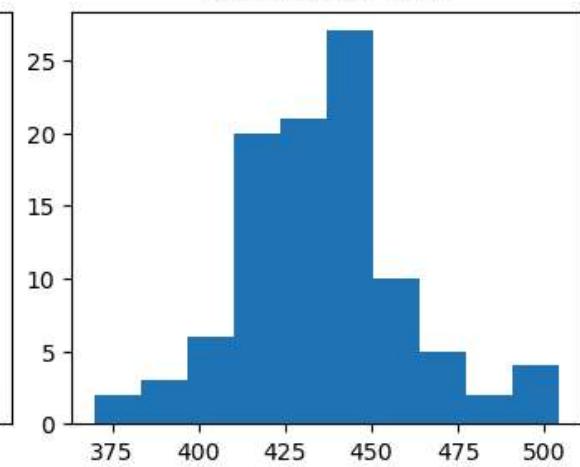
Bernoulli: N = 174



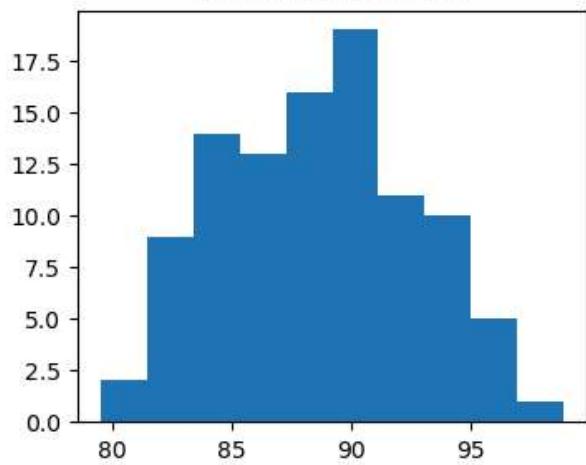
Uniforme: N = 175



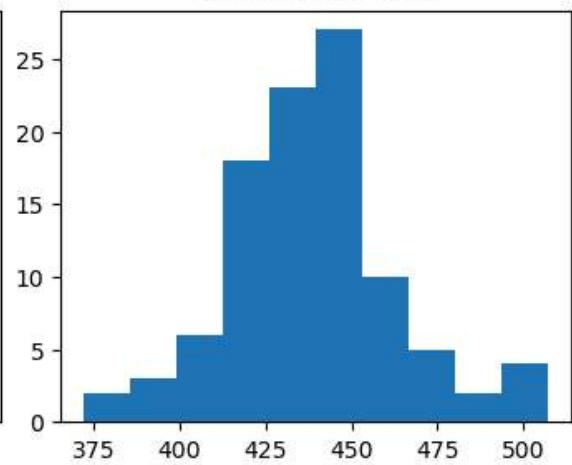
Bernoulli: N = 175



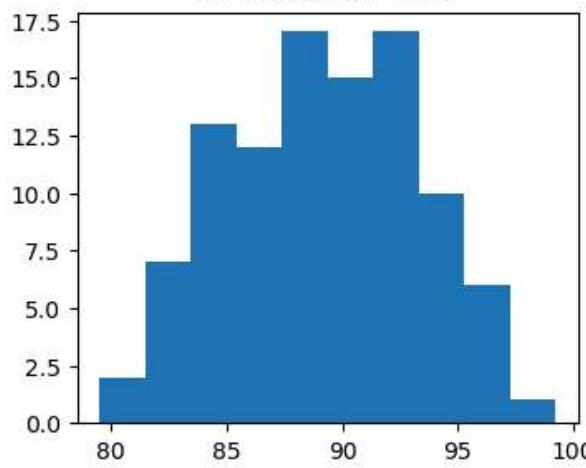
Uniforme: N = 176



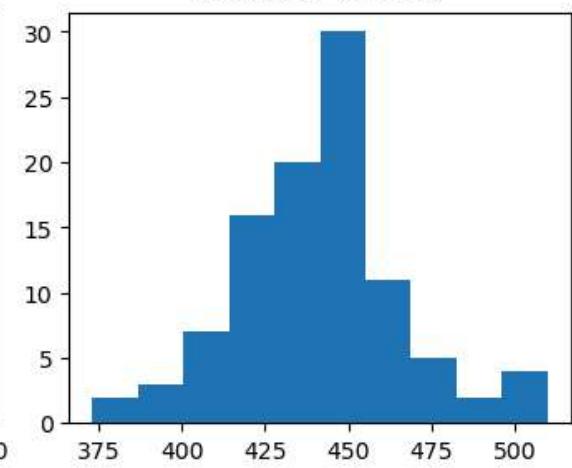
Bernoulli: N = 176



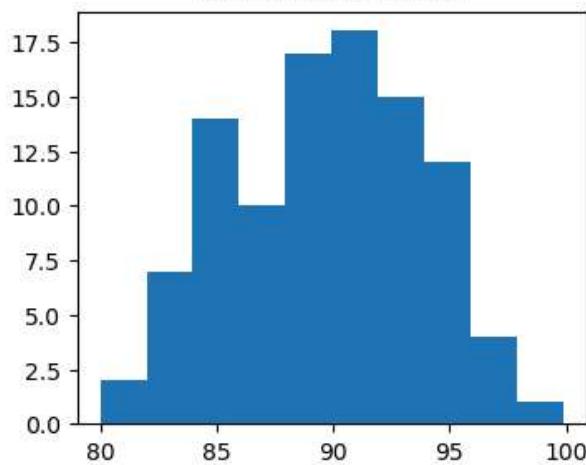
Uniforme: N = 177



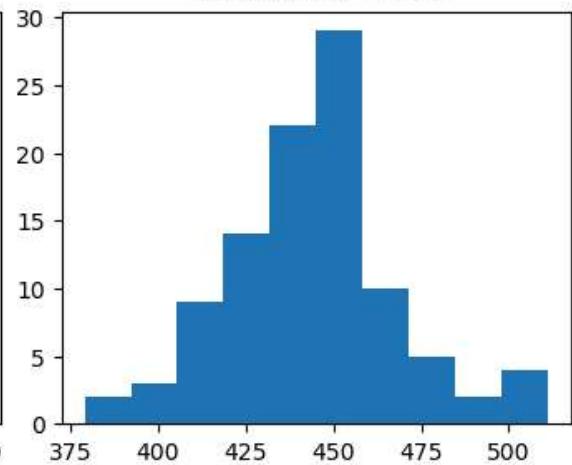
Bernoulli: N = 177



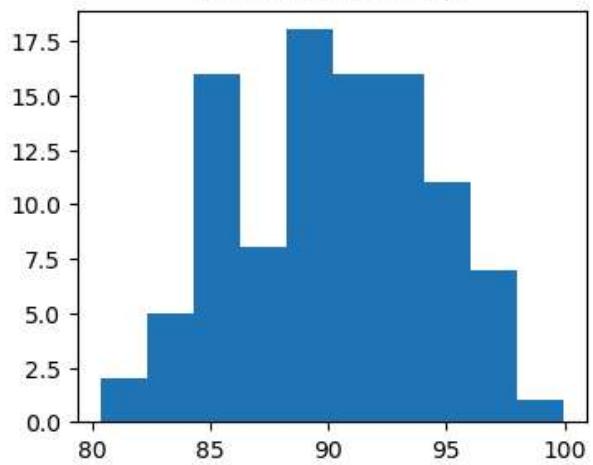
Uniforme: N = 178



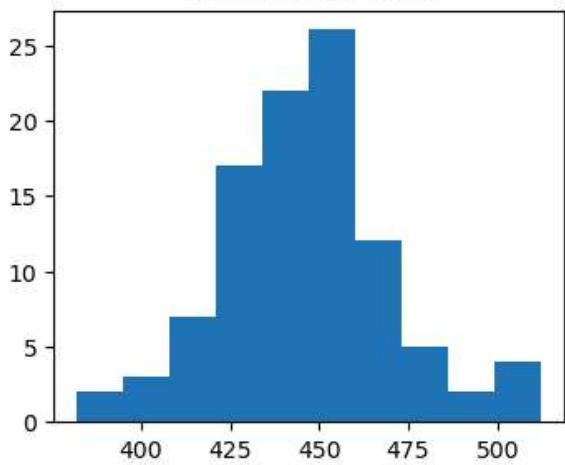
Bernoulli: N = 178



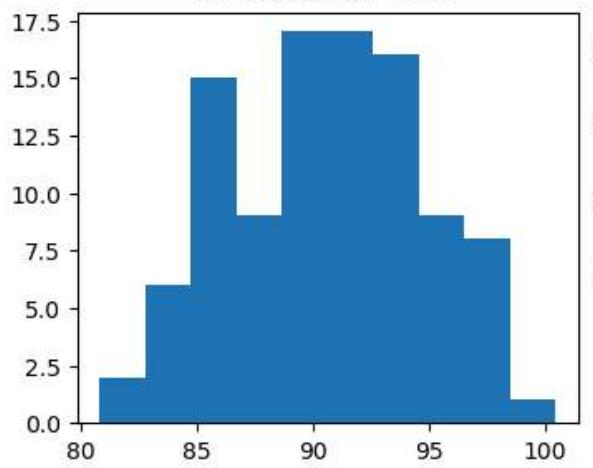
Uniforme: N = 179



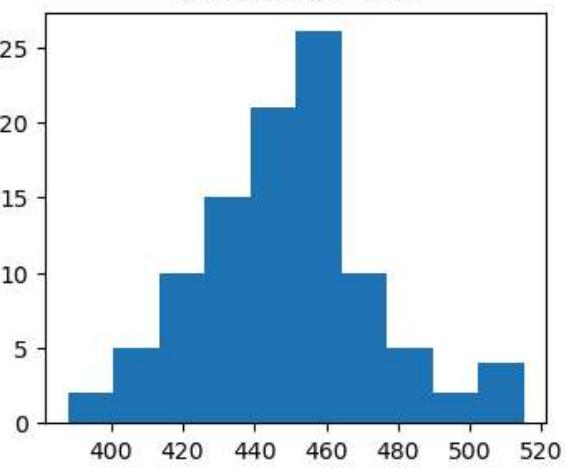
Bernoulli: N = 179



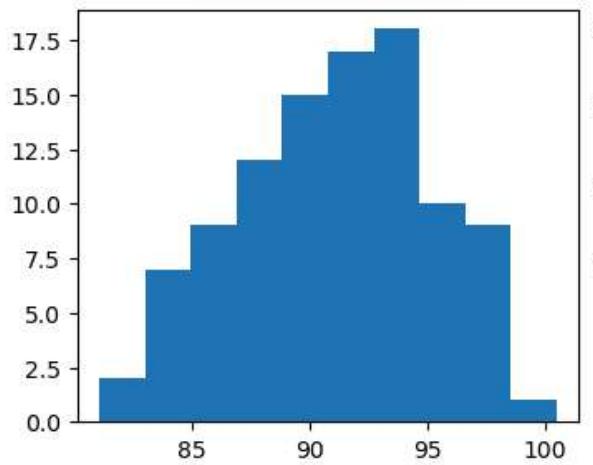
Uniforme: N = 180



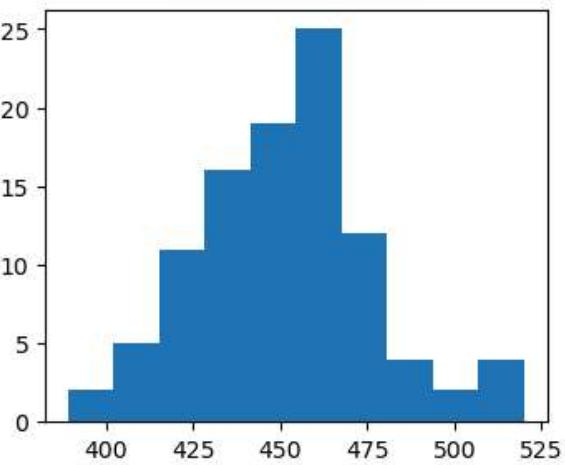
Bernoulli: N = 180



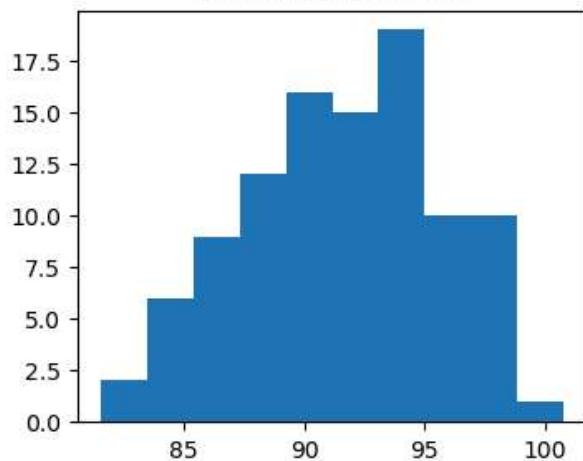
Uniforme: N = 181



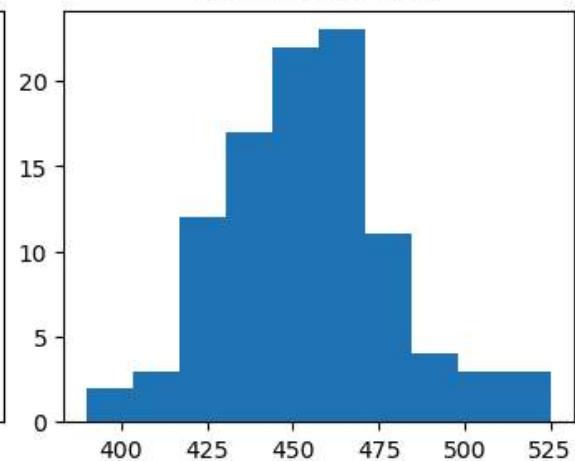
Bernoulli: N = 181



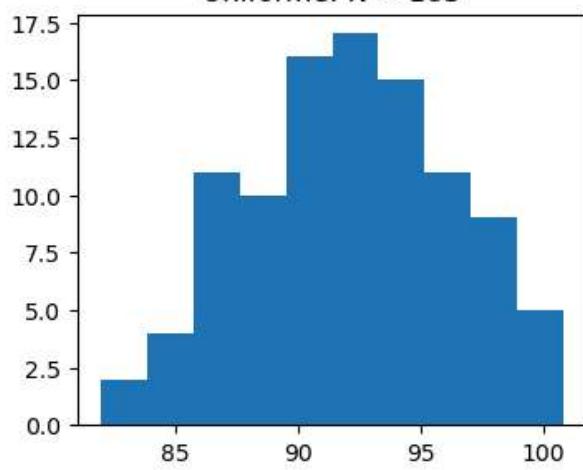
Uniforme: N = 182



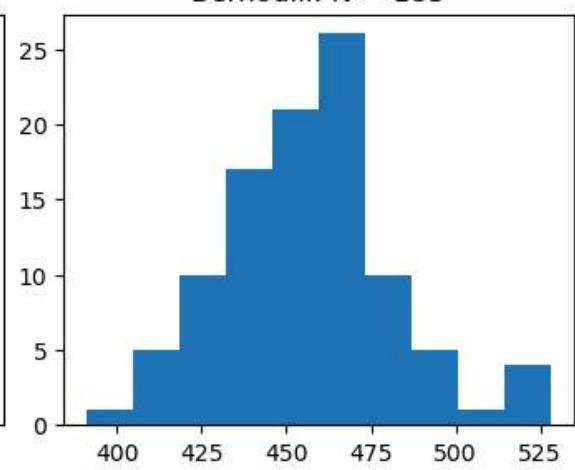
Bernoulli: N = 182



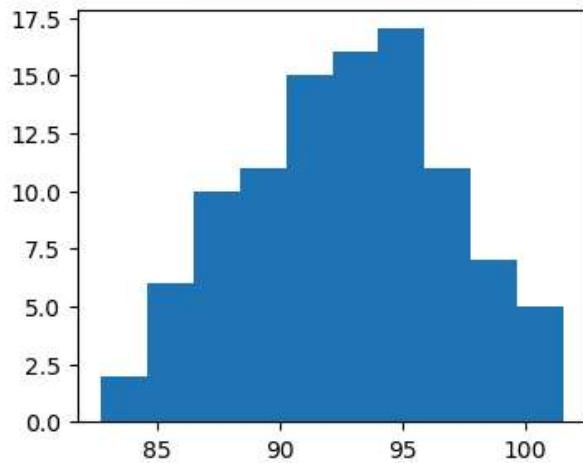
Uniforme: N = 183



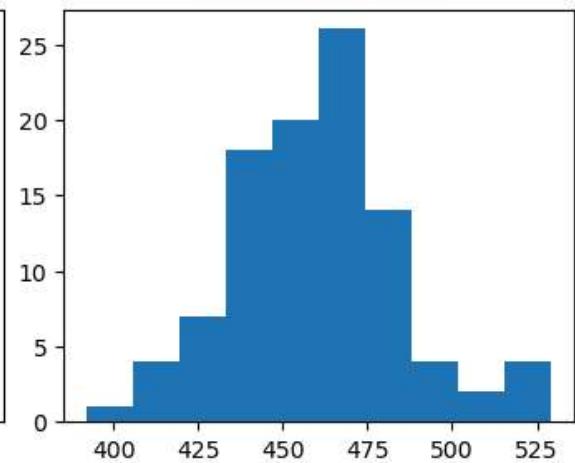
Bernoulli: N = 183

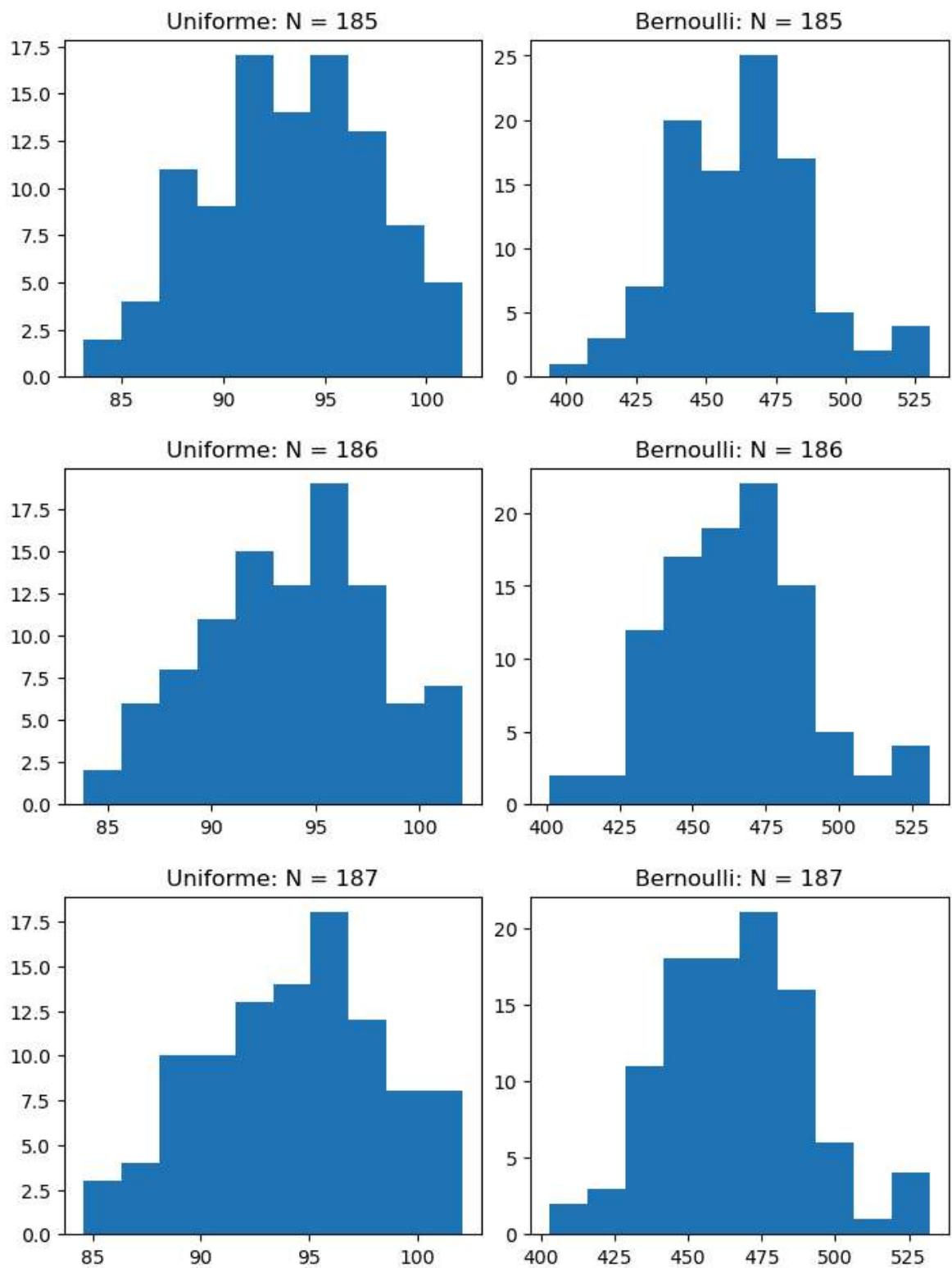


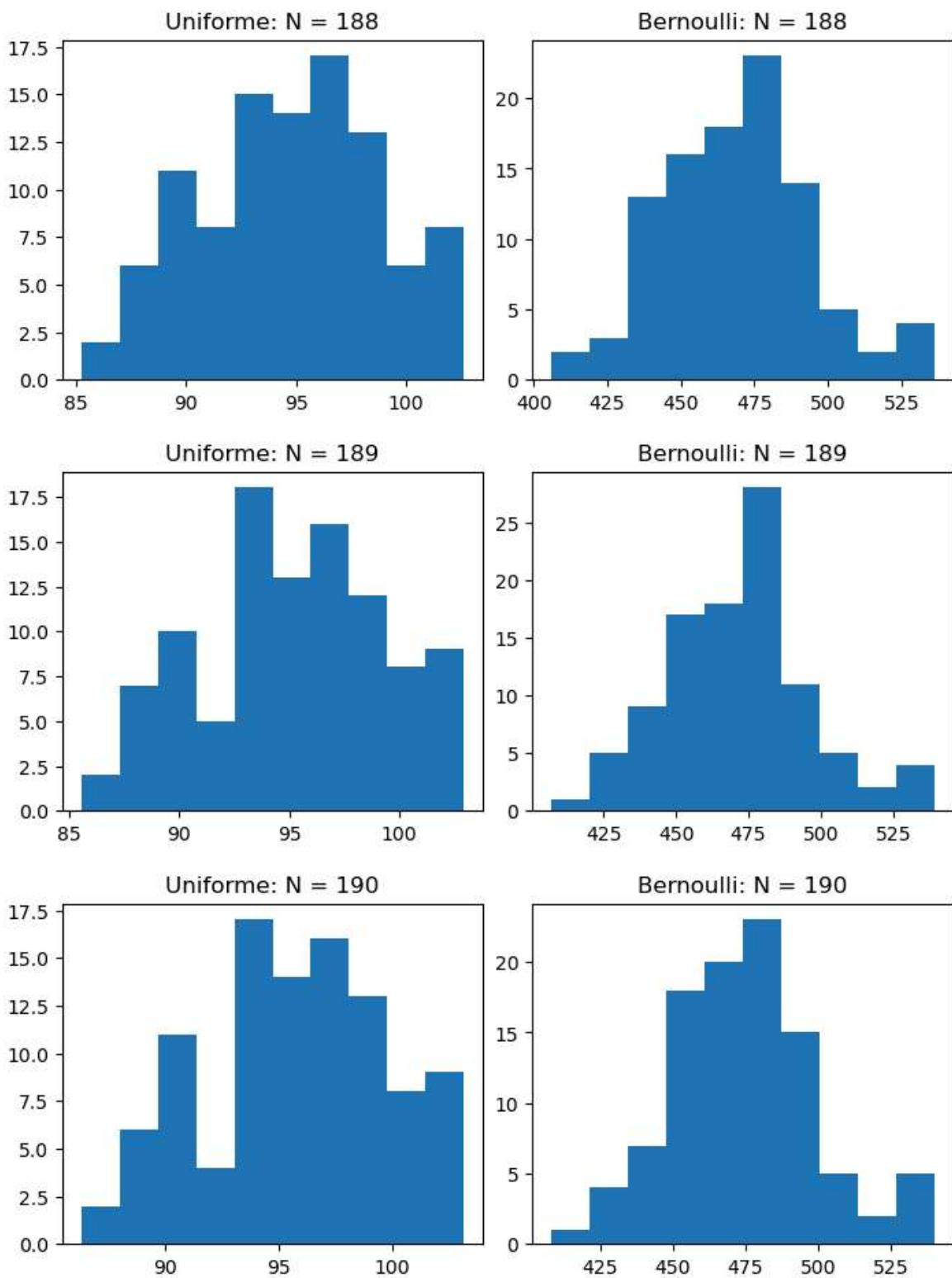
Uniforme: N = 184



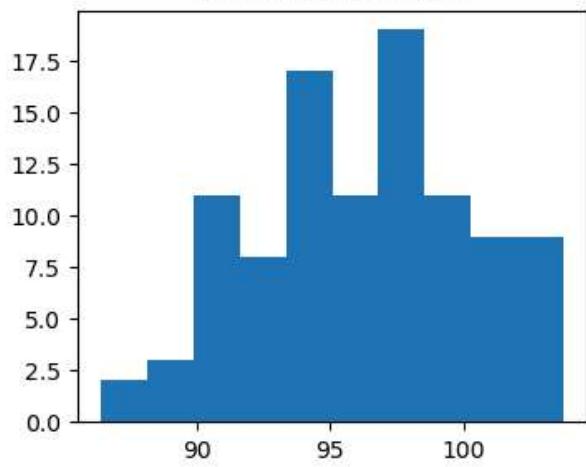
Bernoulli: N = 184



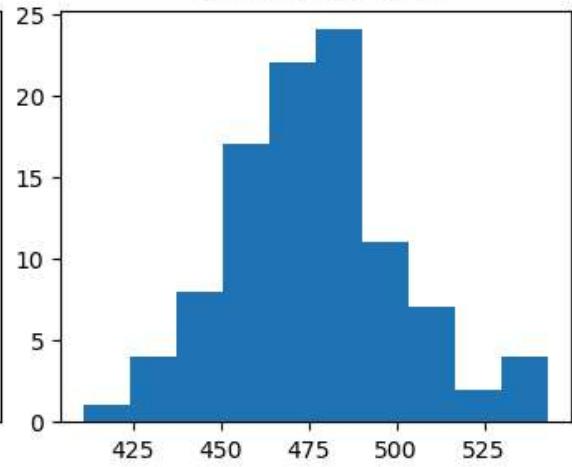




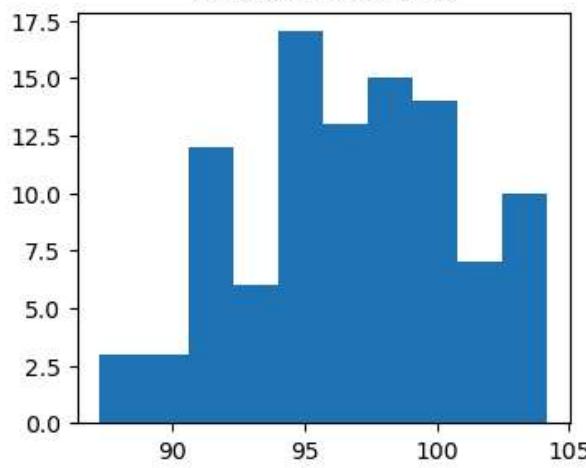
Uniforme: N = 191



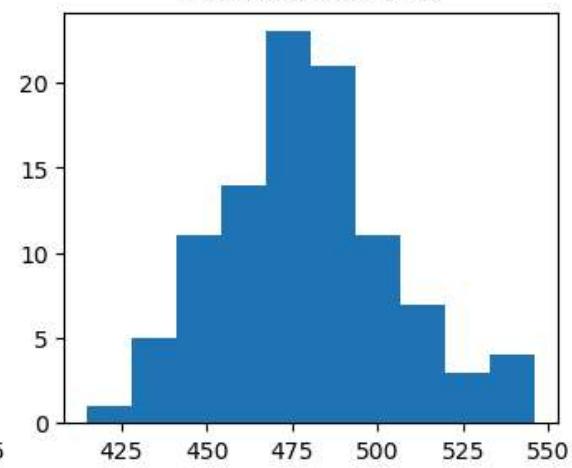
Bernoulli: N = 191



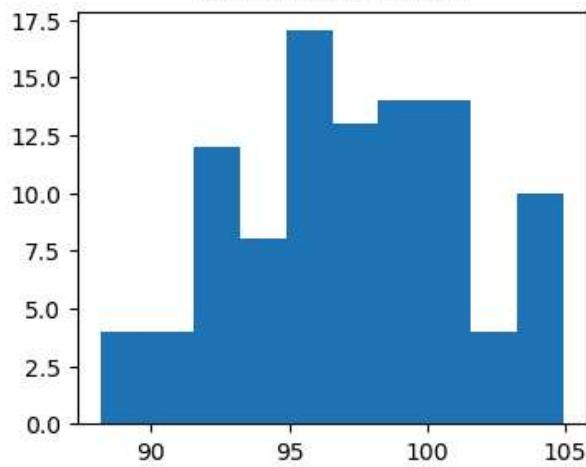
Uniforme: N = 192



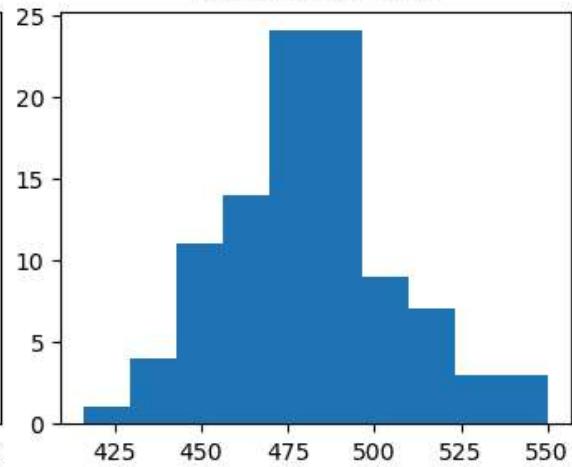
Bernoulli: N = 192



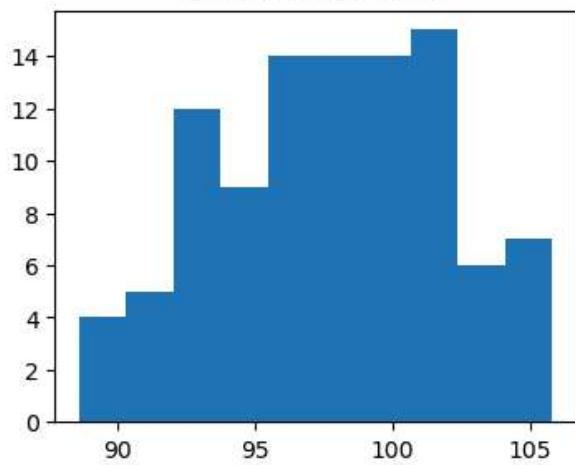
Uniforme: N = 193



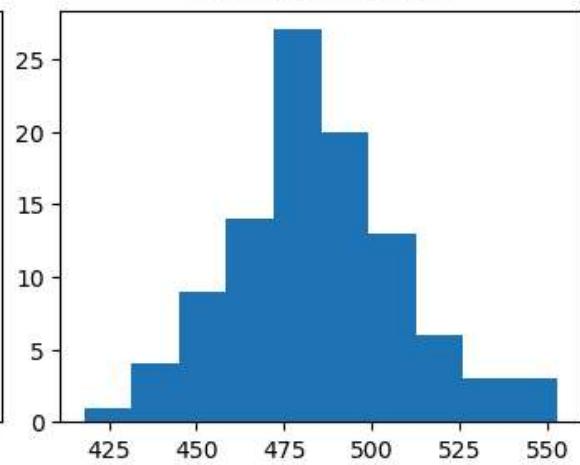
Bernoulli: N = 193



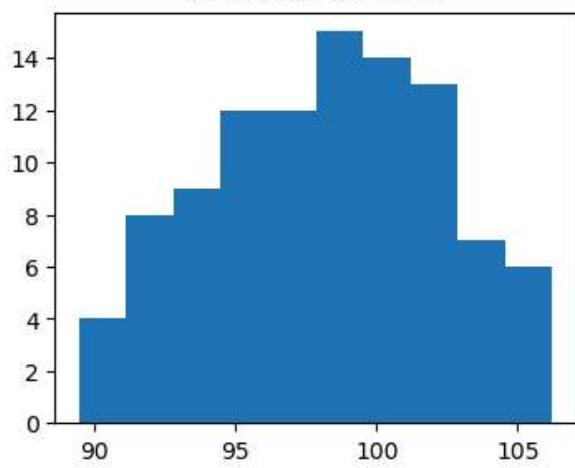
Uniforme: N = 194



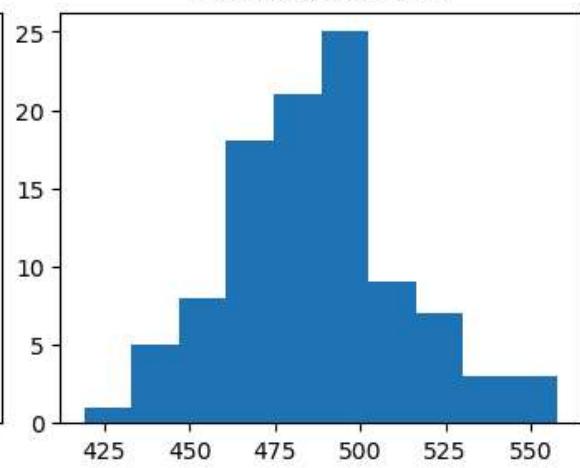
Bernoulli: N = 194



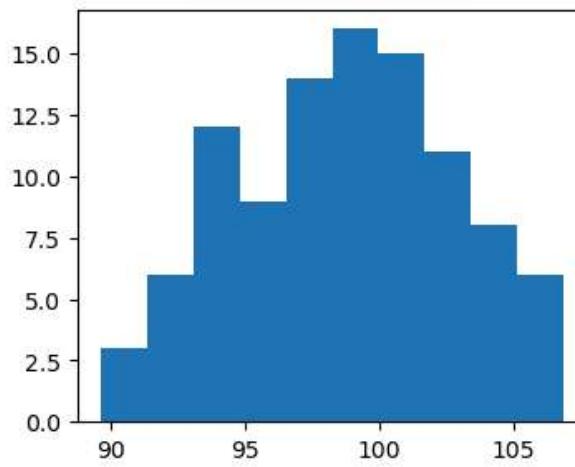
Uniforme: N = 195



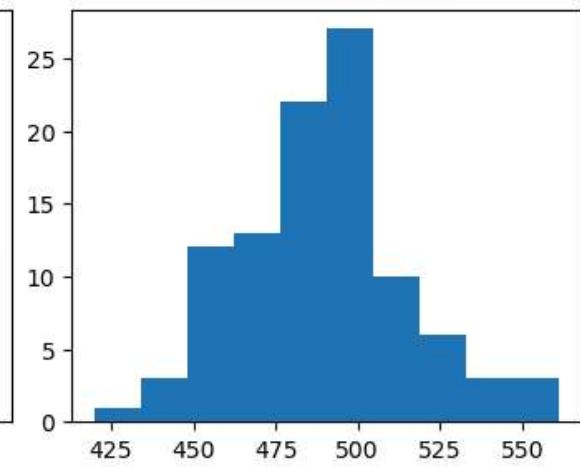
Bernoulli: N = 195



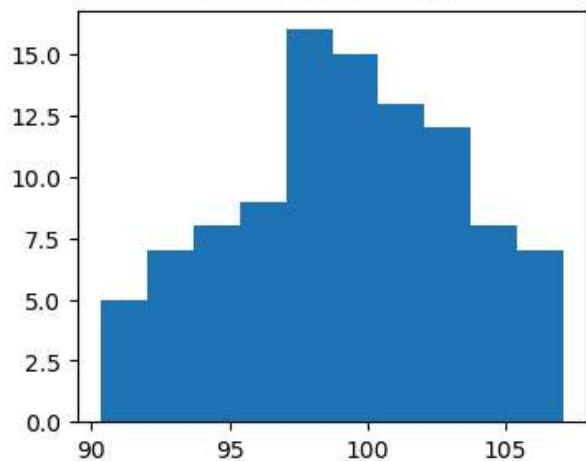
Uniforme: N = 196



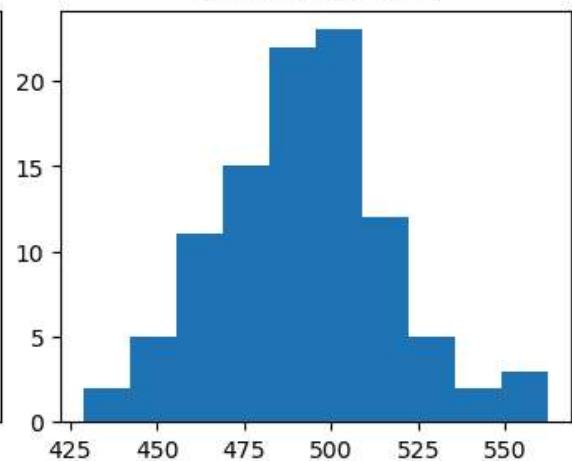
Bernoulli: N = 196



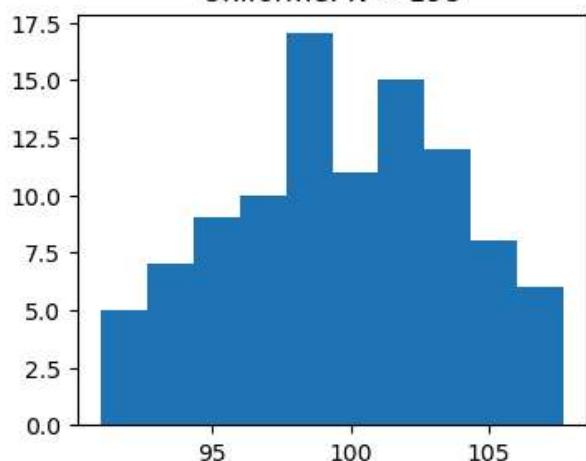
Uniforme: N = 197



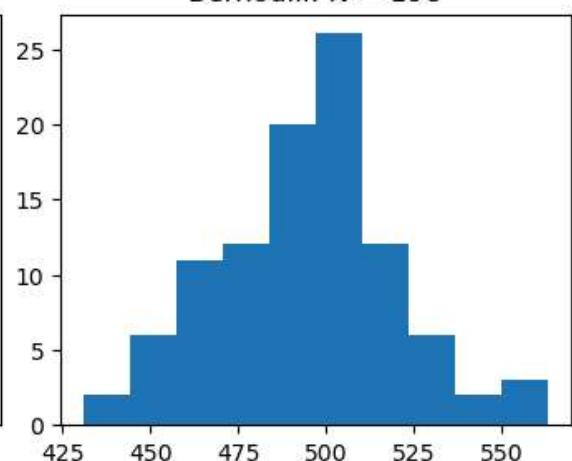
Bernoulli: N = 197



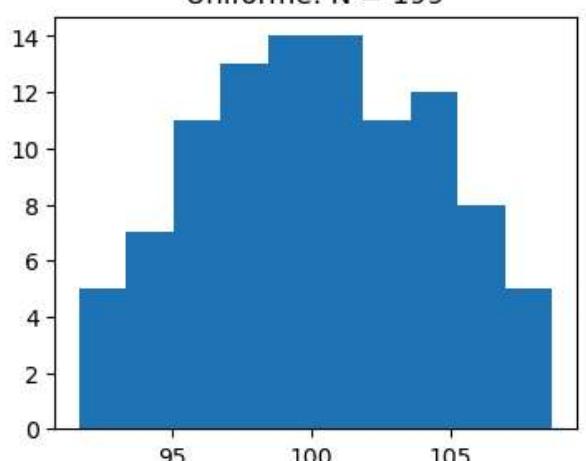
Uniforme: N = 198



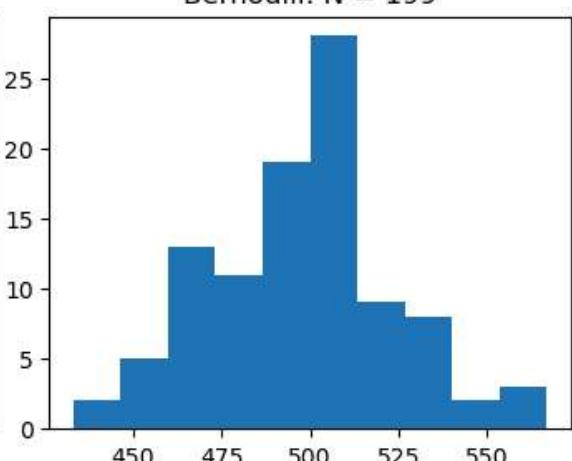
Bernoulli: N = 198

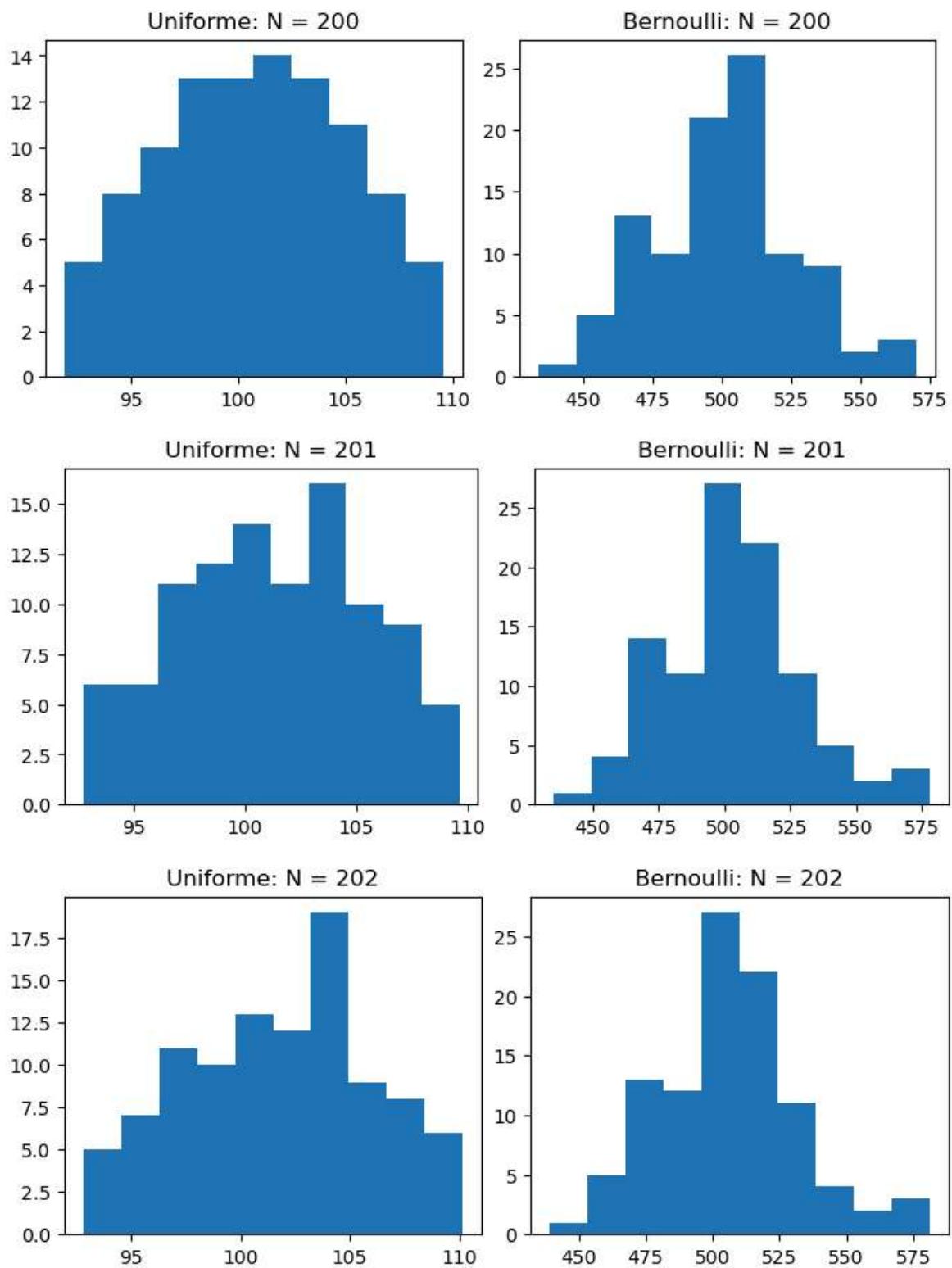


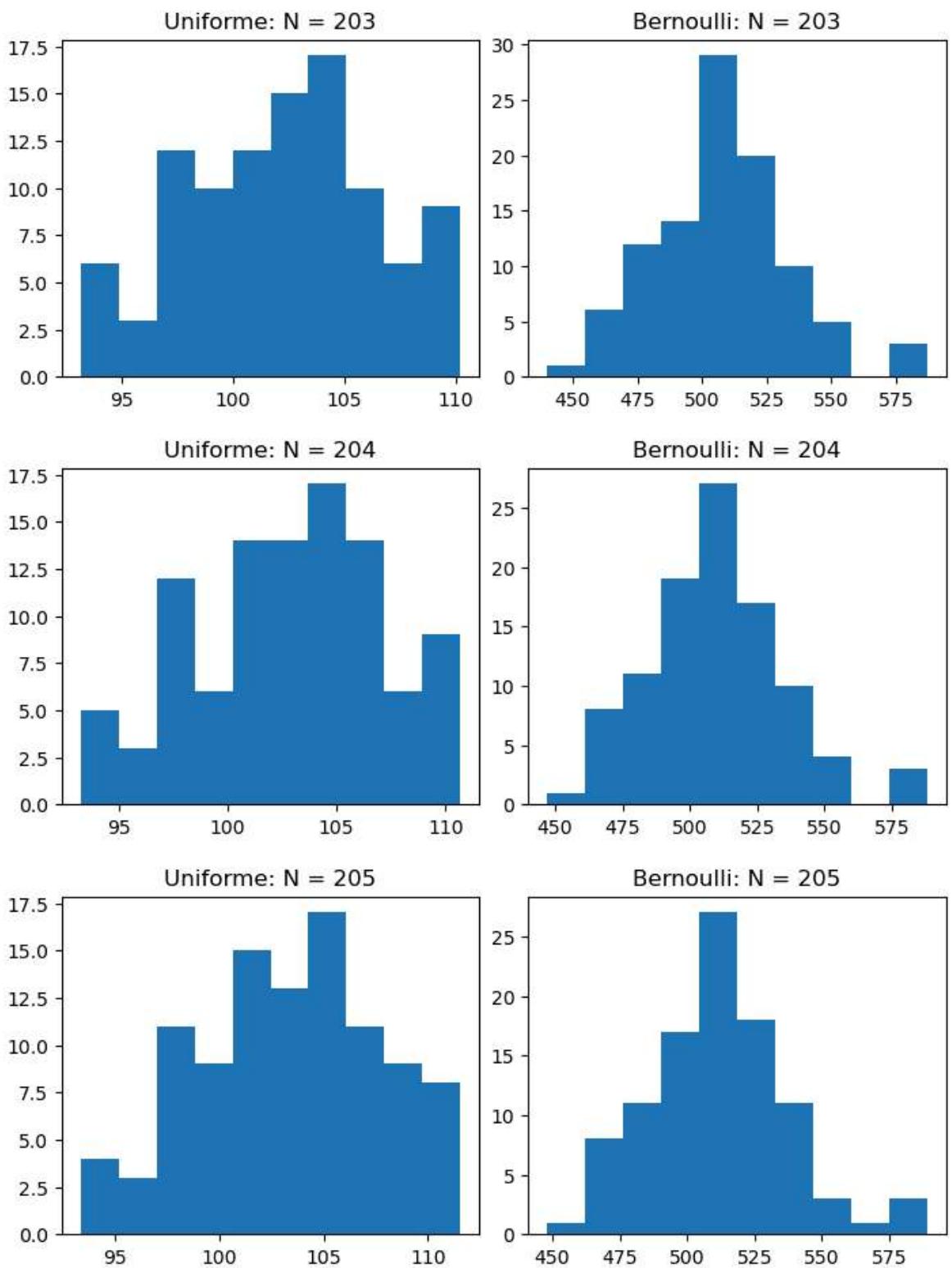
Uniforme: N = 199

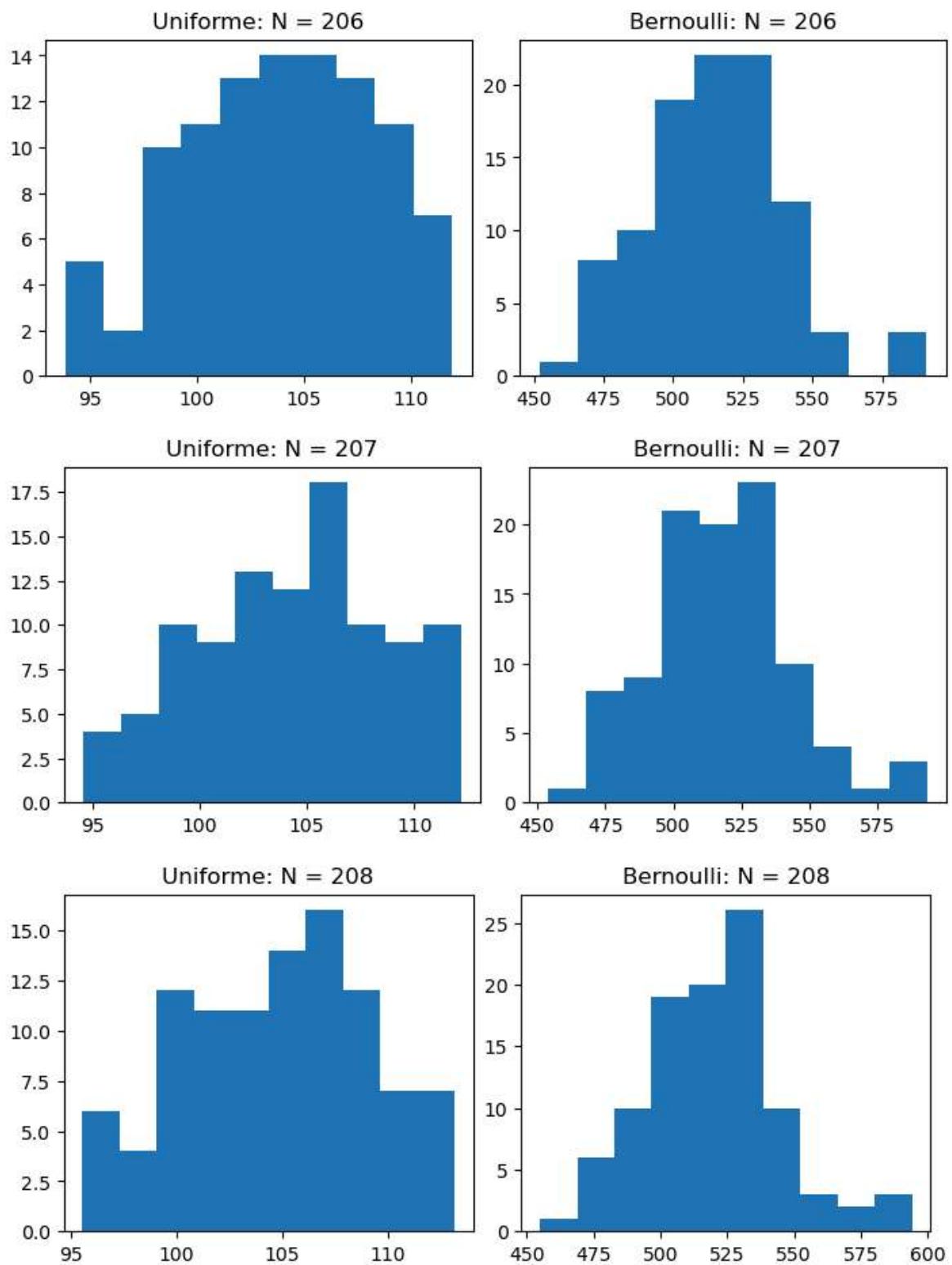


Bernoulli: N = 199

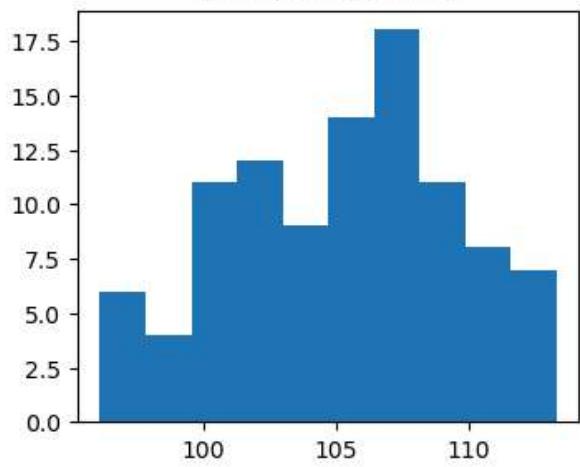




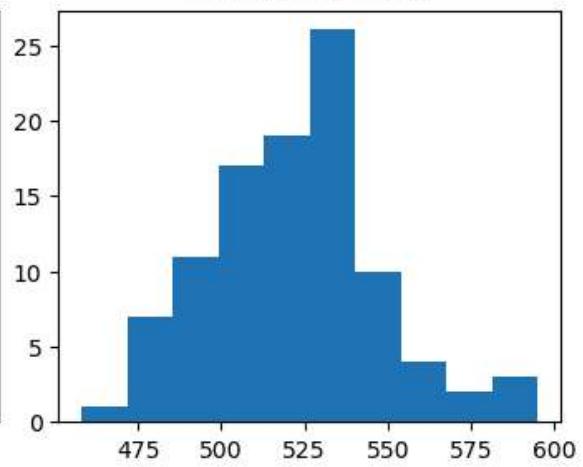




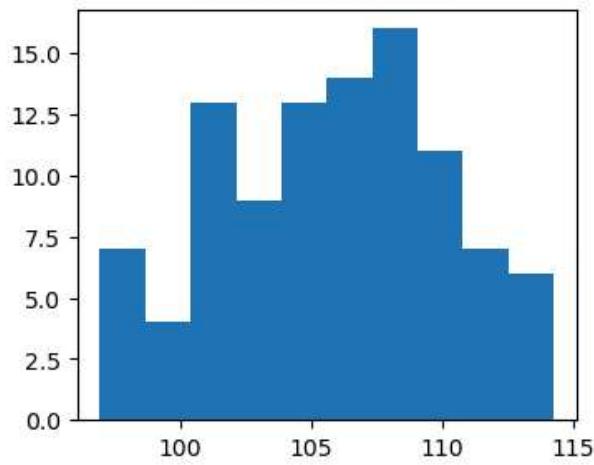
Uniforme: N = 209



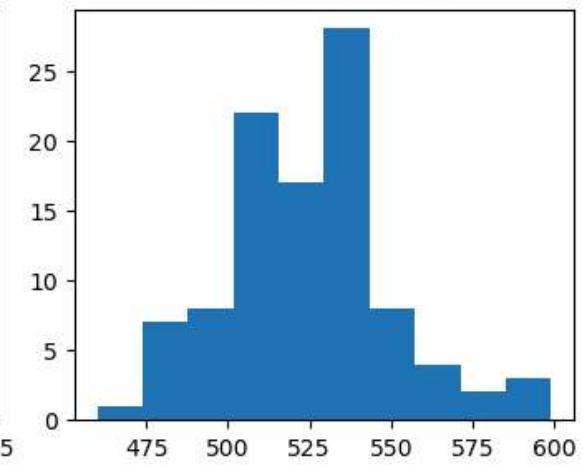
Bernoulli: N = 209



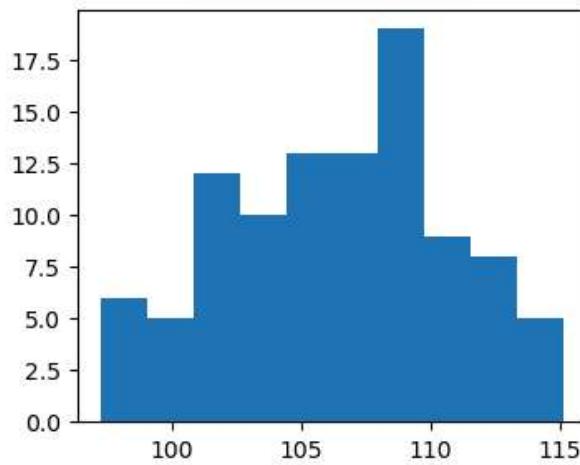
Uniforme: N = 210



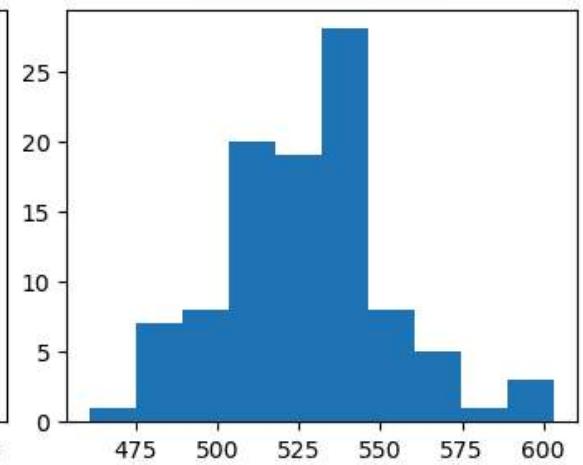
Bernoulli: N = 210

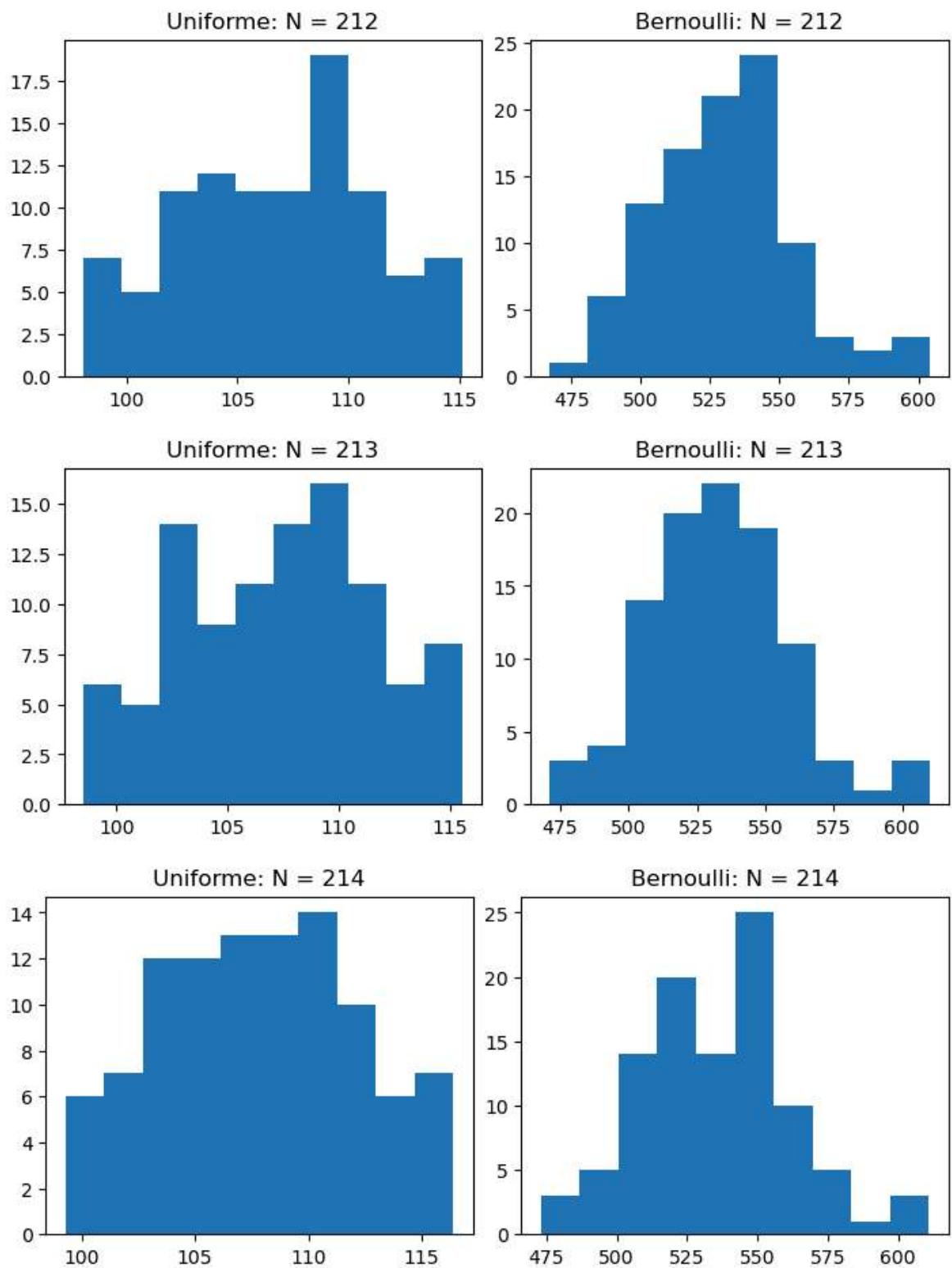


Uniforme: N = 211

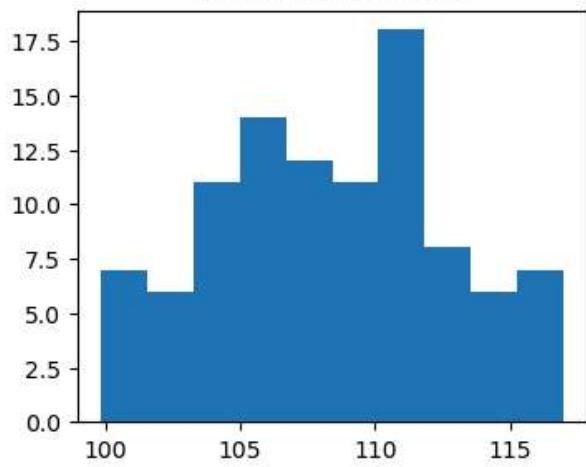


Bernoulli: N = 211

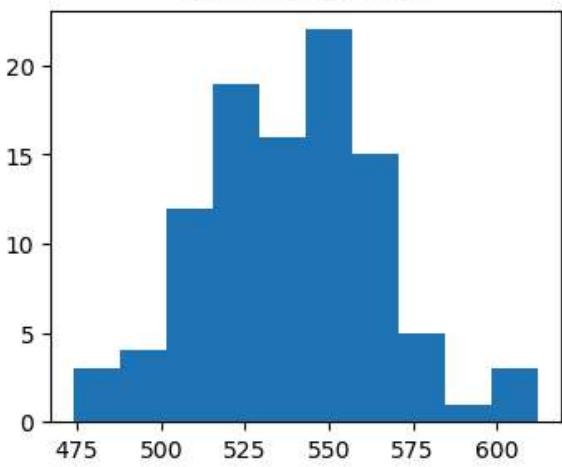




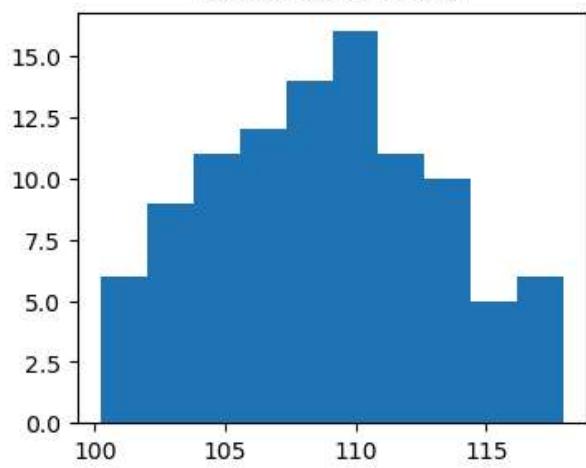
Uniforme: N = 215



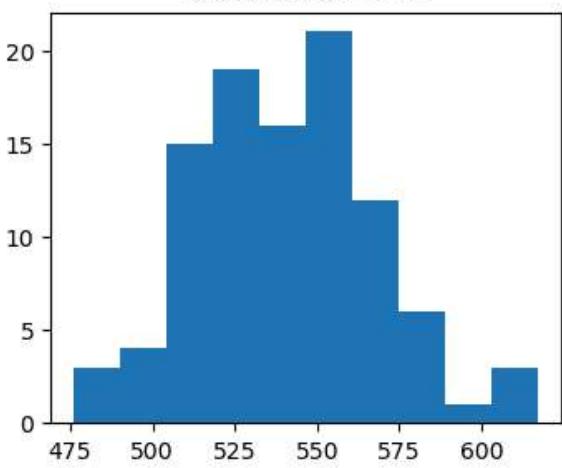
Bernoulli: N = 215



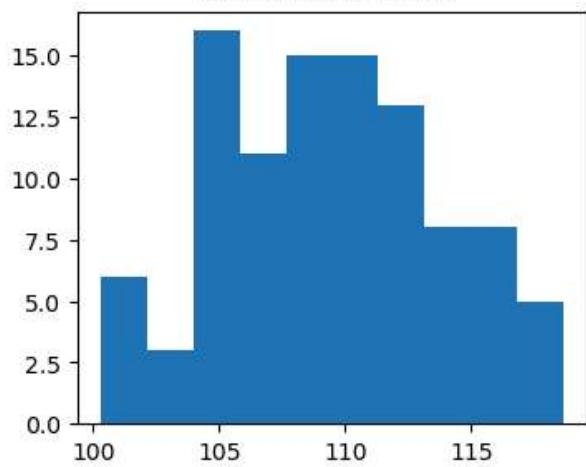
Uniforme: N = 216



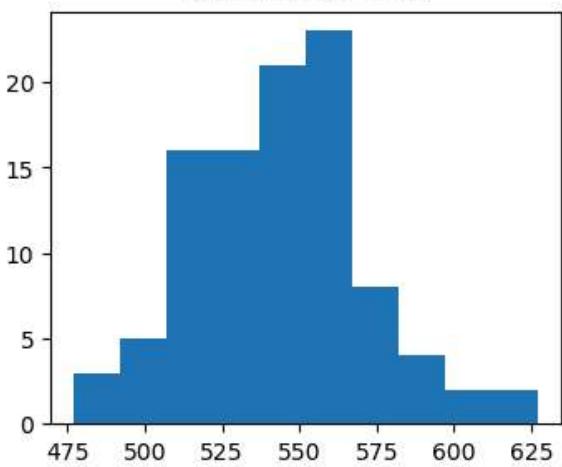
Bernoulli: N = 216

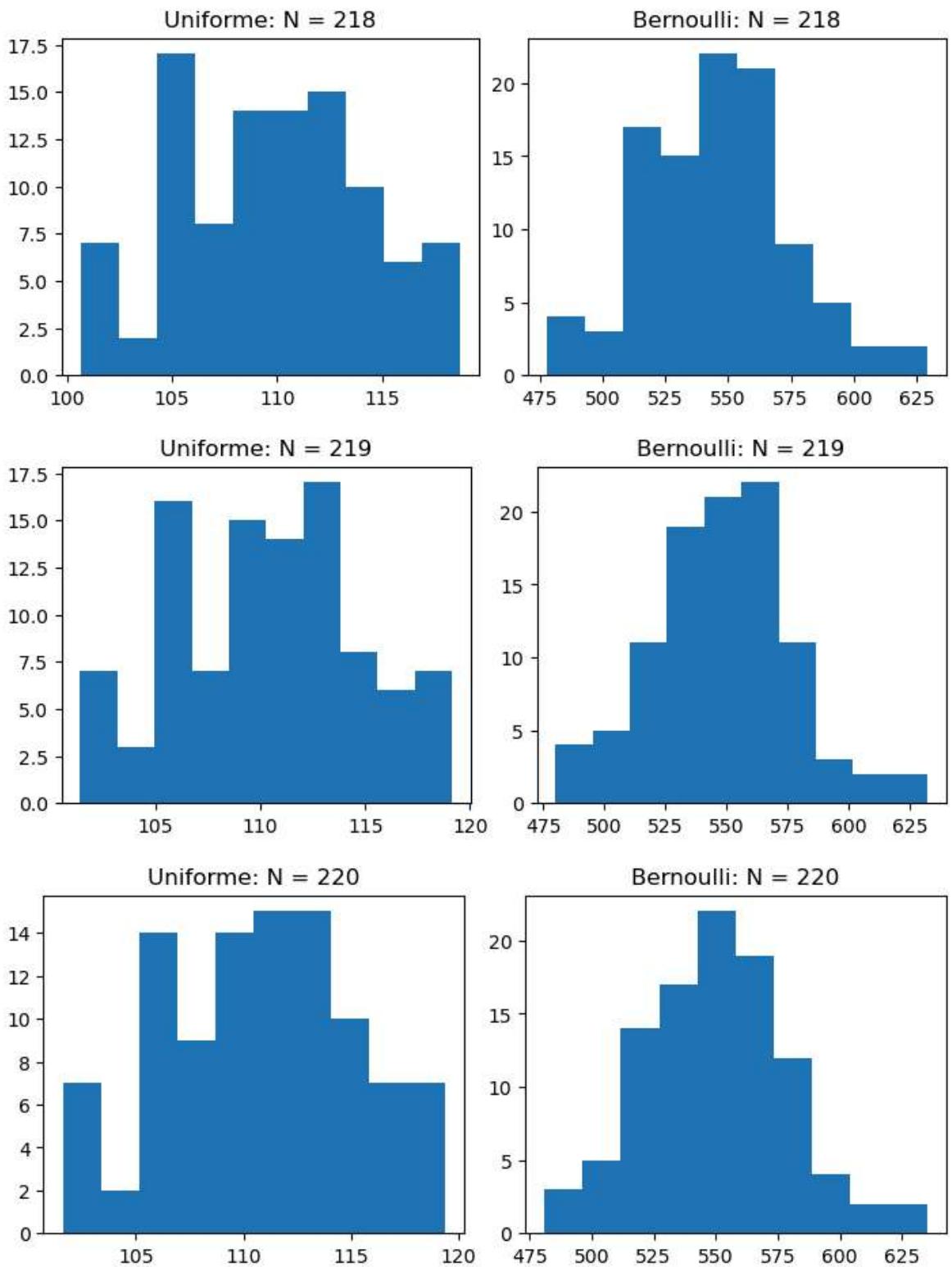


Uniforme: N = 217

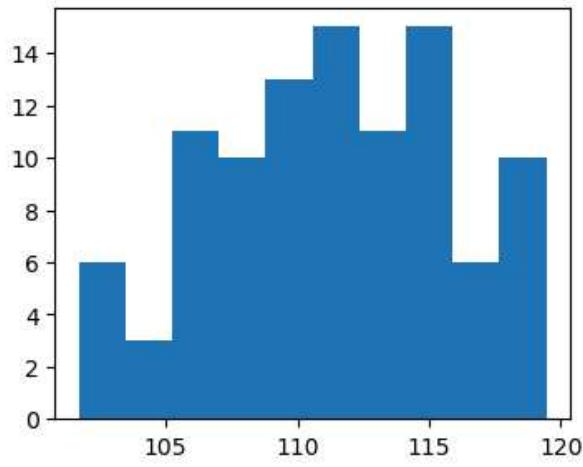


Bernoulli: N = 217

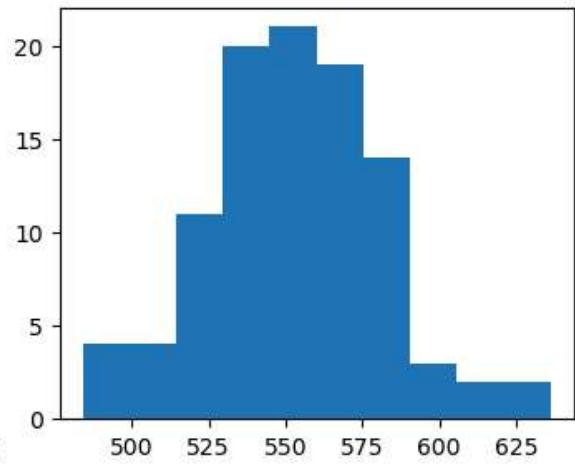




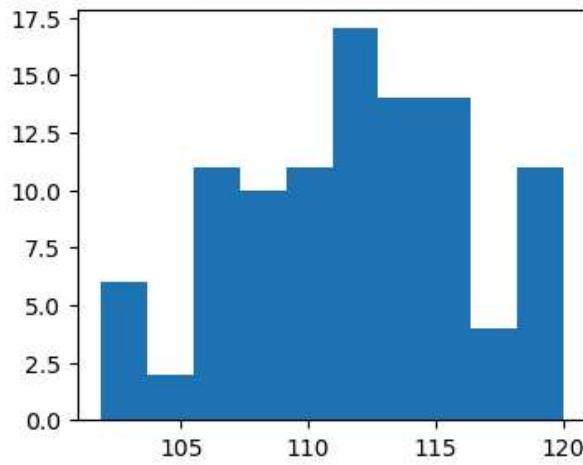
Uniforme: N = 221



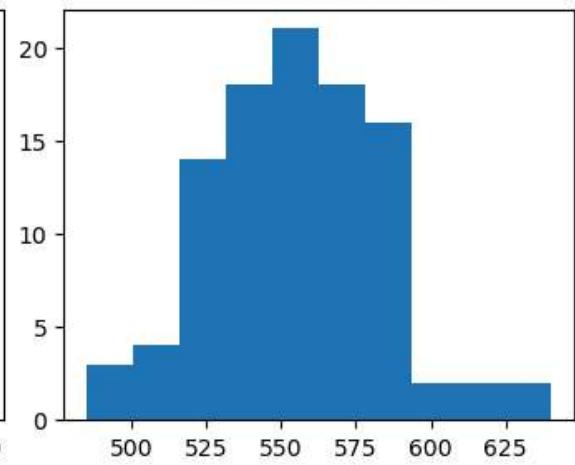
Bernoulli: N = 221



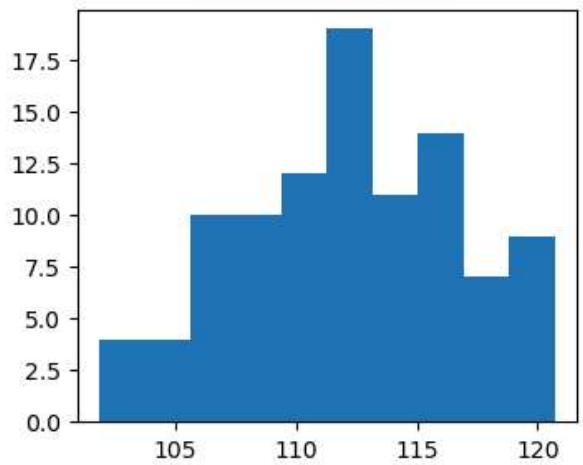
Uniforme: N = 222



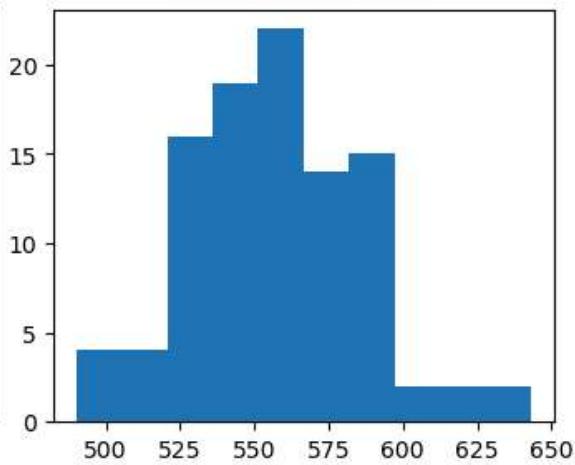
Bernoulli: N = 222



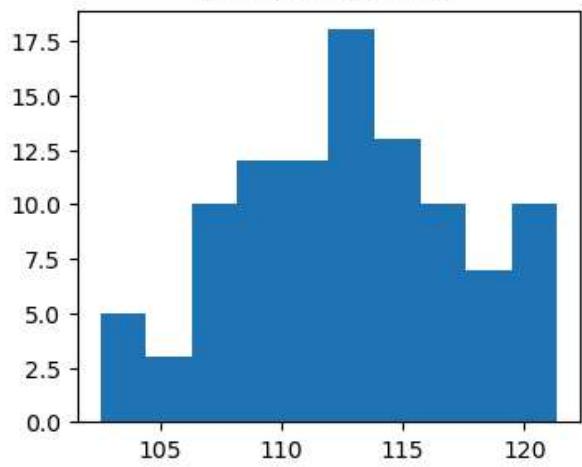
Uniforme: N = 223



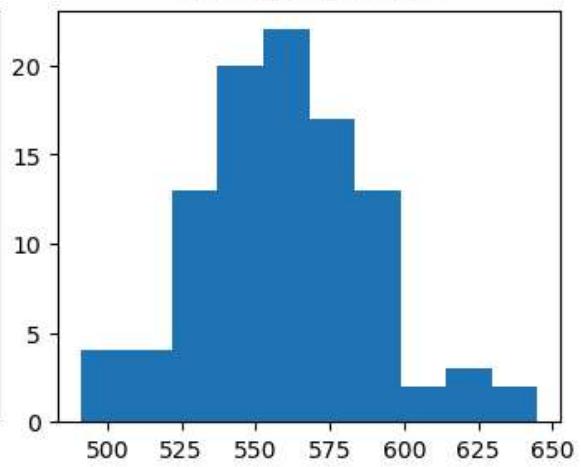
Bernoulli: N = 223



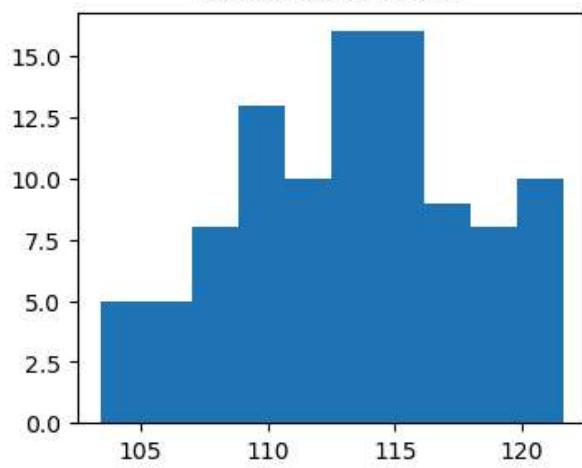
Uniforme: N = 224



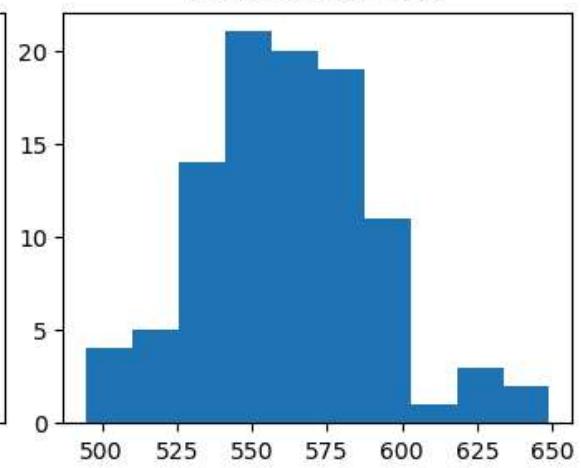
Bernoulli: N = 224



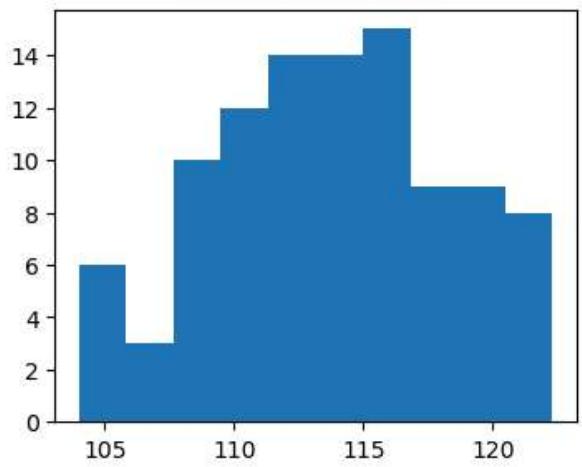
Uniforme: N = 225



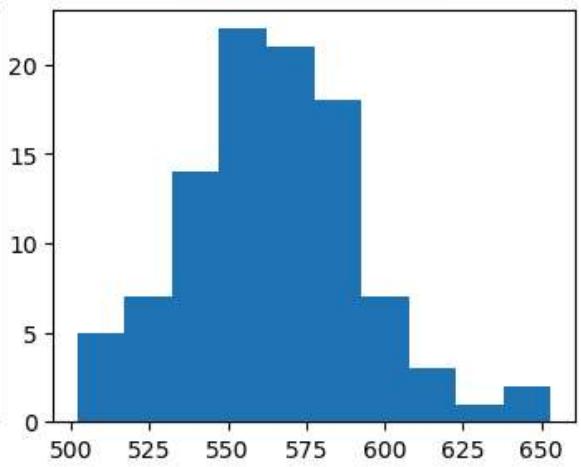
Bernoulli: N = 225



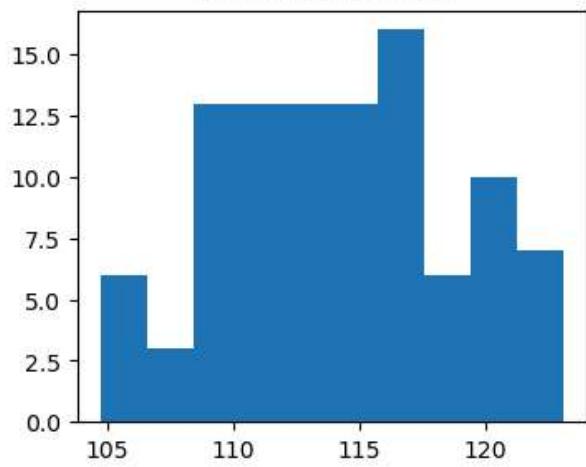
Uniforme: N = 226



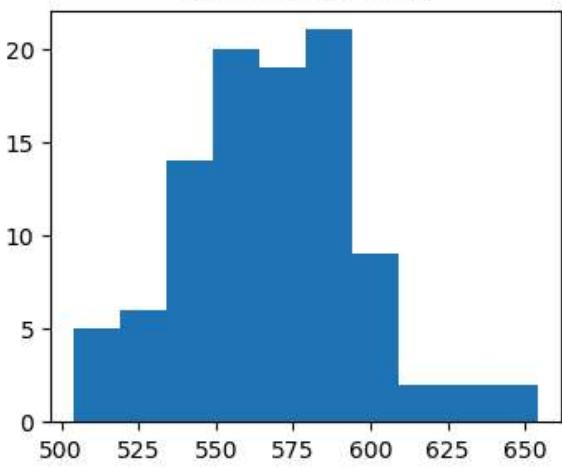
Bernoulli: N = 226



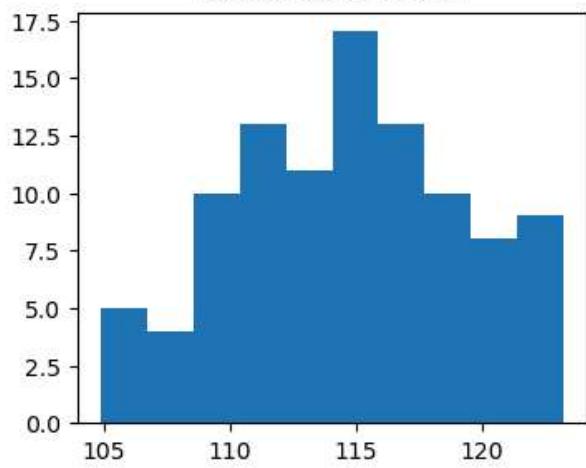
Uniforme: N = 227



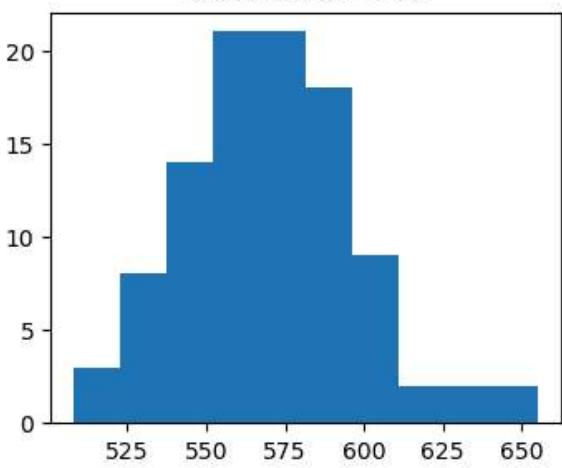
Bernoulli: N = 227



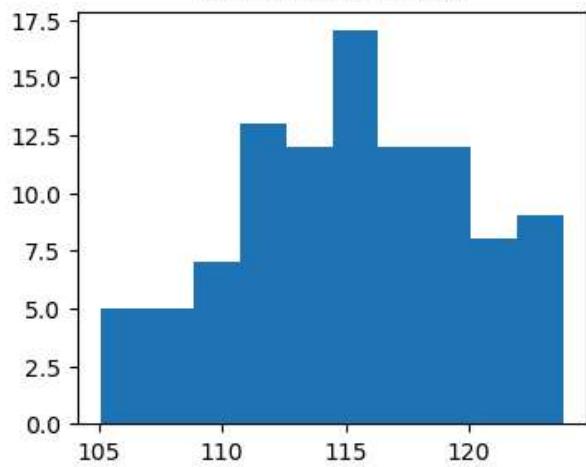
Uniforme: N = 228



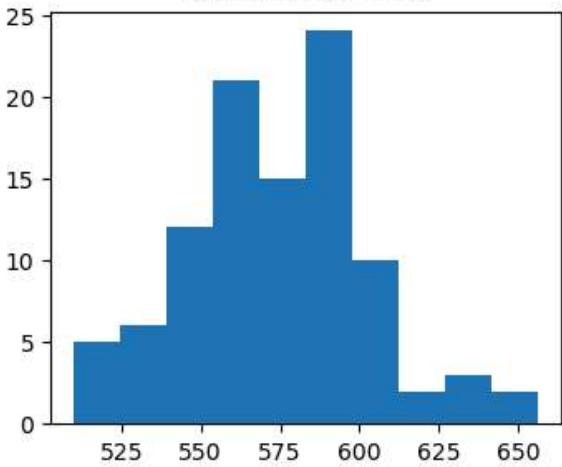
Bernoulli: N = 228

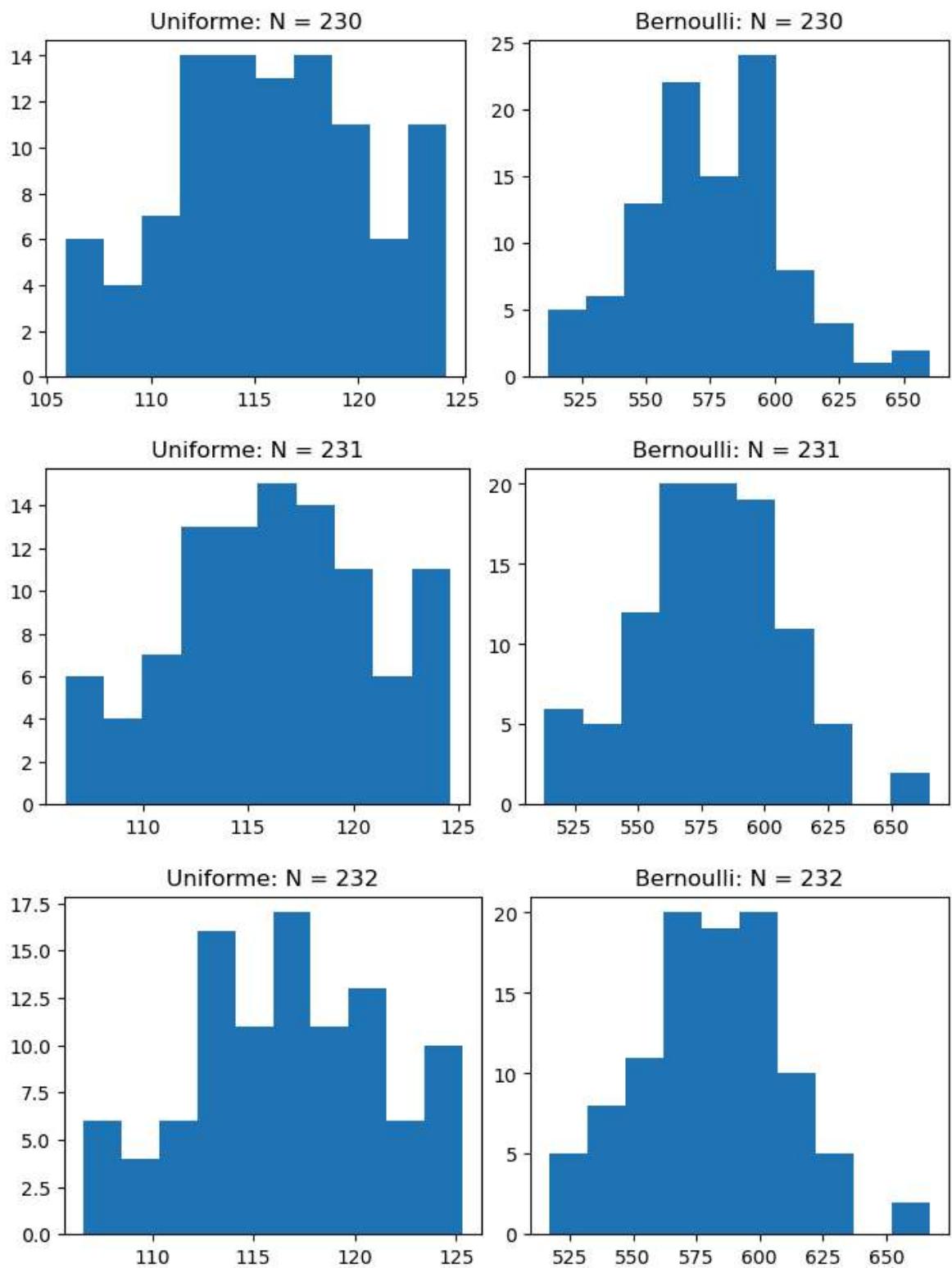


Uniforme: N = 229

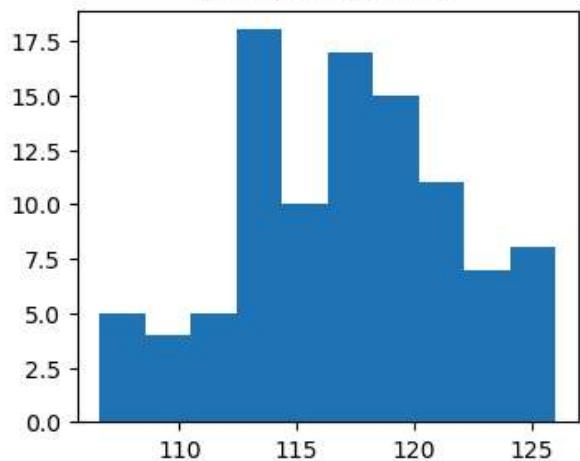


Bernoulli: N = 229

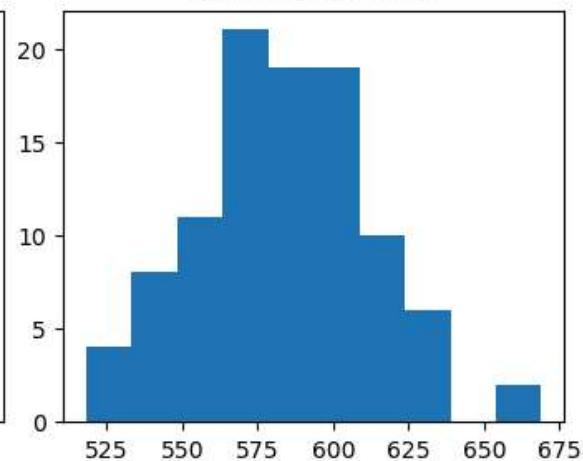




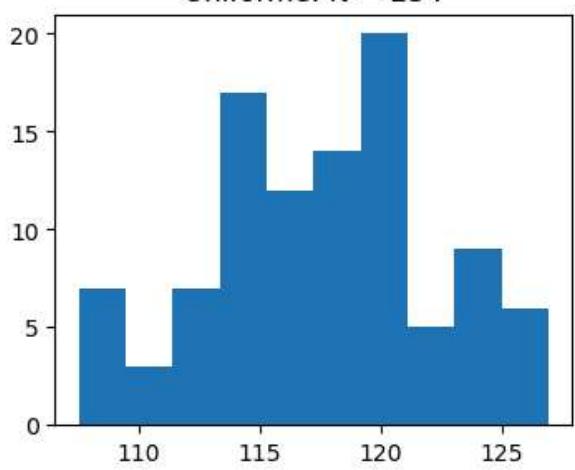
Uniforme: N = 233



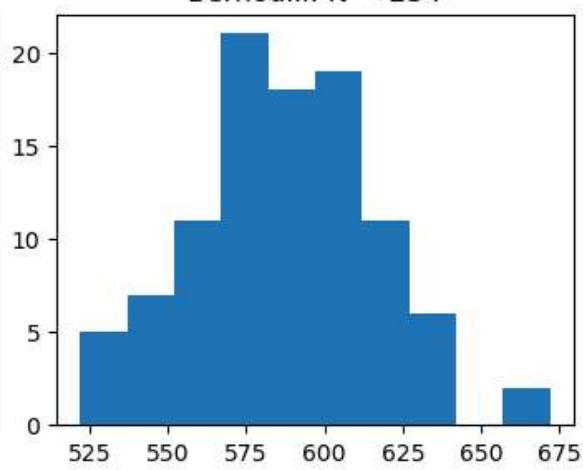
Bernoulli: N = 233



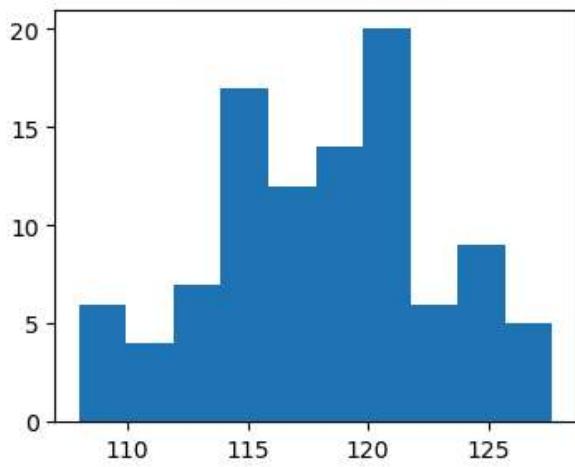
Uniforme: N = 234



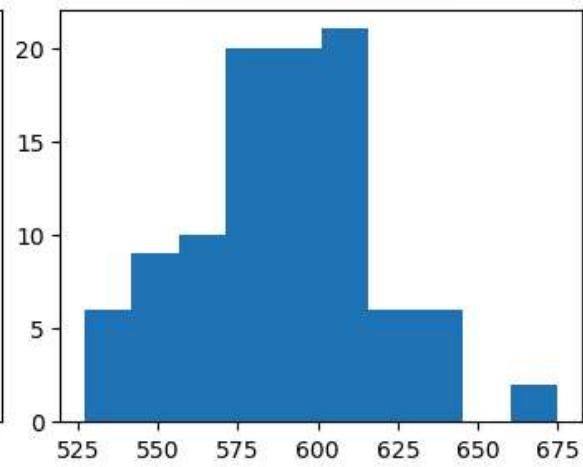
Bernoulli: N = 234

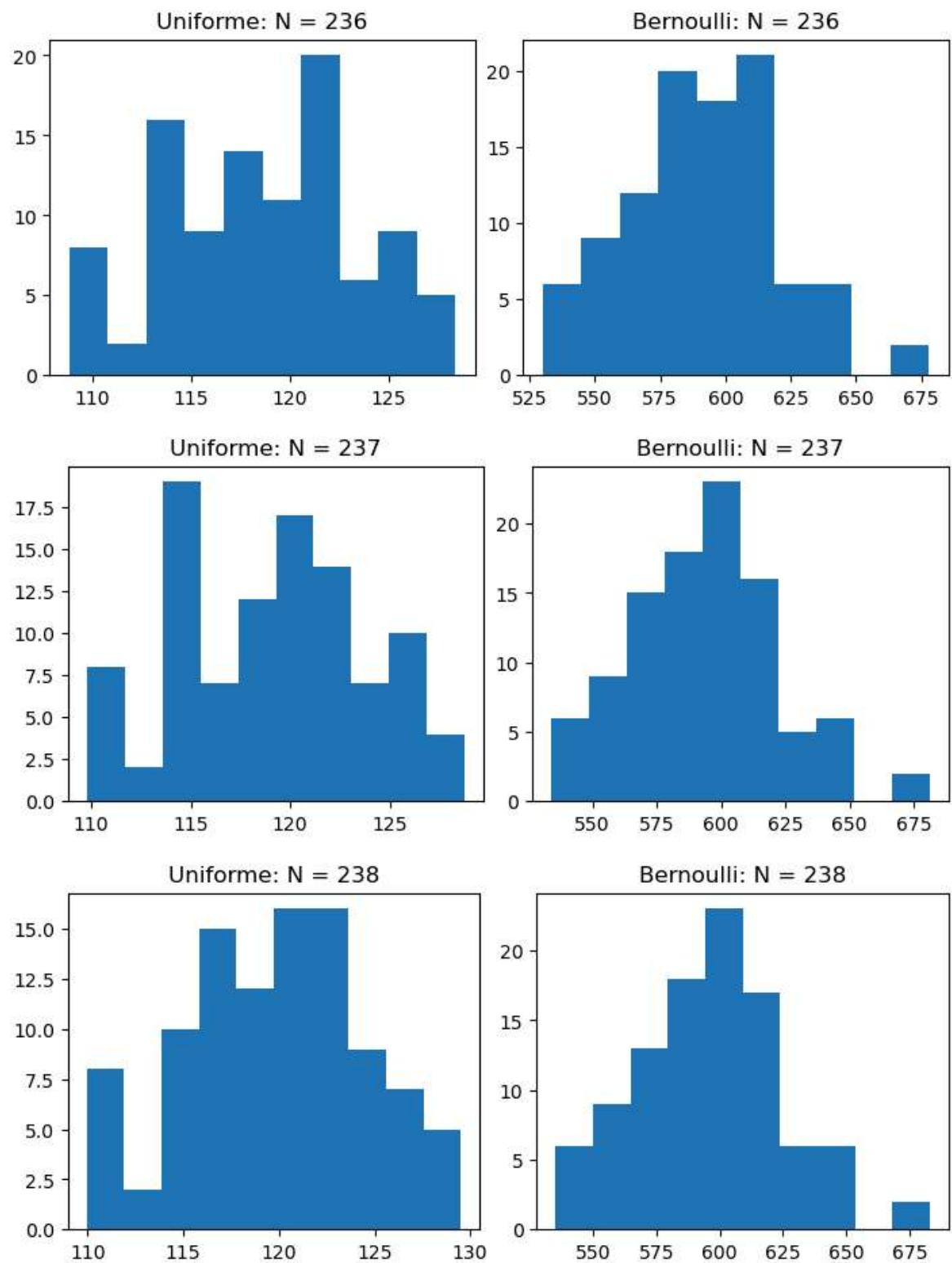


Uniforme: N = 235

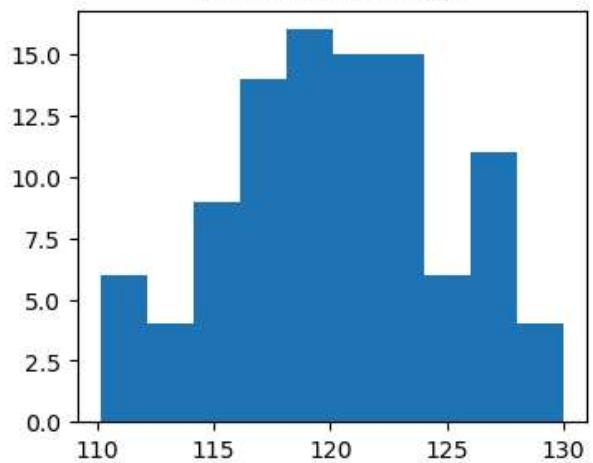


Bernoulli: N = 235

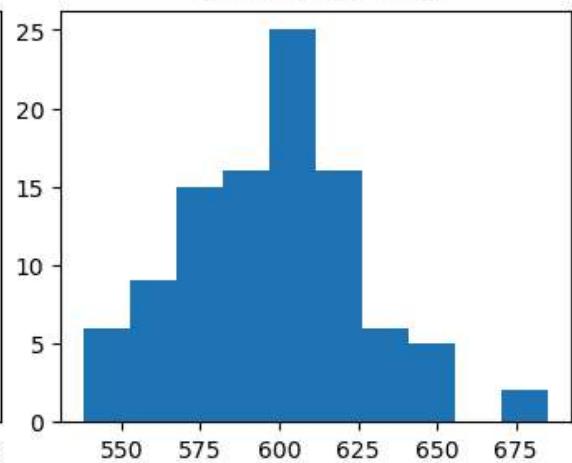




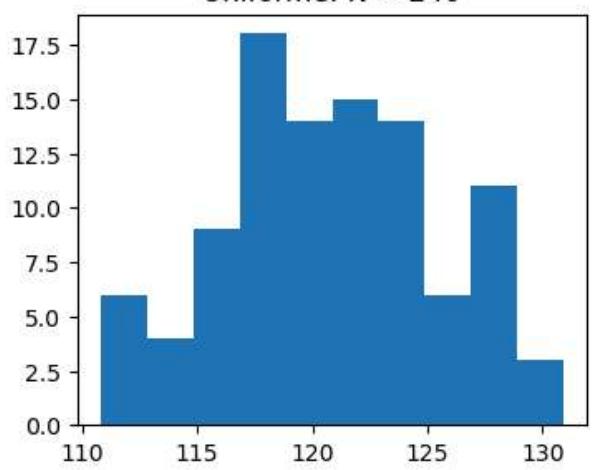
Uniforme: N = 239



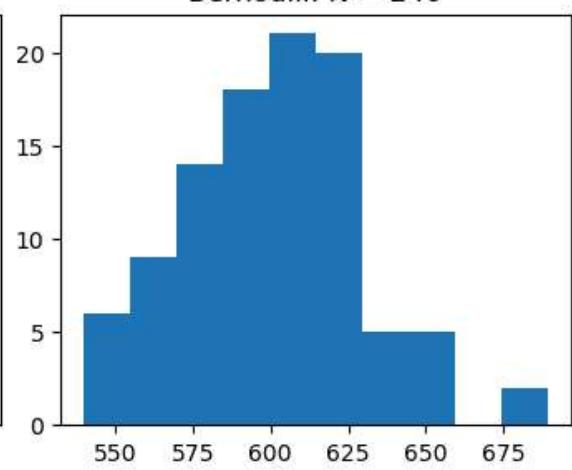
Bernoulli: N = 239



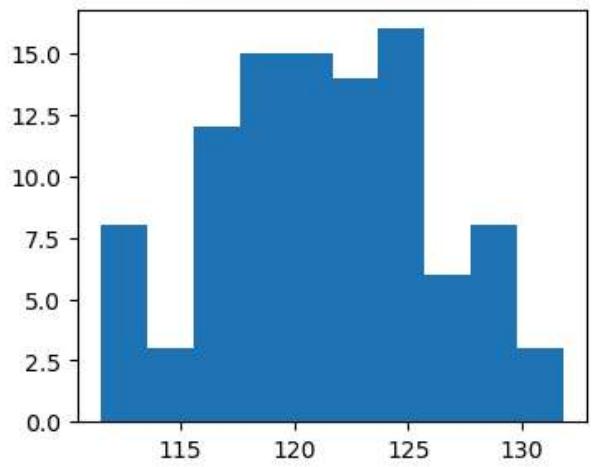
Uniforme: N = 240



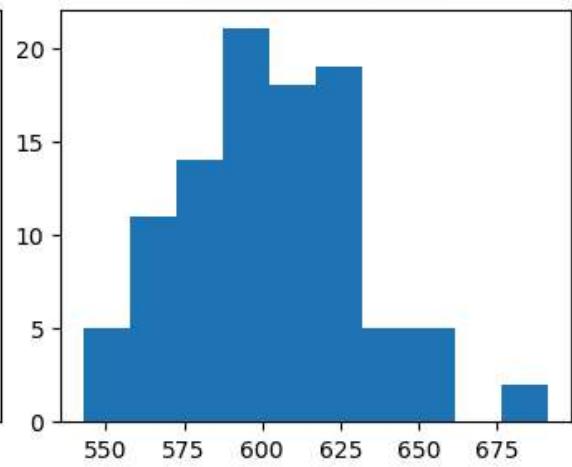
Bernoulli: N = 240

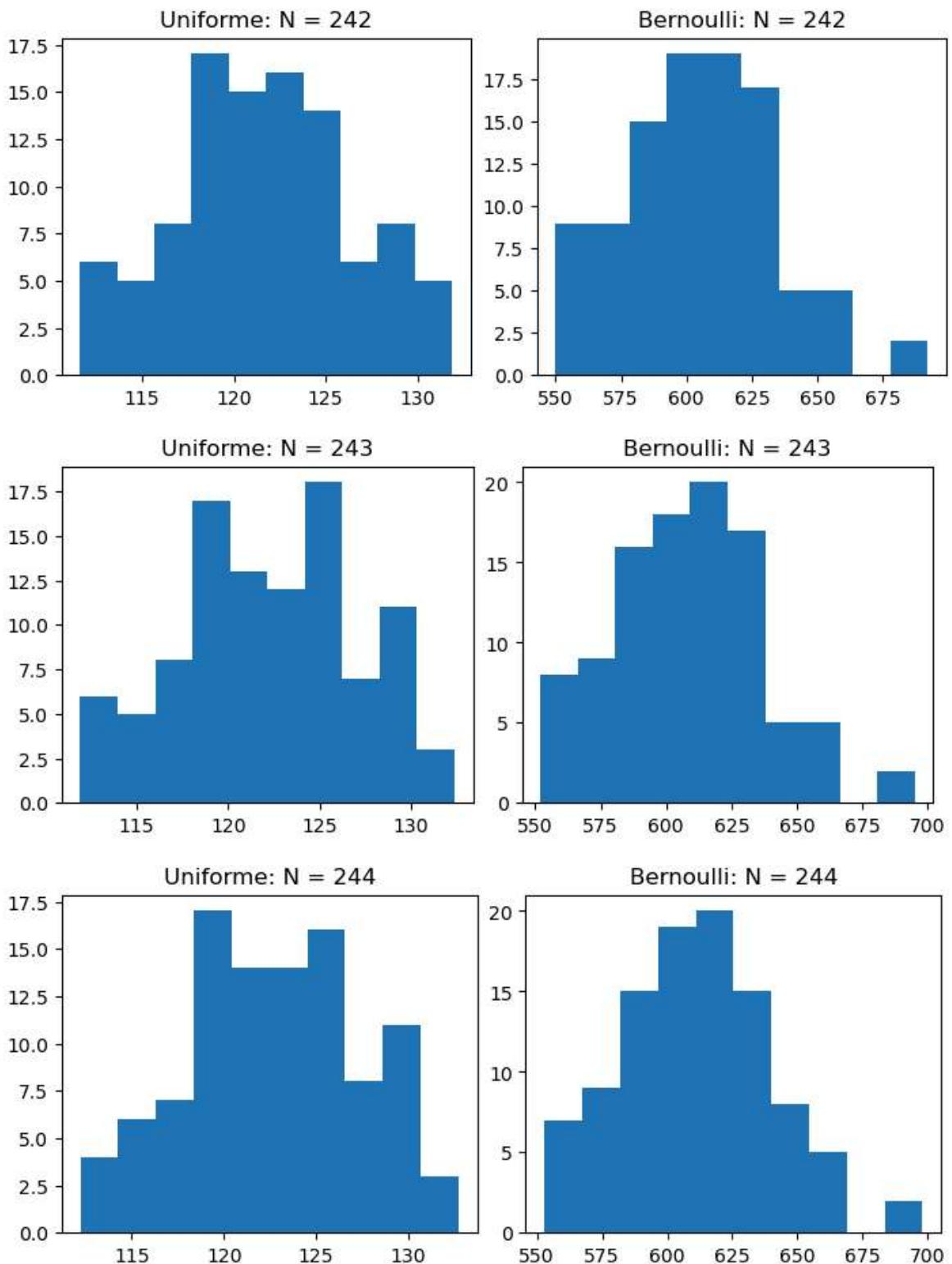


Uniforme: N = 241

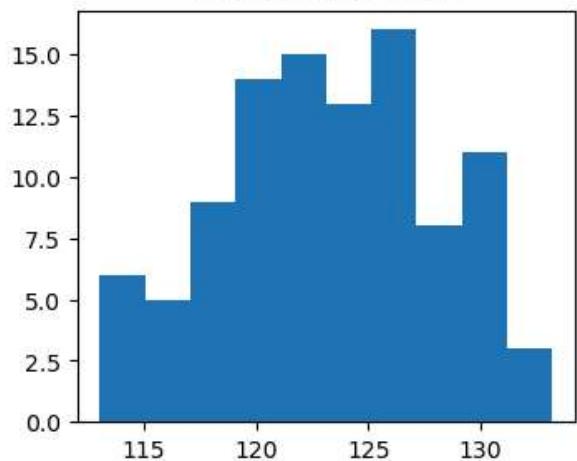


Bernoulli: N = 241

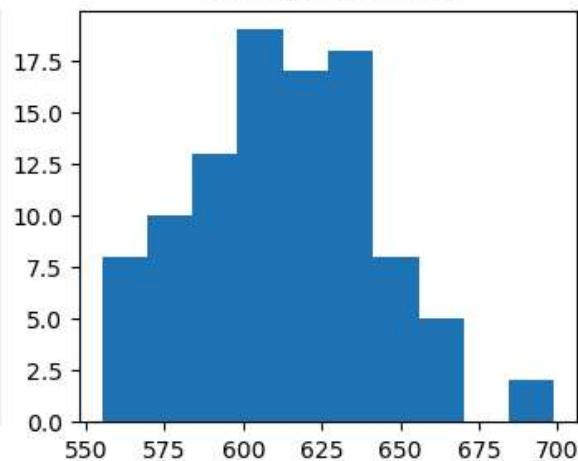




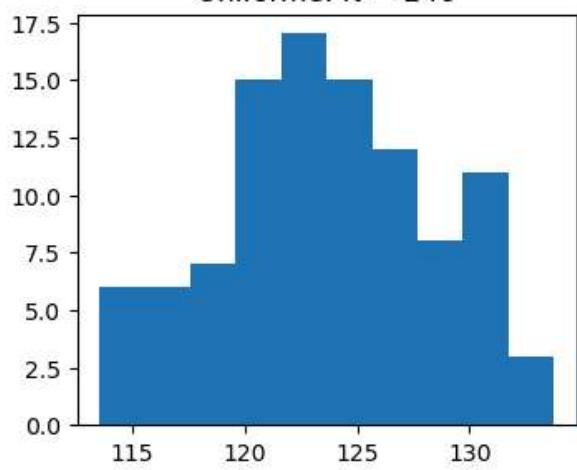
Uniforme: N = 245



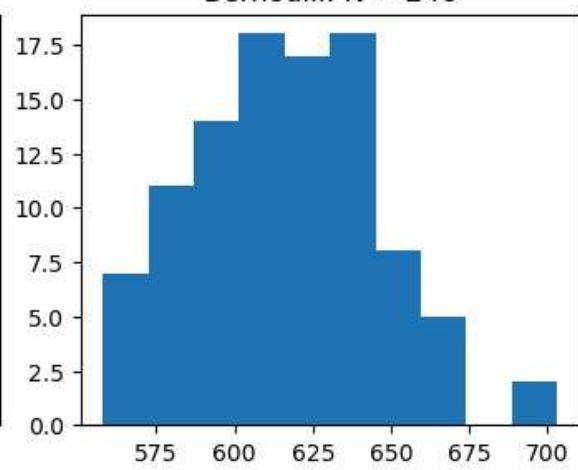
Bernoulli: N = 245



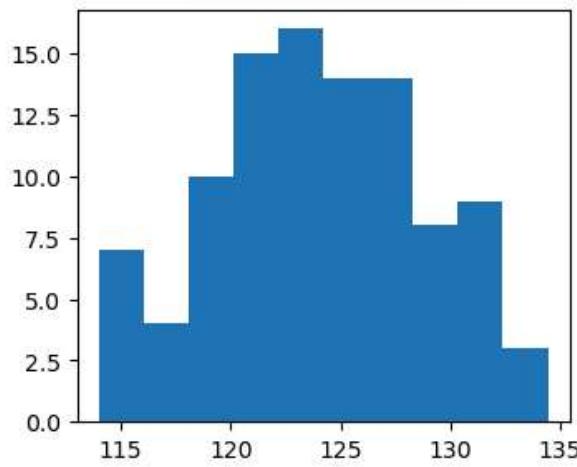
Uniforme: N = 246



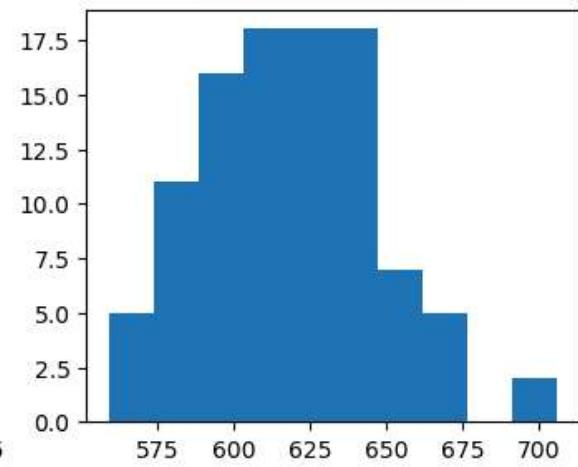
Bernoulli: N = 246



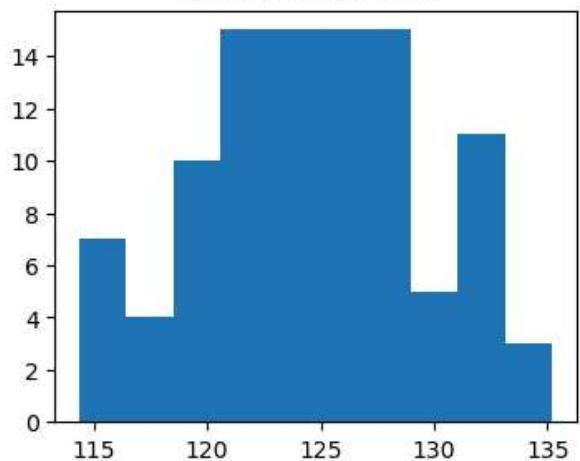
Uniforme: N = 247



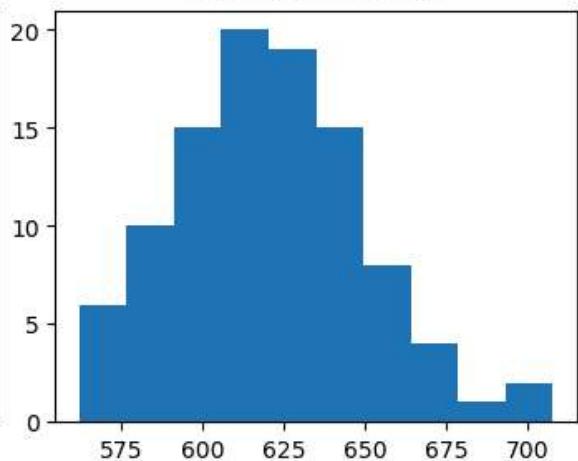
Bernoulli: N = 247



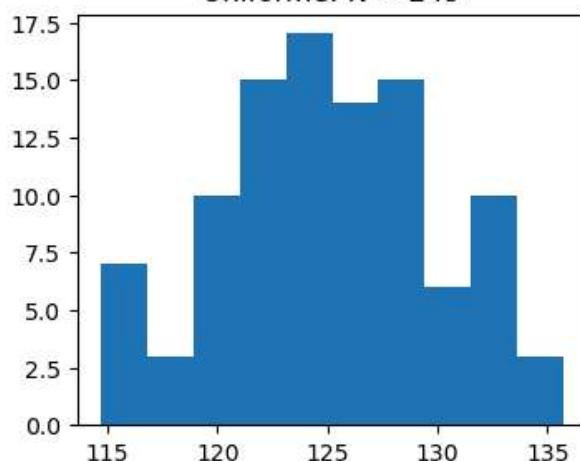
Uniforme: N = 248



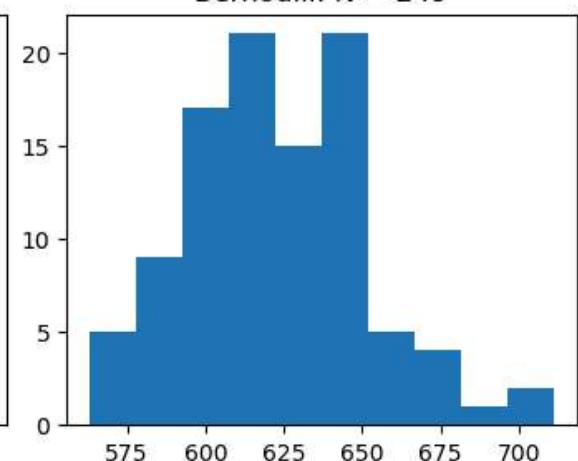
Bernoulli: N = 248



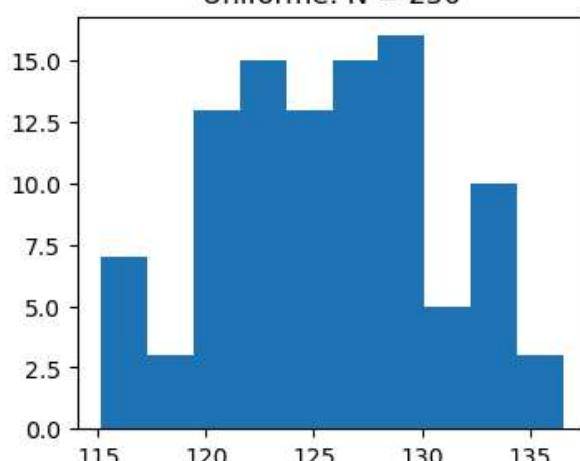
Uniforme: N = 249



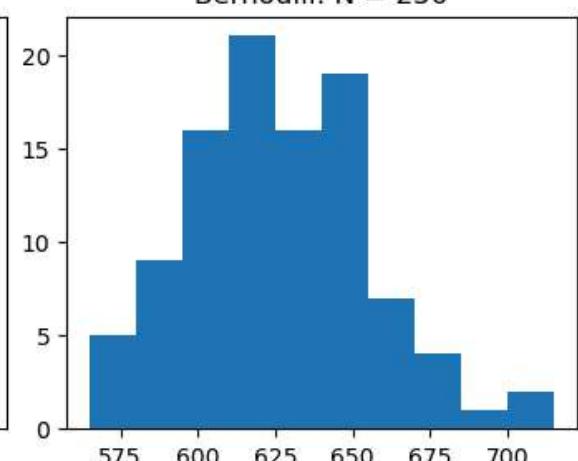
Bernoulli: N = 249

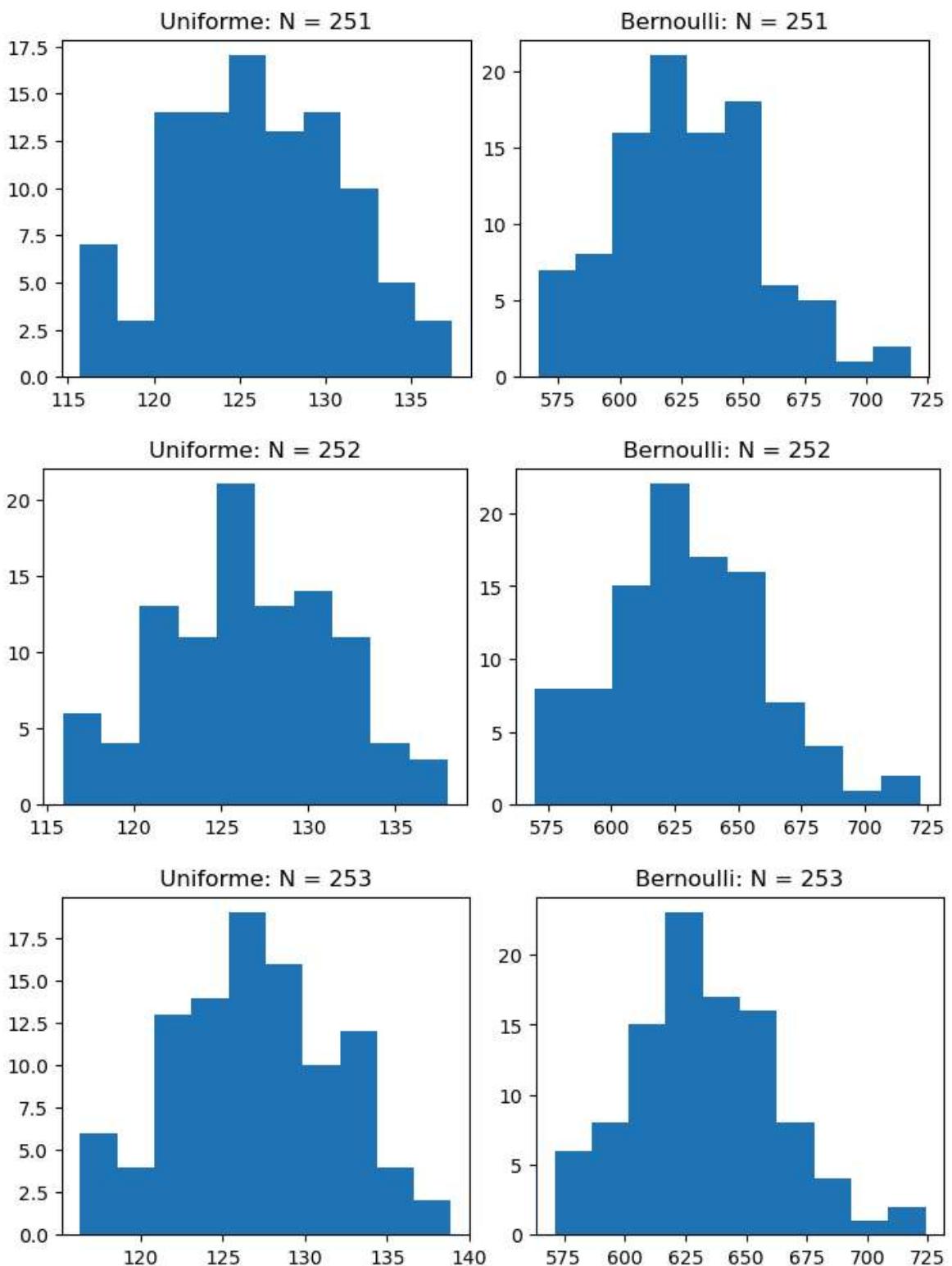


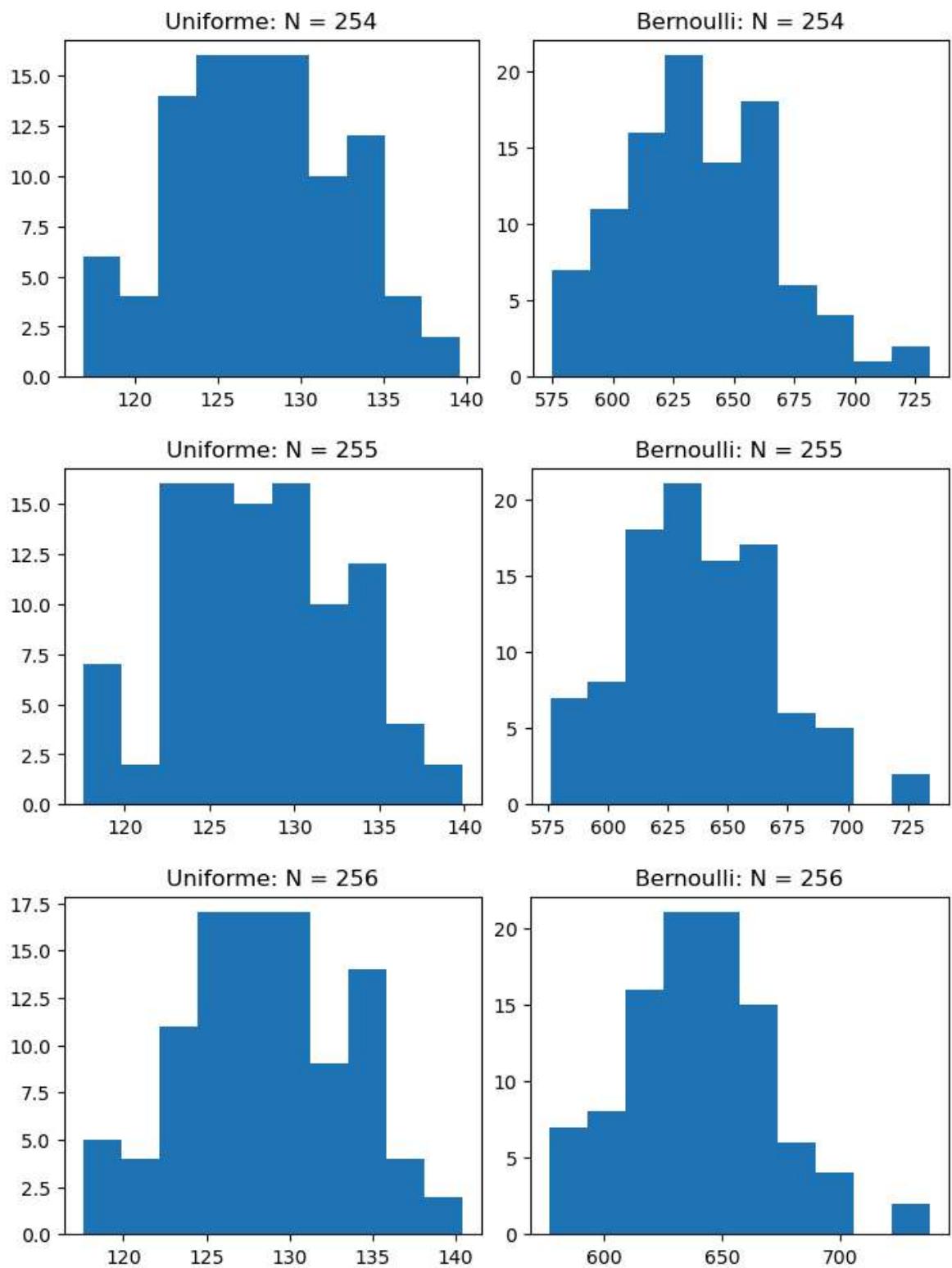
Uniforme: N = 250

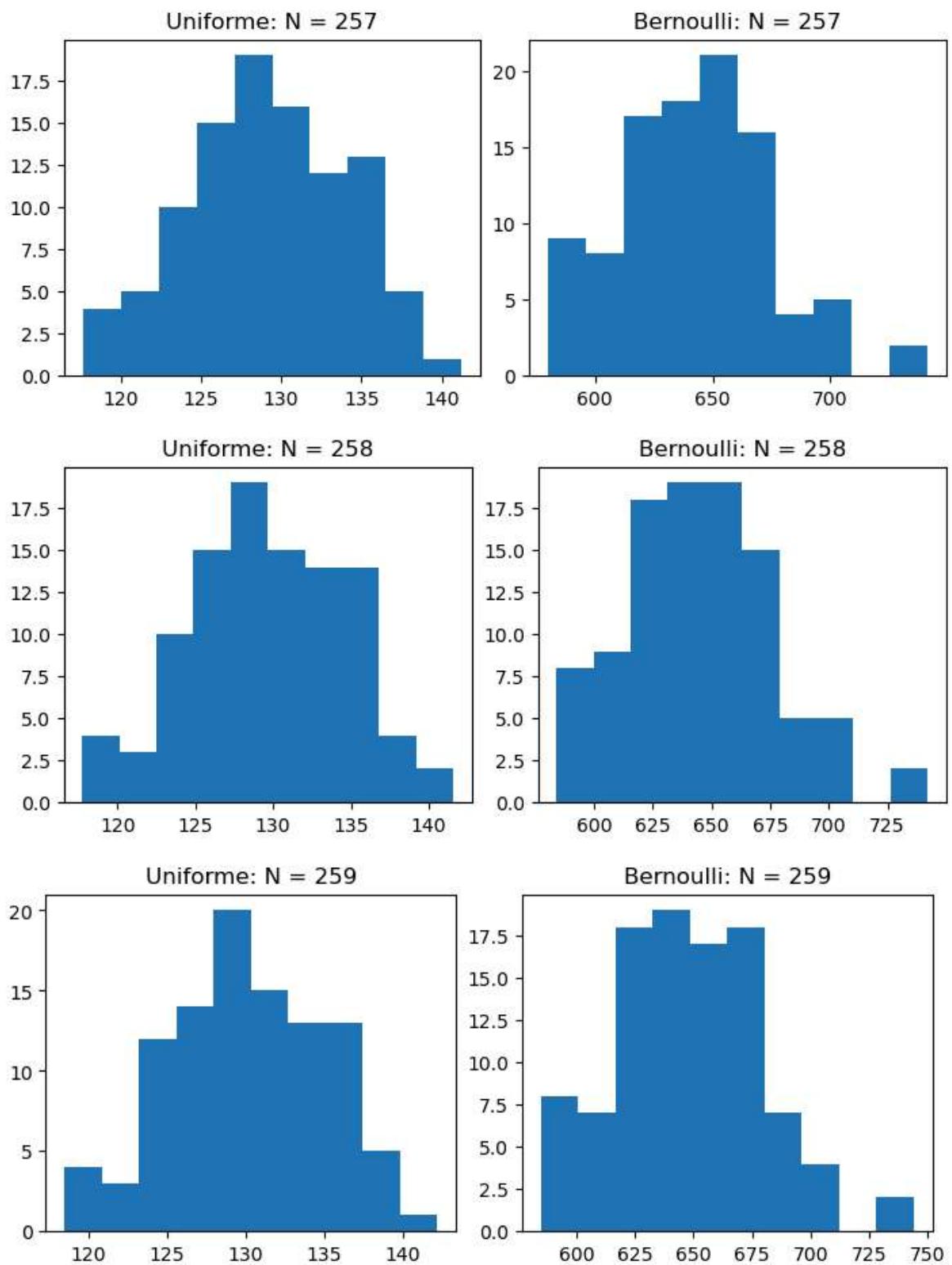


Bernoulli: N = 250

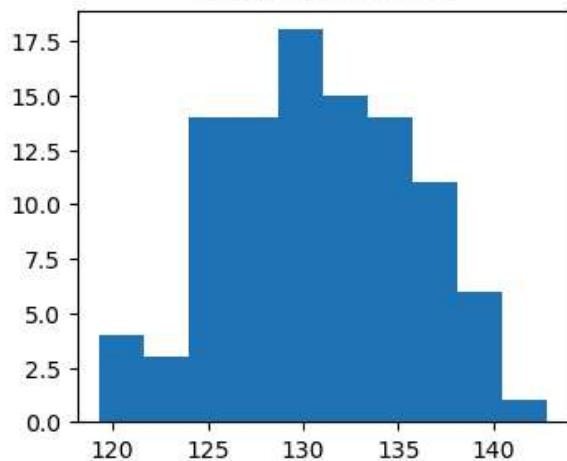




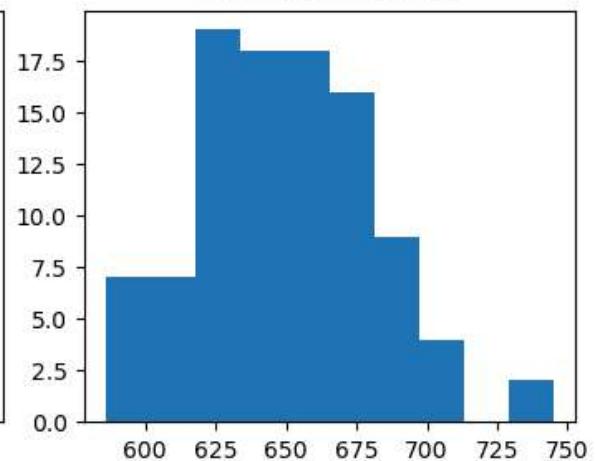




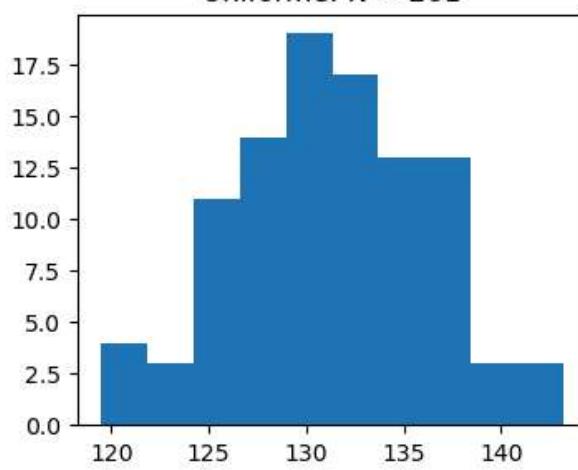
Uniforme: N = 260



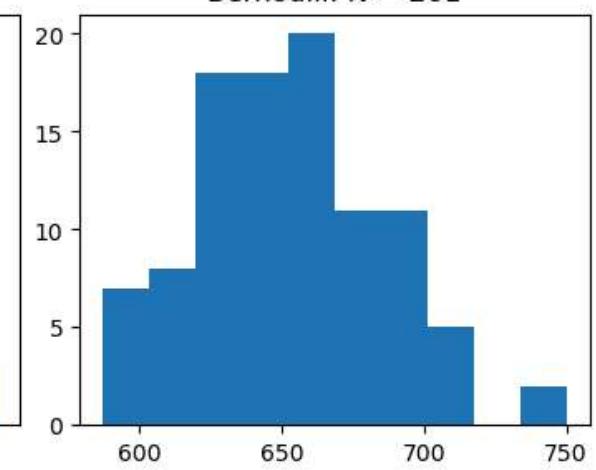
Bernoulli: N = 260



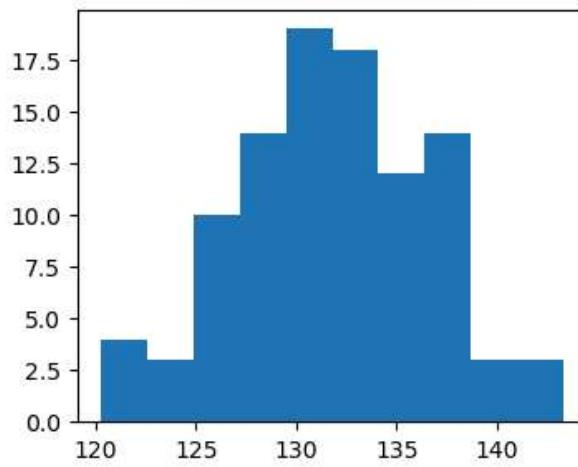
Uniforme: N = 261



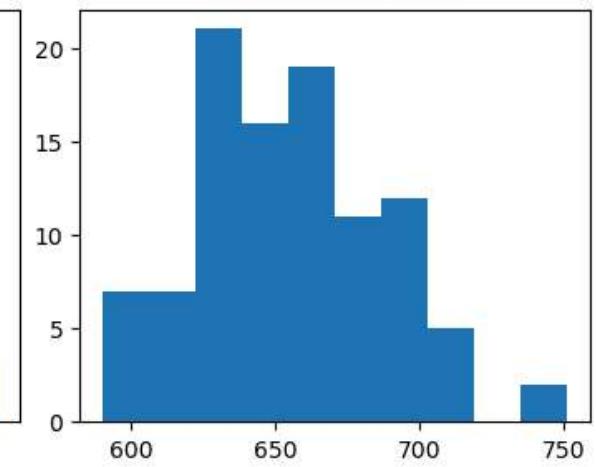
Bernoulli: N = 261

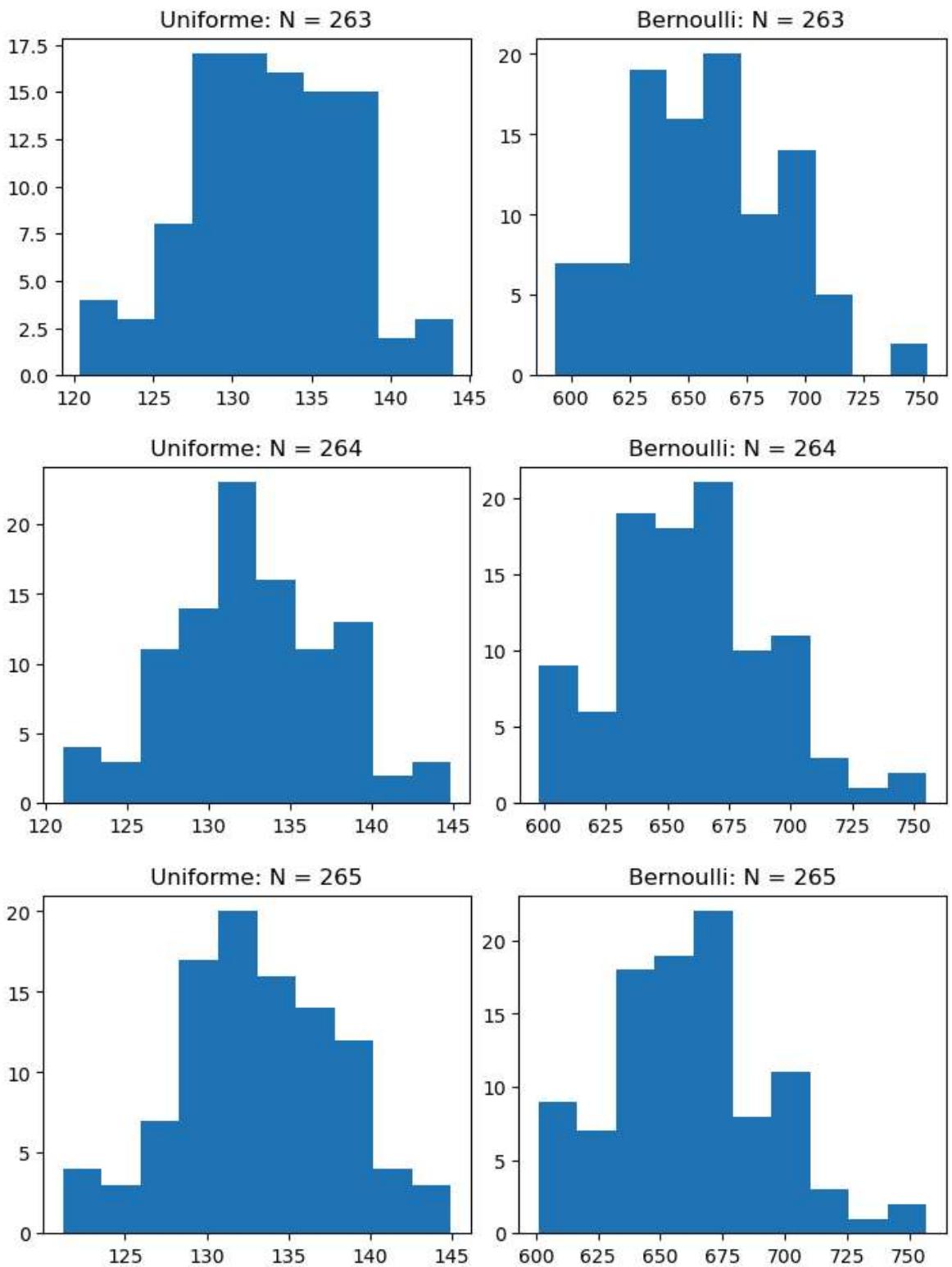


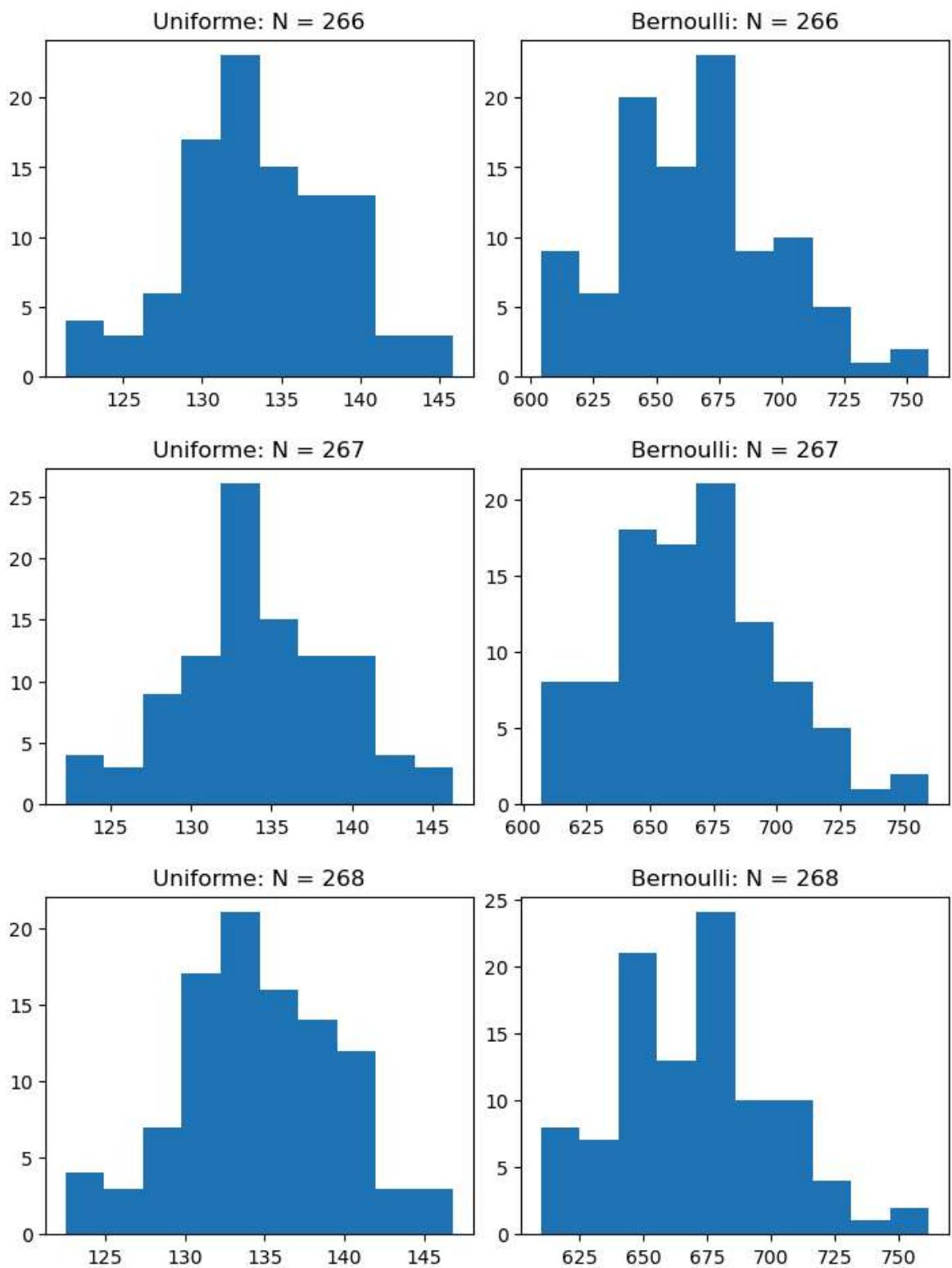
Uniforme: N = 262



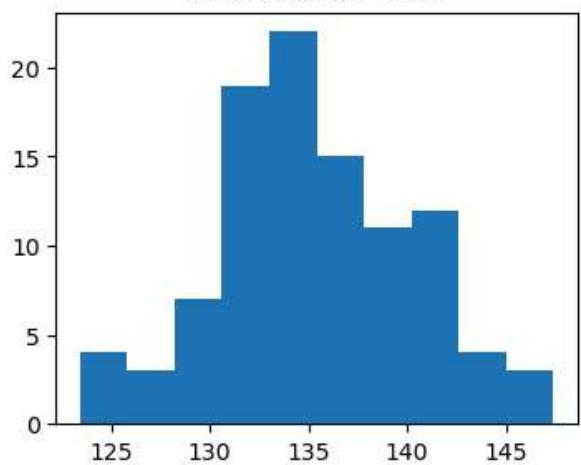
Bernoulli: N = 262



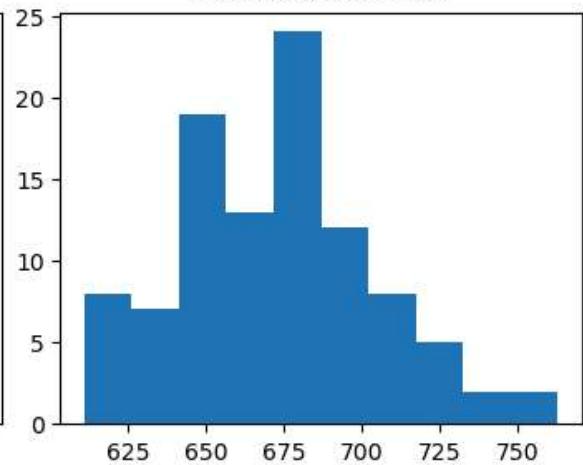




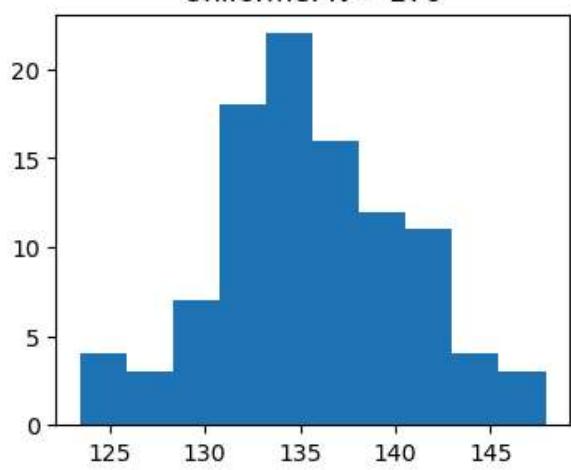
Uniforme: N = 269



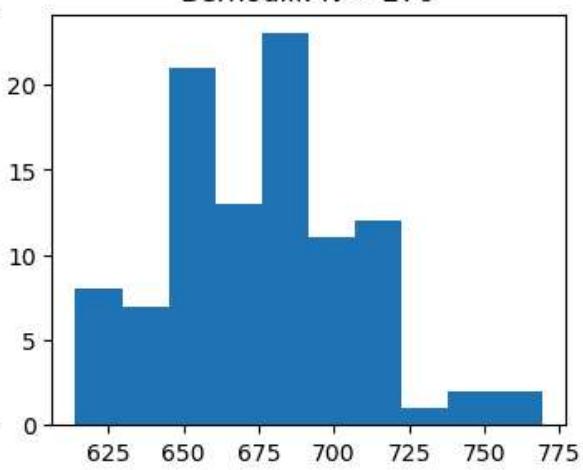
Bernoulli: N = 269



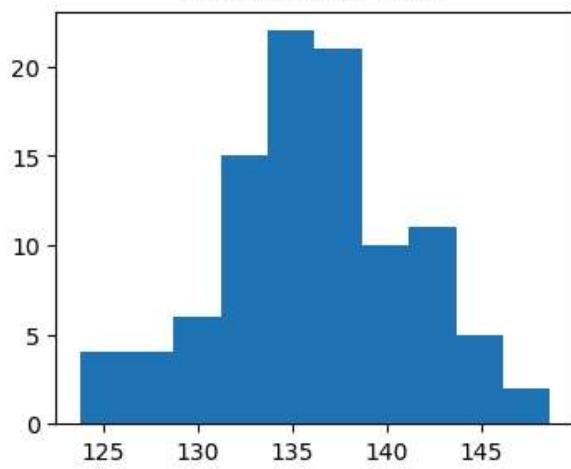
Uniforme: N = 270



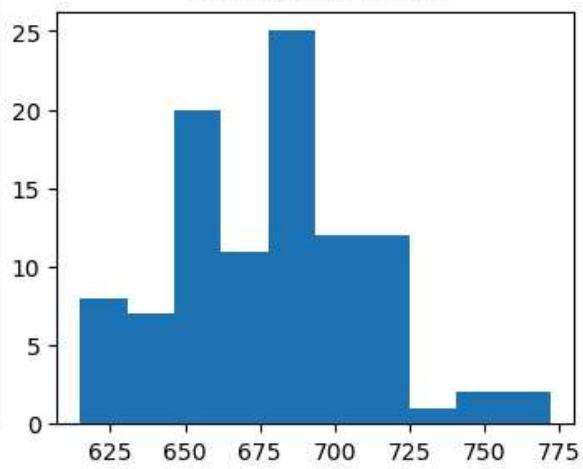
Bernoulli: N = 270



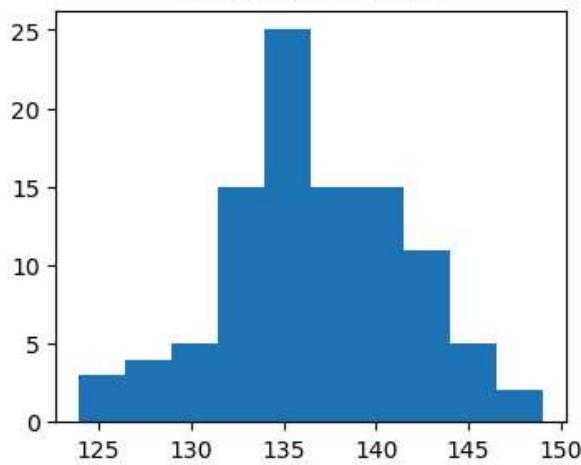
Uniforme: N = 271



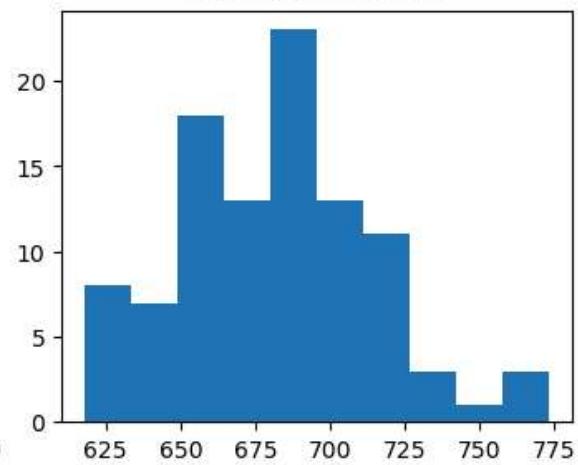
Bernoulli: N = 271



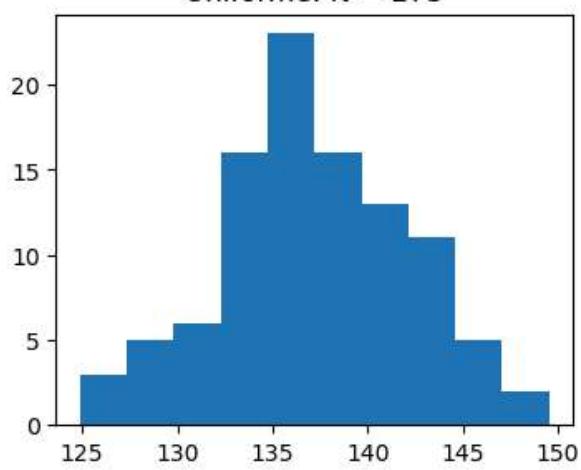
Uniforme: N = 272



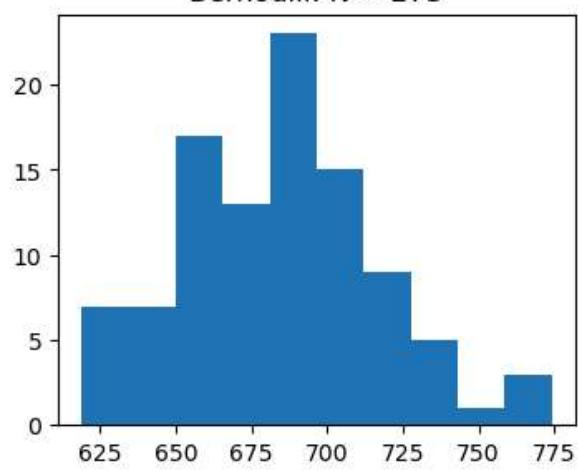
Bernoulli: N = 272



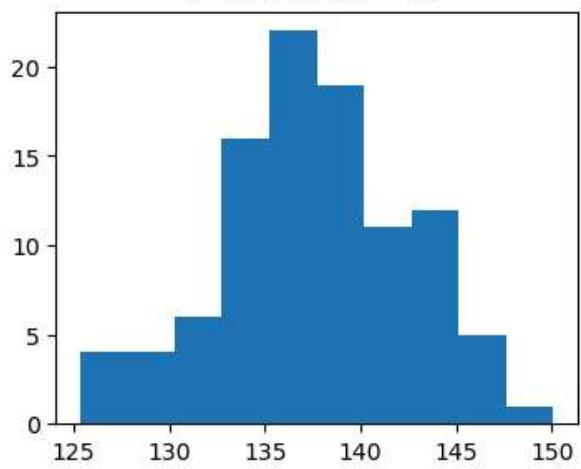
Uniforme: N = 273



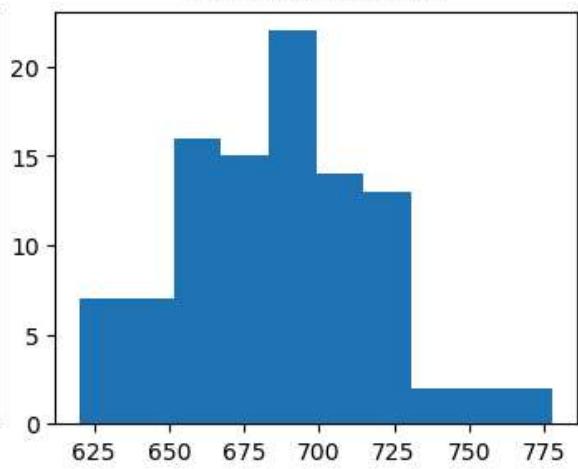
Bernoulli: N = 273



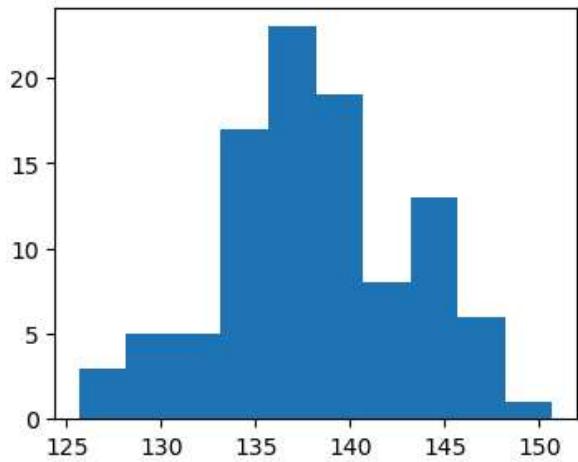
Uniforme: N = 274



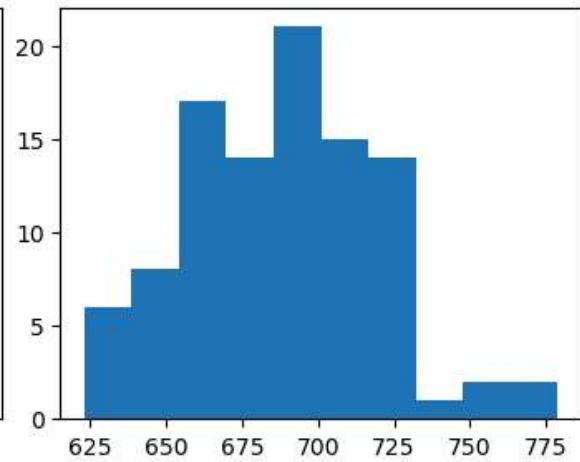
Bernoulli: N = 274



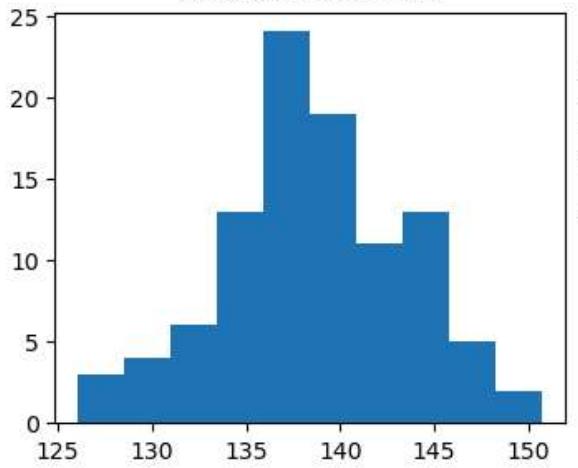
Uniforme: N = 275



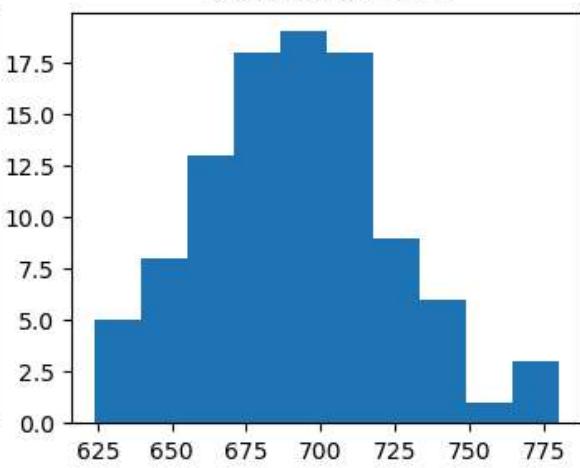
Bernoulli: N = 275



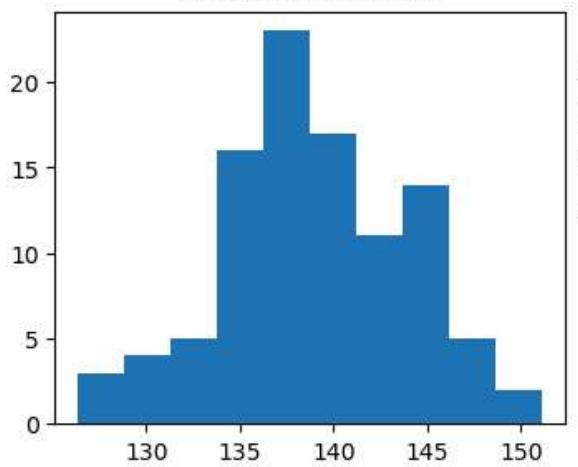
Uniforme: N = 276



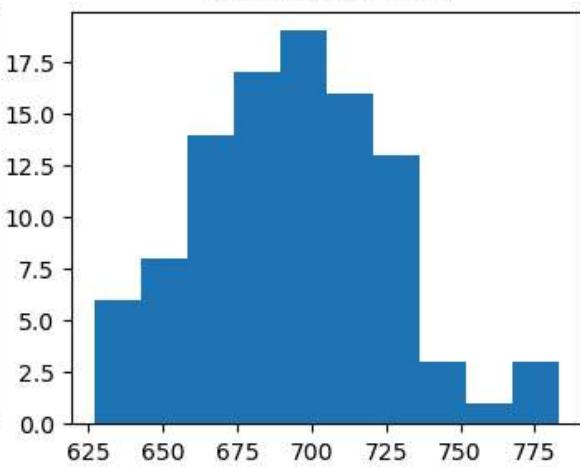
Bernoulli: N = 276

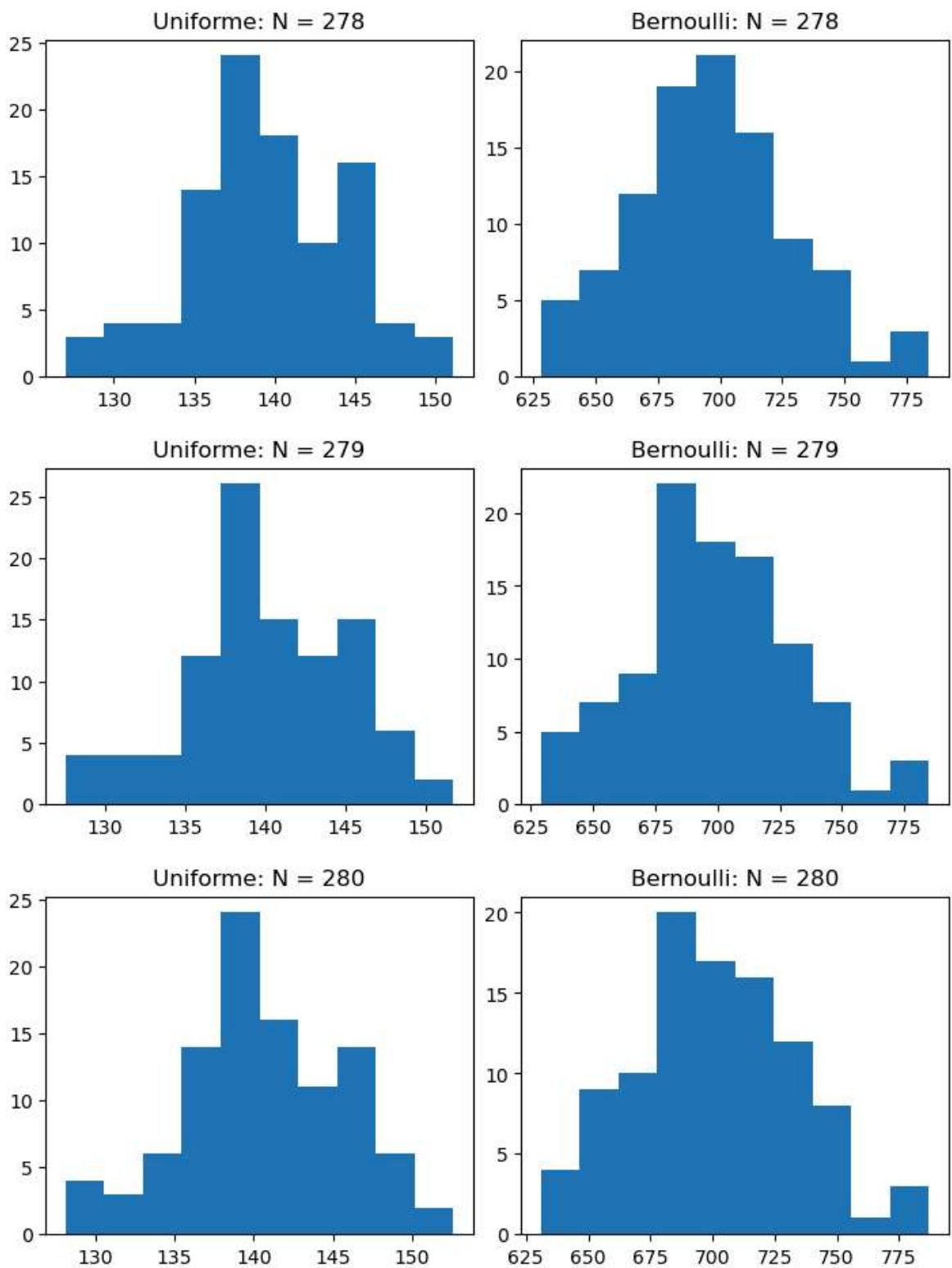


Uniforme: N = 277

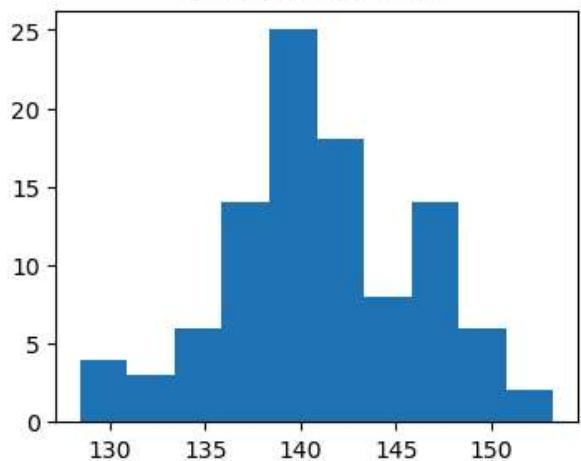


Bernoulli: N = 277

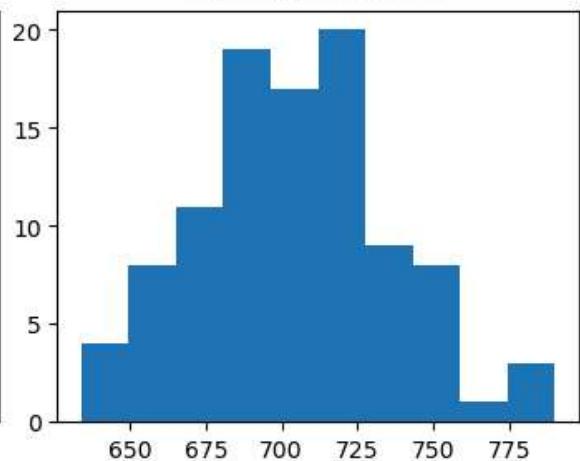




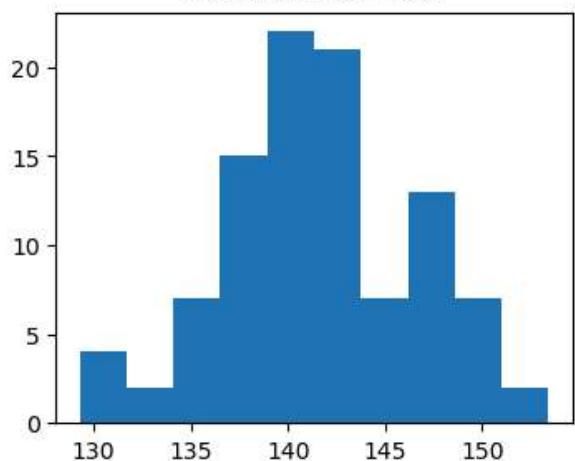
Uniforme: N = 281



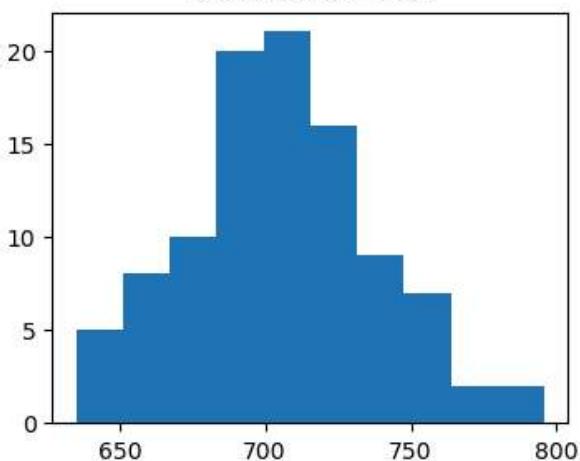
Bernoulli: N = 281



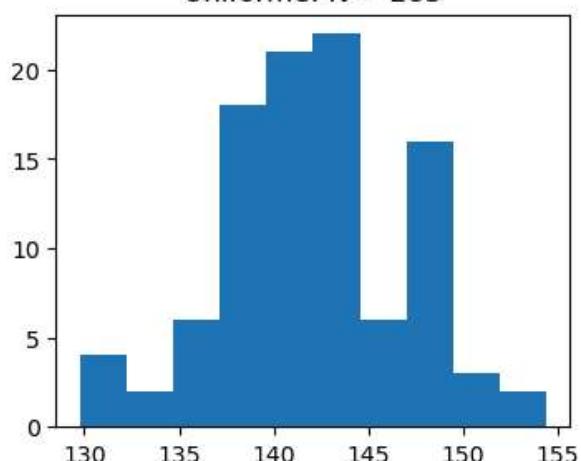
Uniforme: N = 282



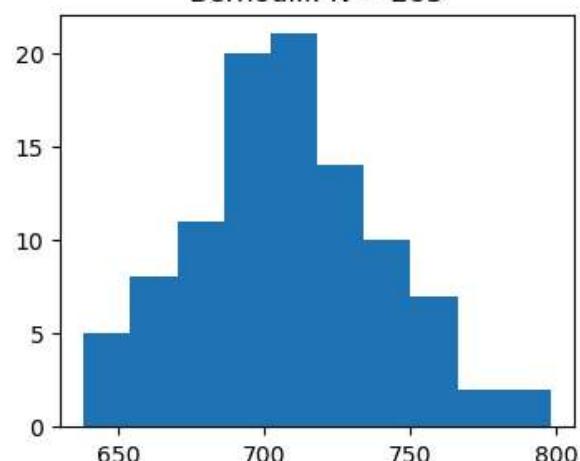
Bernoulli: N = 282



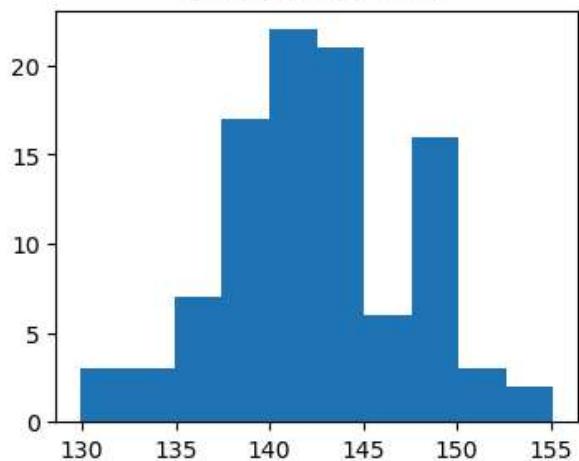
Uniforme: N = 283



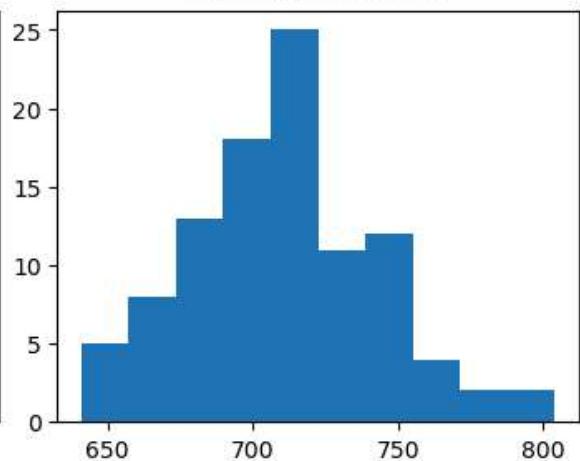
Bernoulli: N = 283



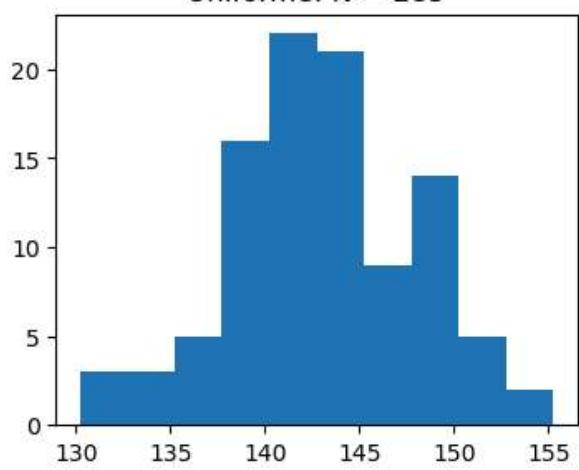
Uniforme: N = 284



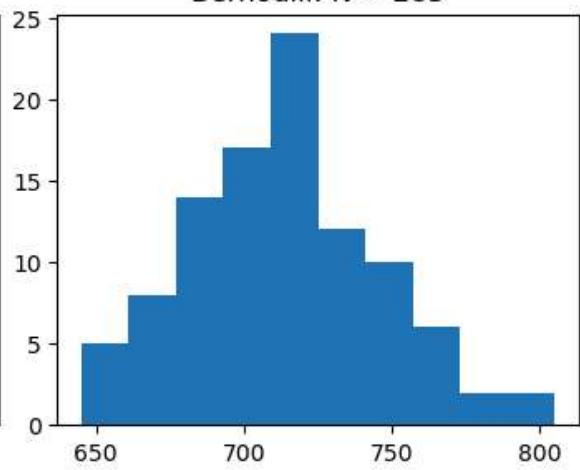
Bernoulli: N = 284



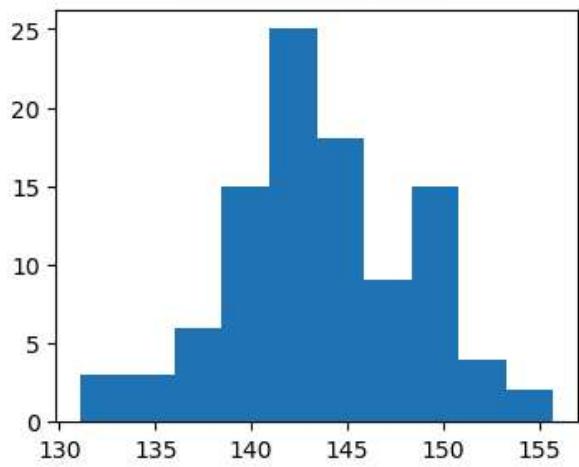
Uniforme: N = 285



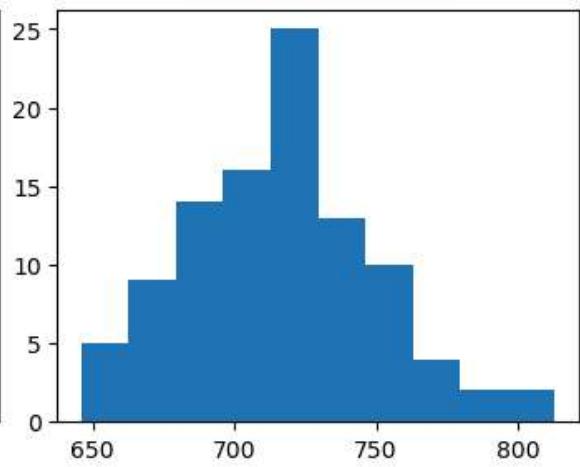
Bernoulli: N = 285

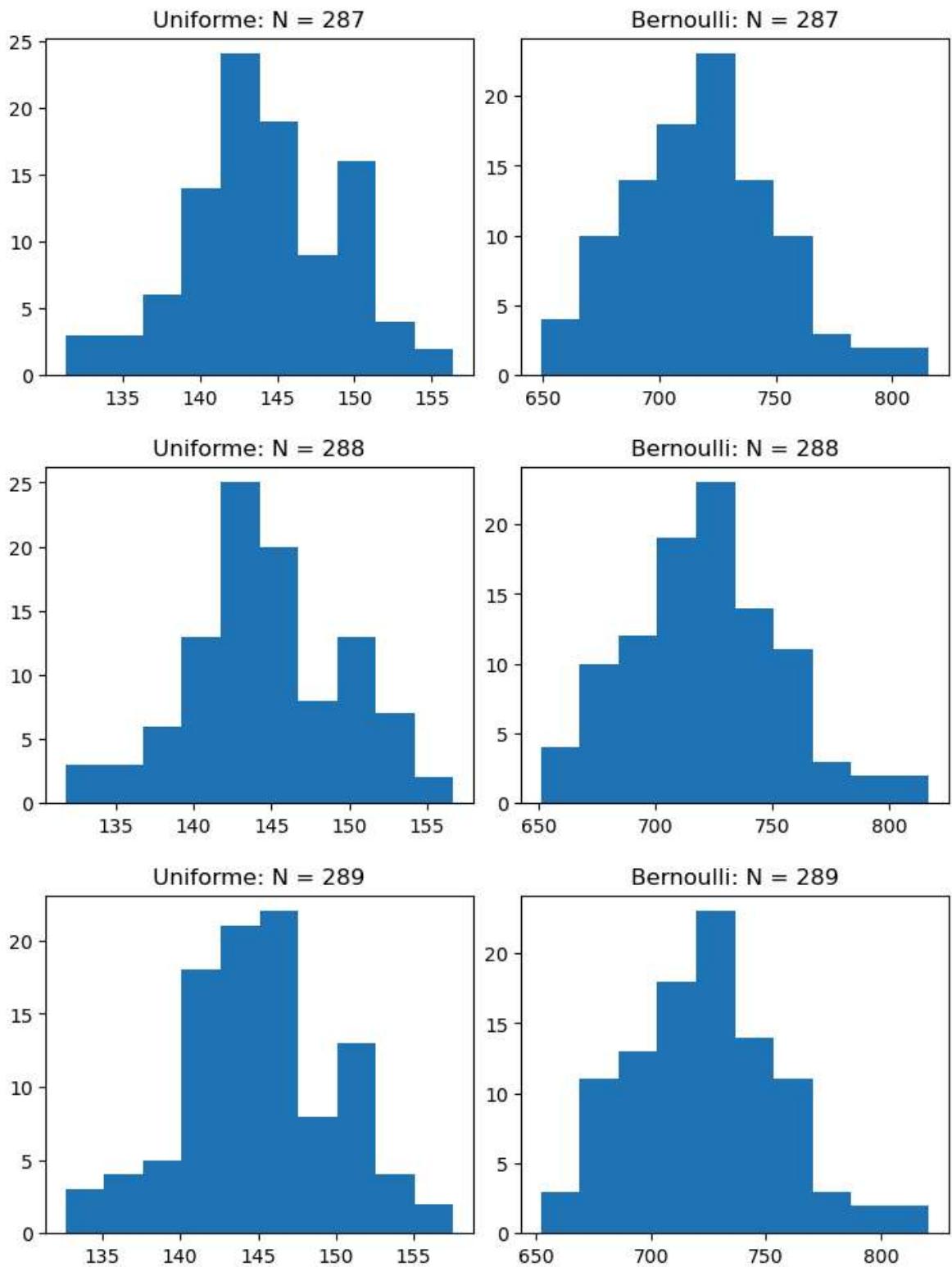


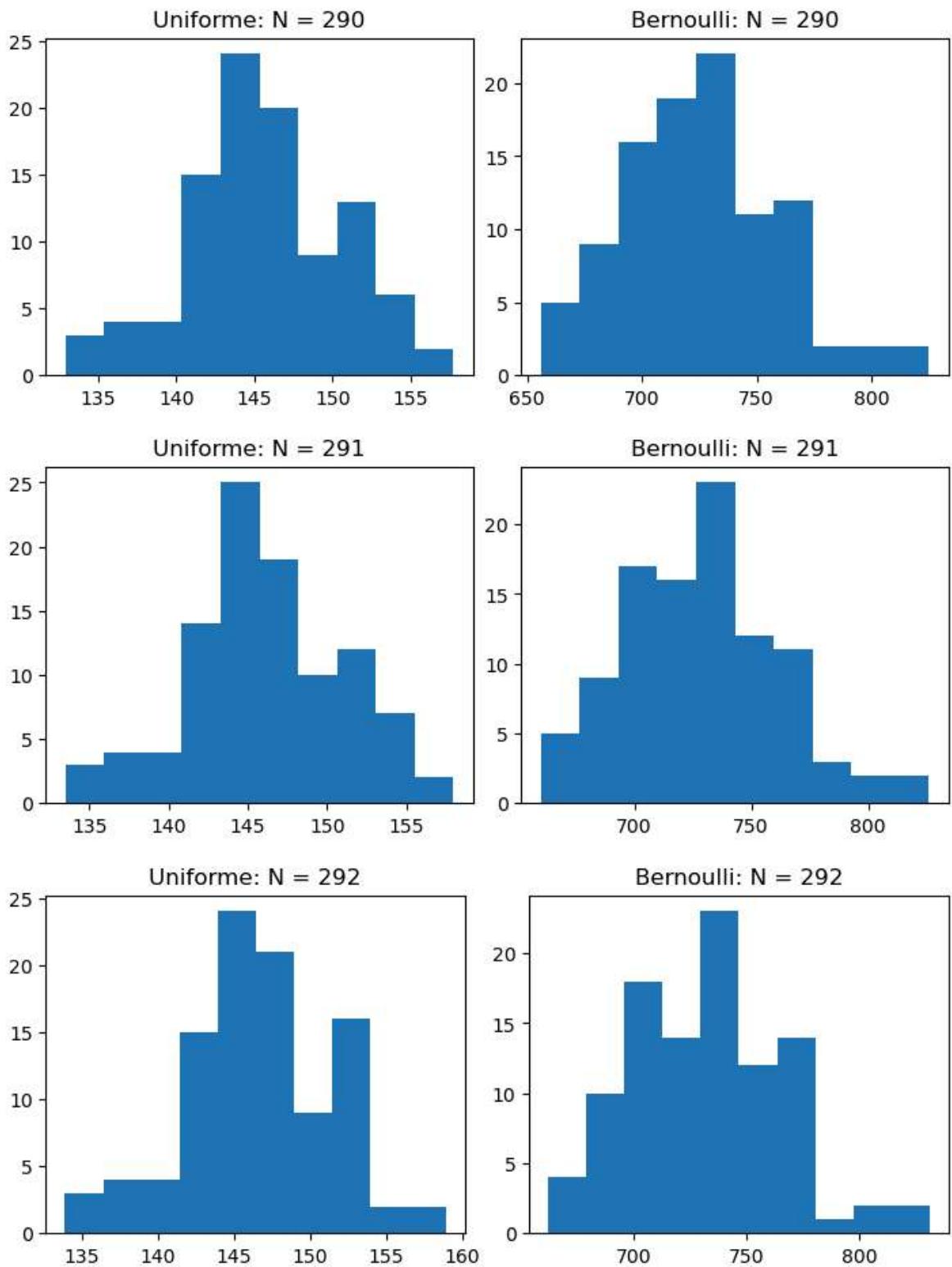
Uniforme: N = 286

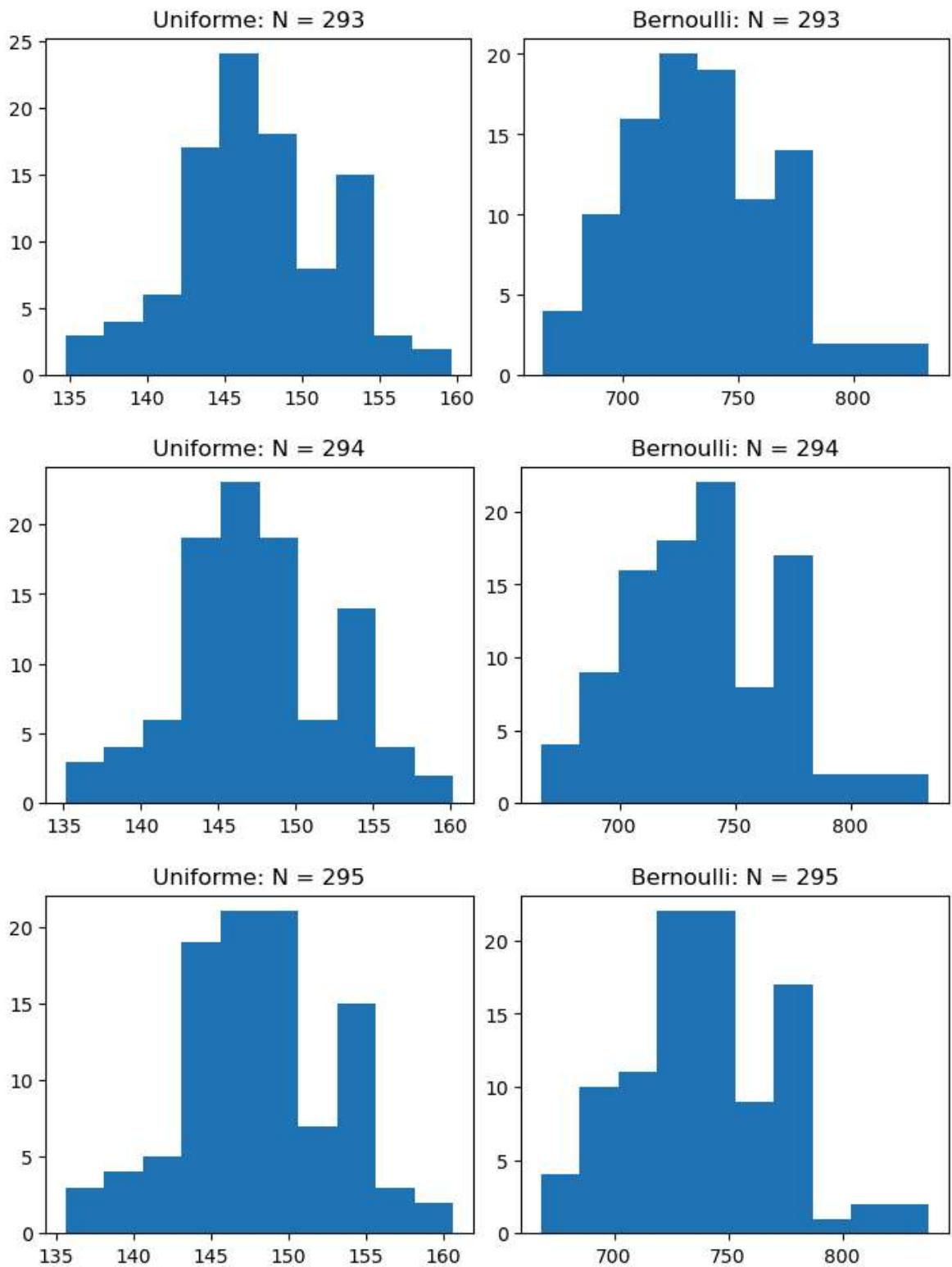


Bernoulli: N = 286

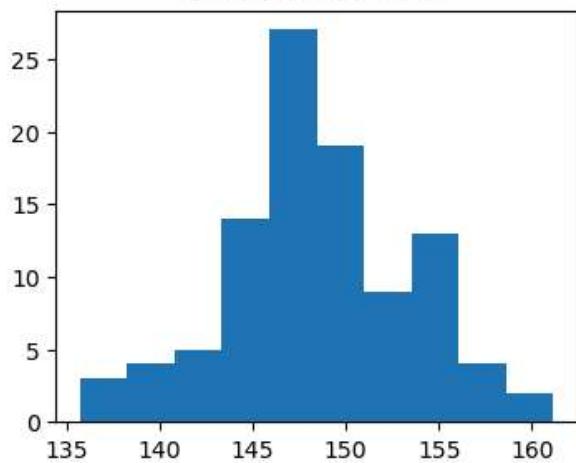




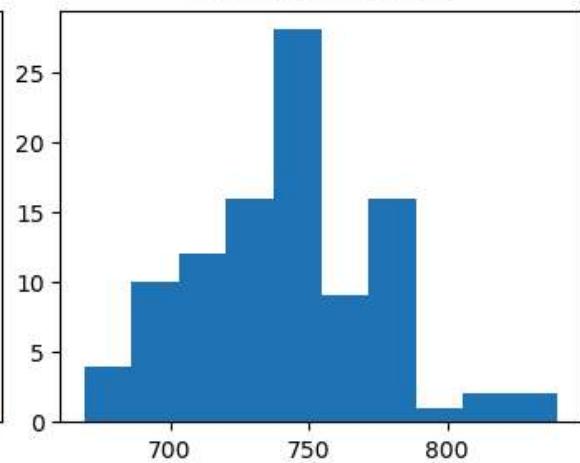




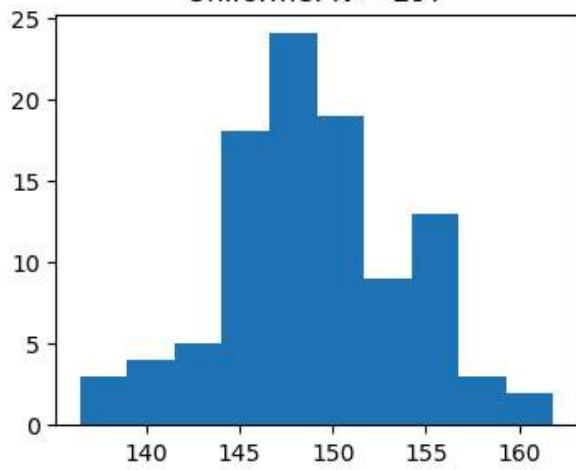
Uniforme: N = 296



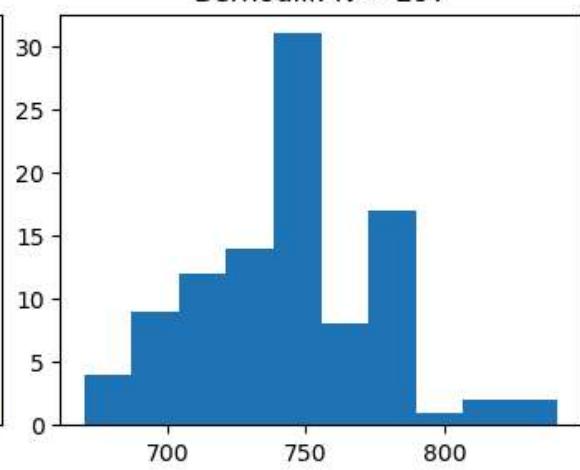
Bernoulli: N = 296



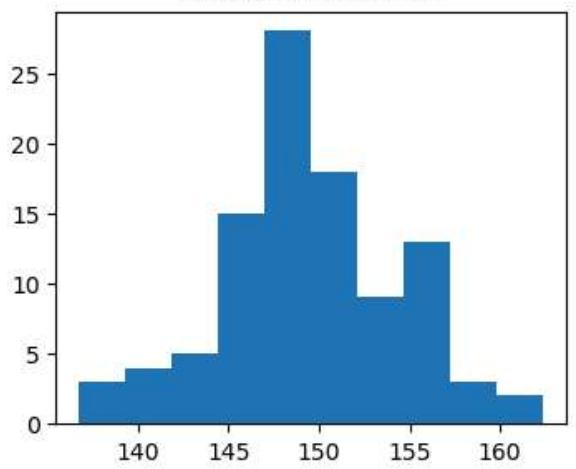
Uniforme: N = 297



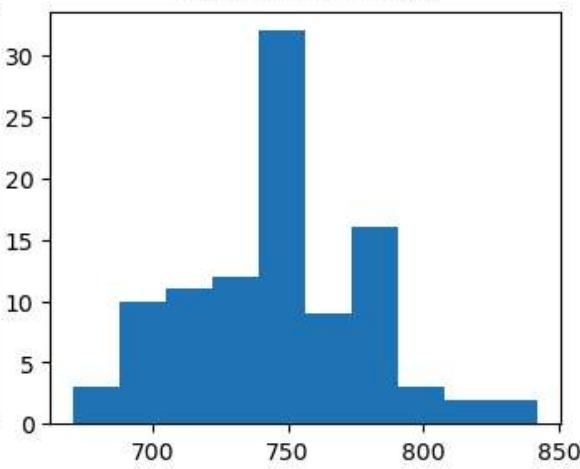
Bernoulli: N = 297

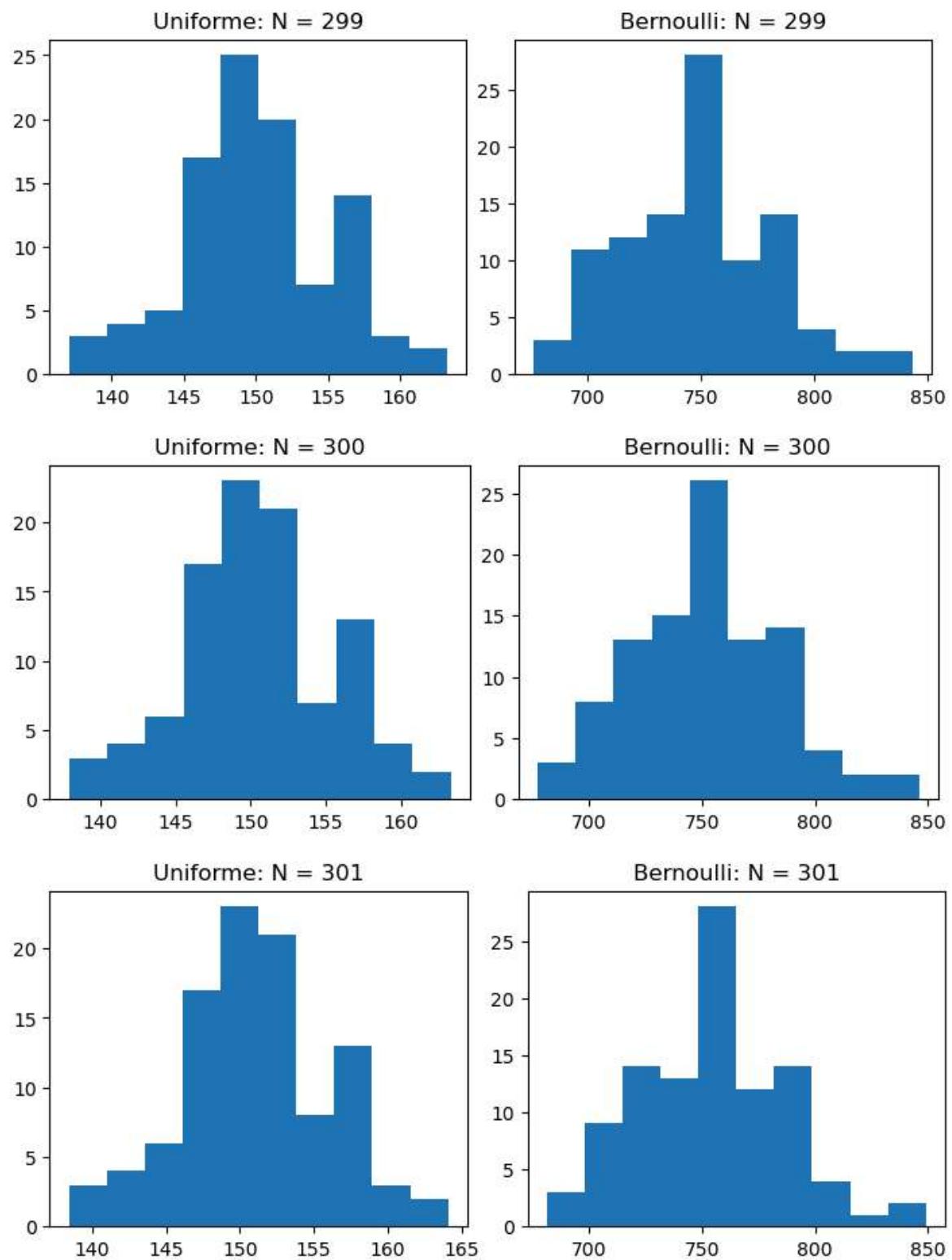


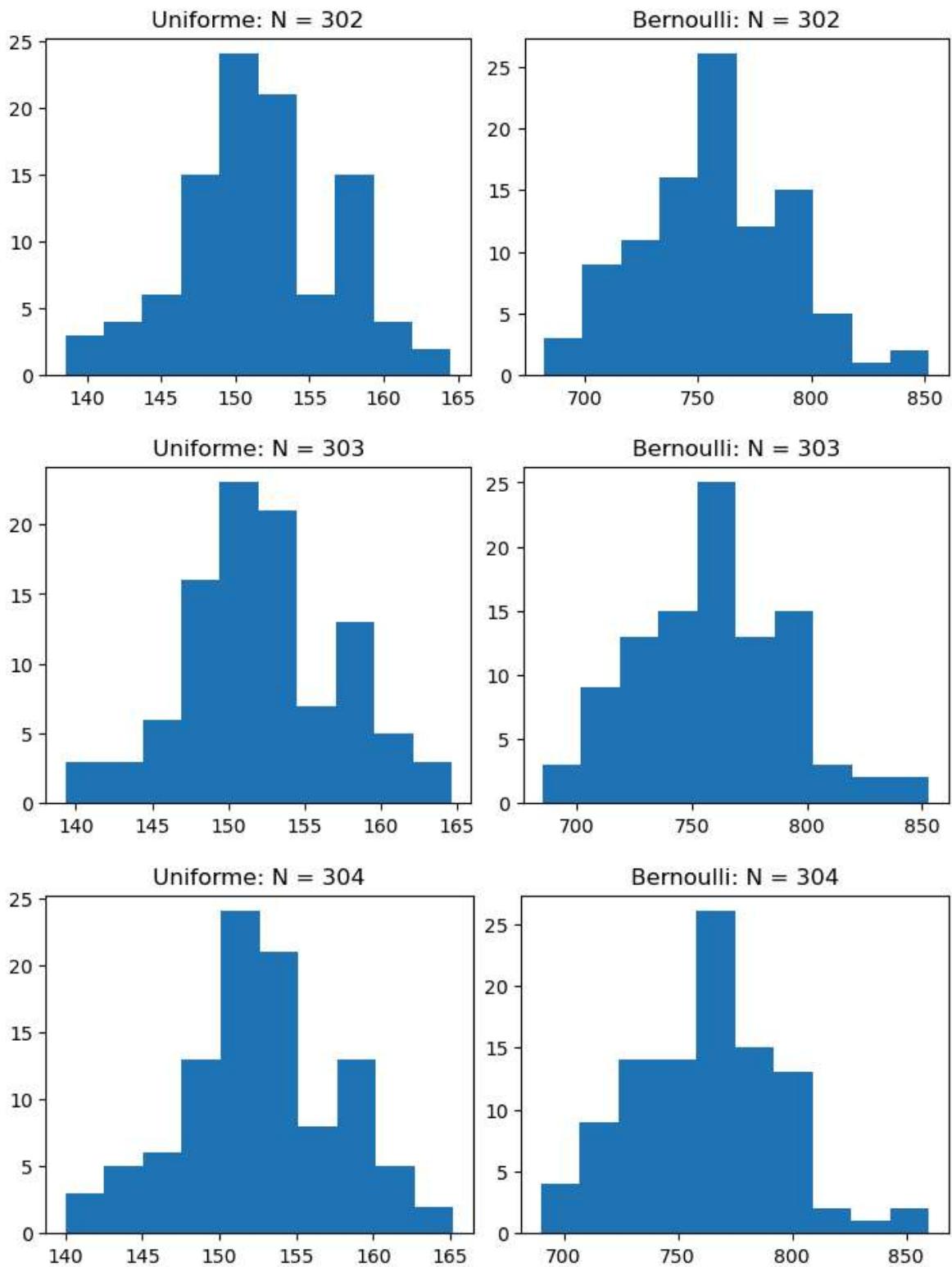
Uniforme: N = 298



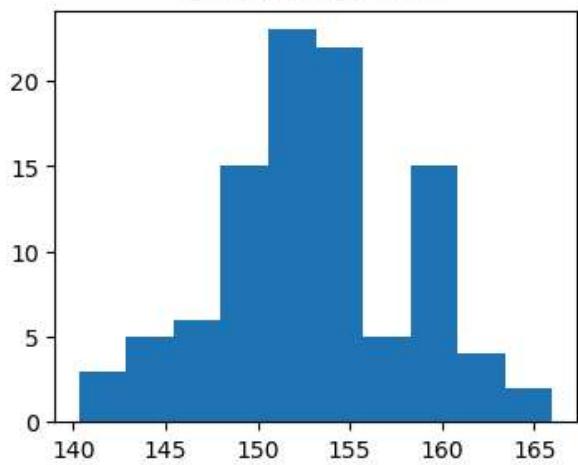
Bernoulli: N = 298



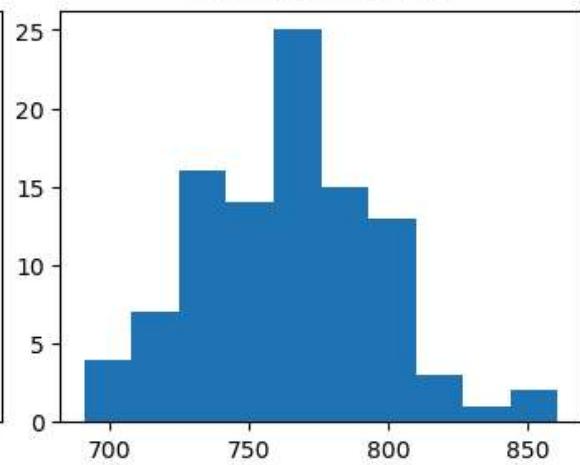




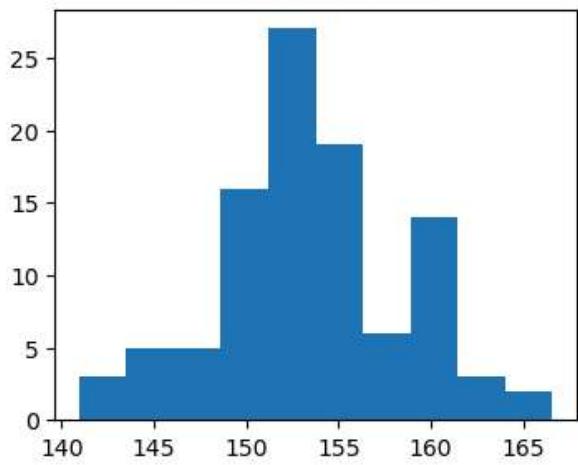
Uniforme: N = 305



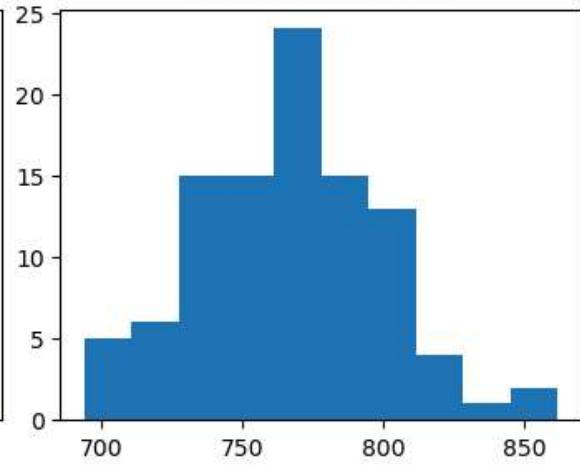
Bernoulli: N = 305



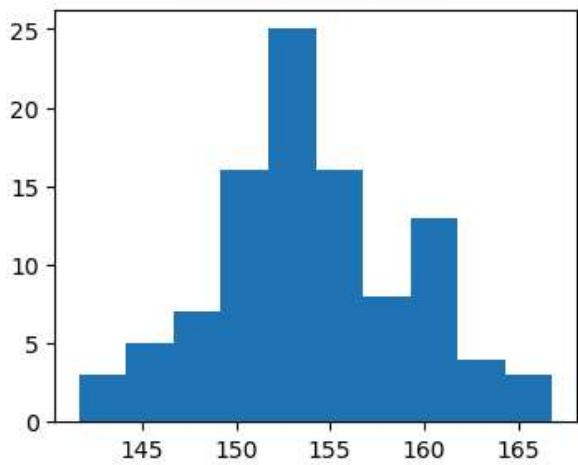
Uniforme: N = 306



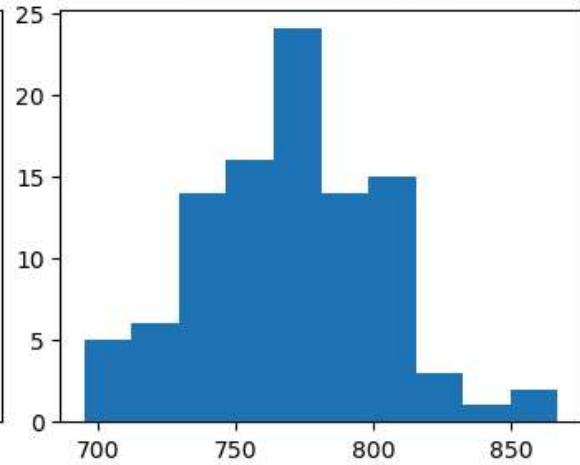
Bernoulli: N = 306



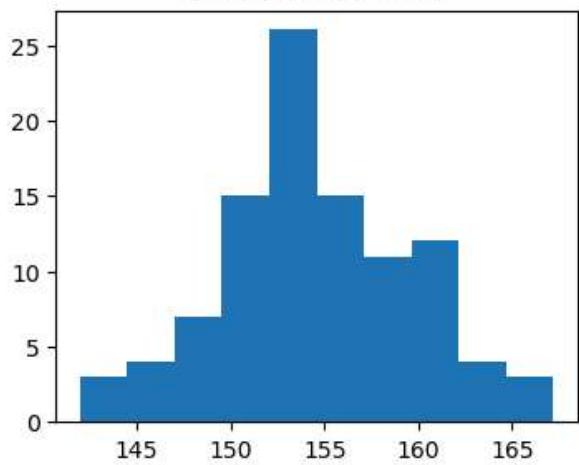
Uniforme: N = 307



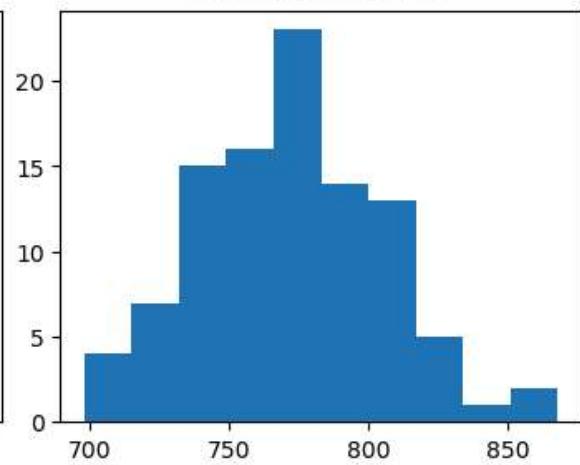
Bernoulli: N = 307



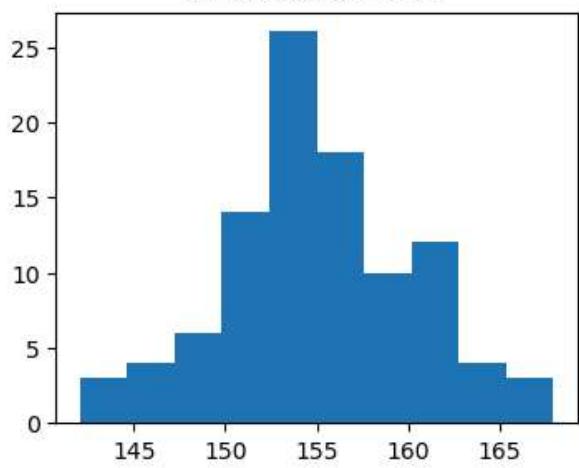
Uniforme: N = 308



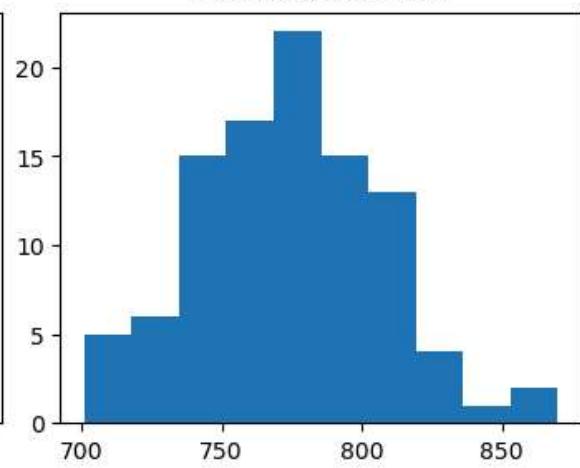
Bernoulli: N = 308



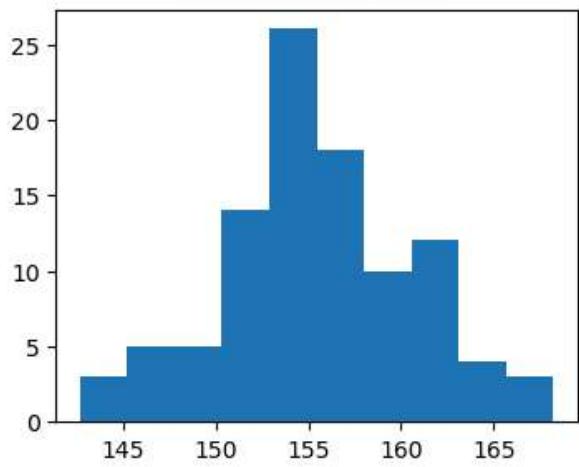
Uniforme: N = 309



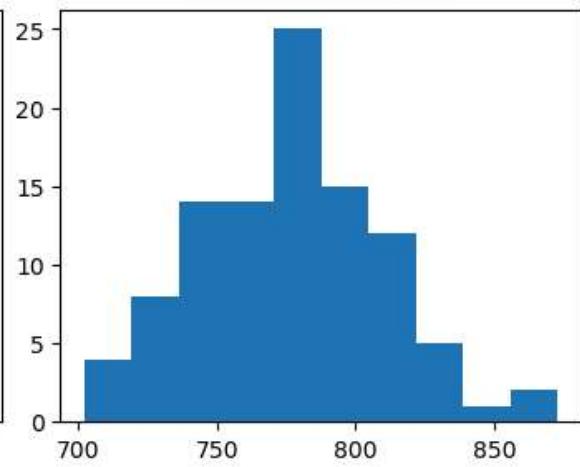
Bernoulli: N = 309



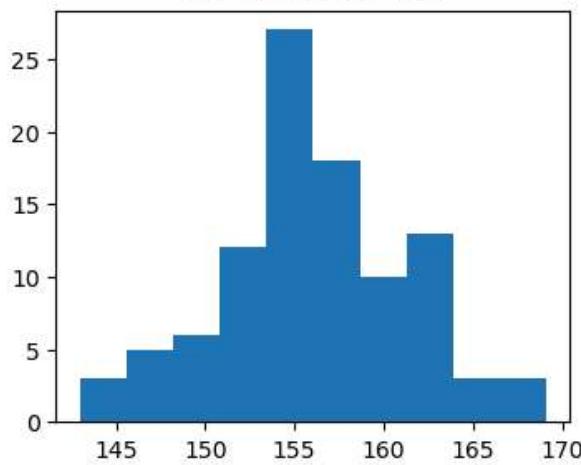
Uniforme: N = 310



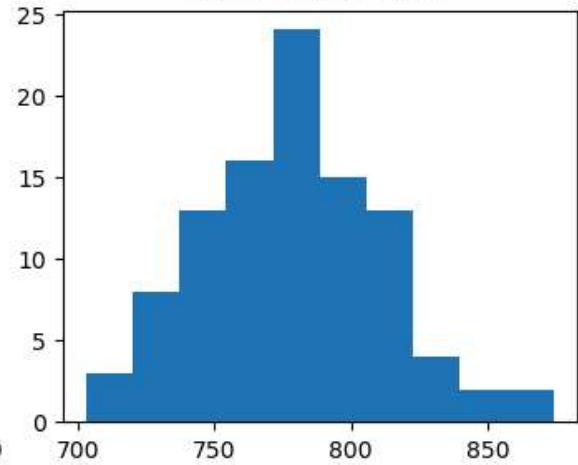
Bernoulli: N = 310



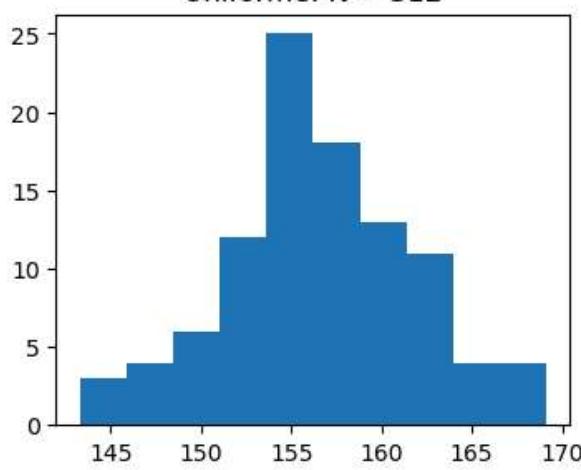
Uniforme: N = 311



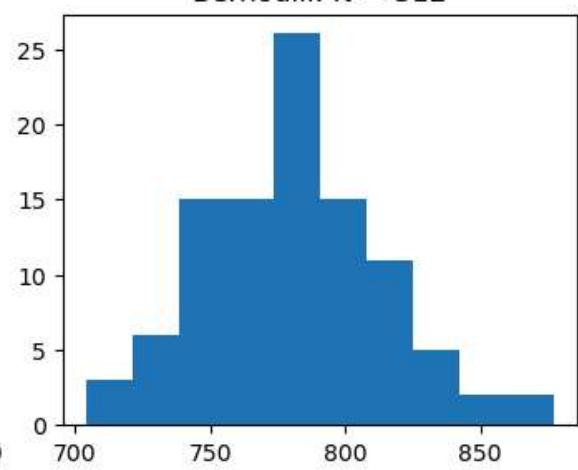
Bernoulli: N = 311



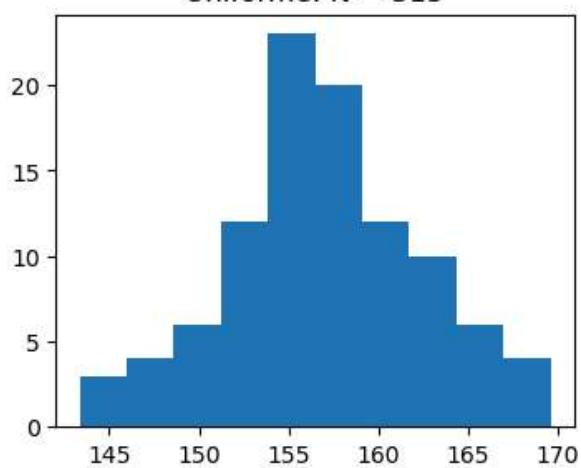
Uniforme: N = 312



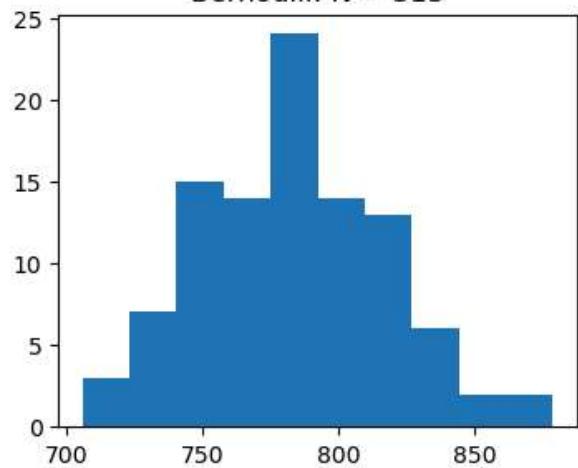
Bernoulli: N = 312

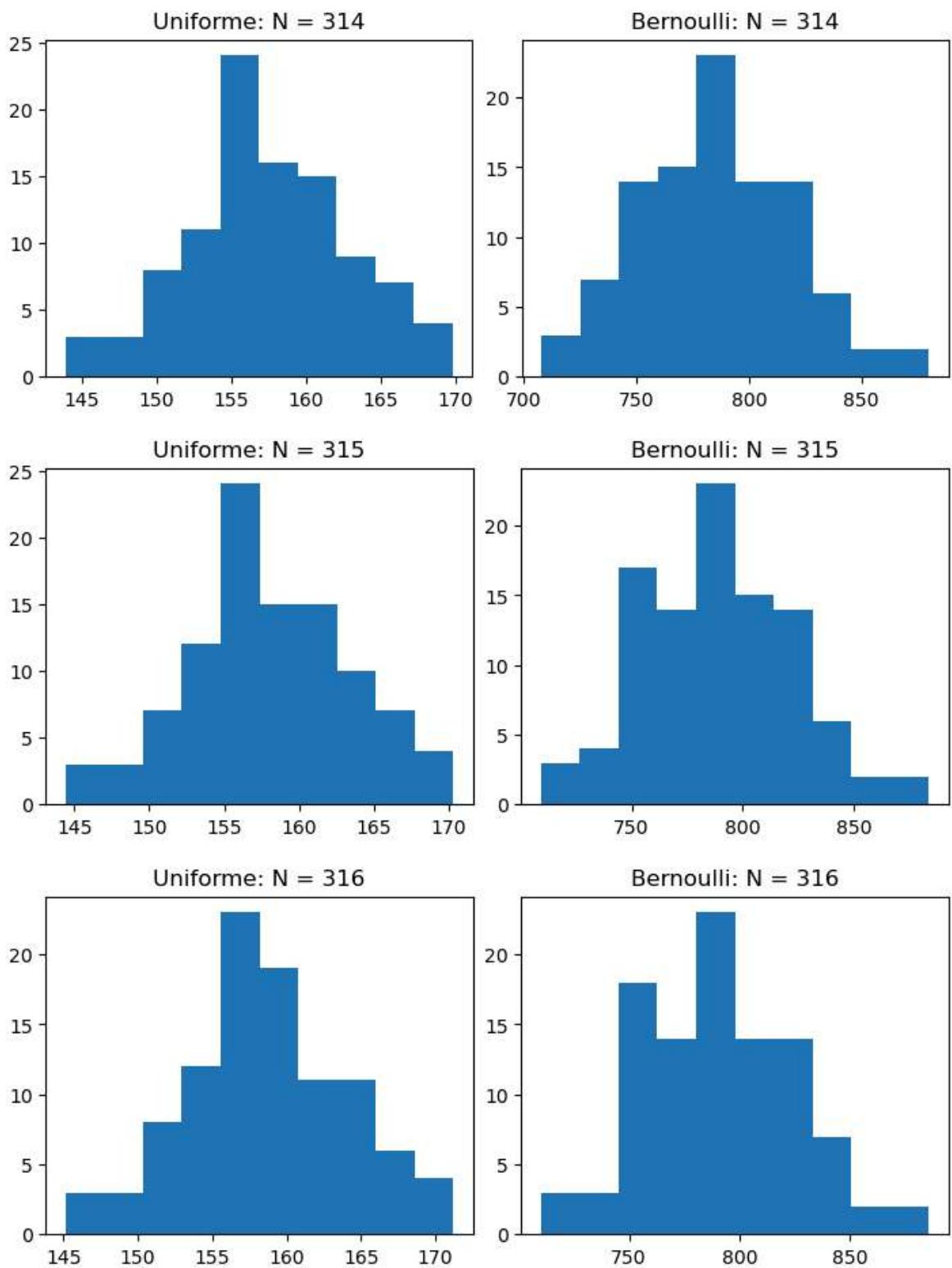


Uniforme: N = 313

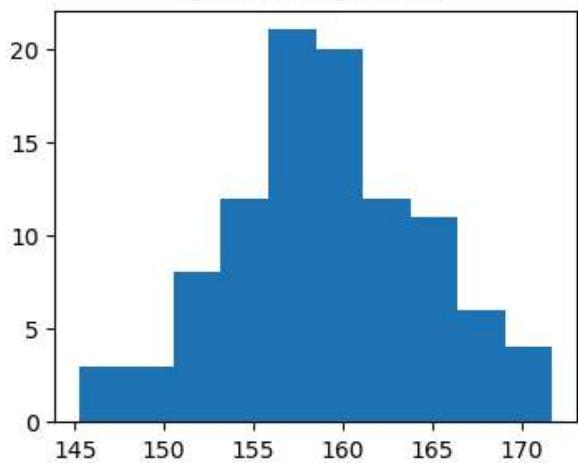


Bernoulli: N = 313

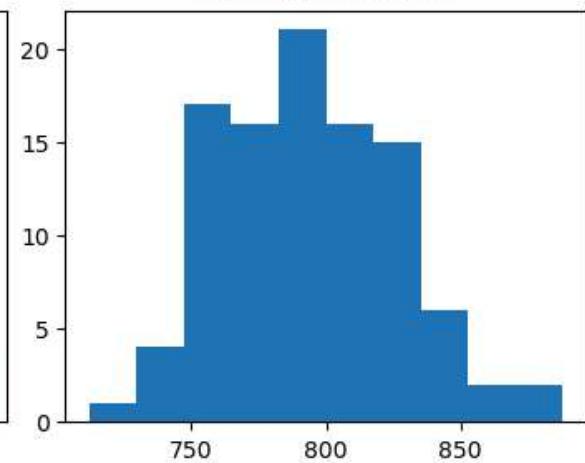




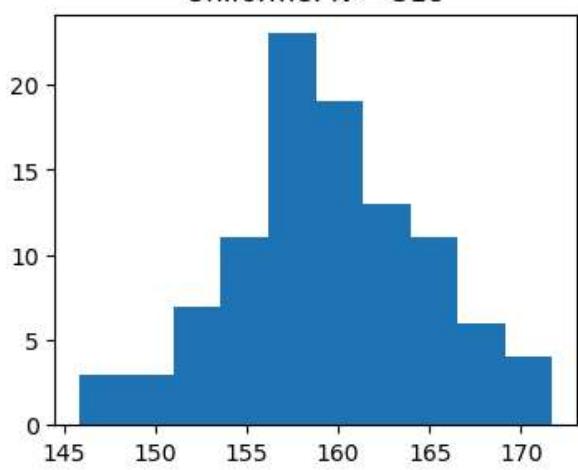
Uniforme: N = 317



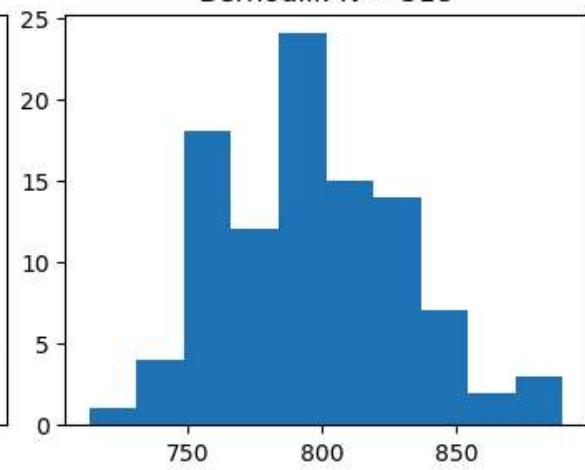
Bernoulli: N = 317



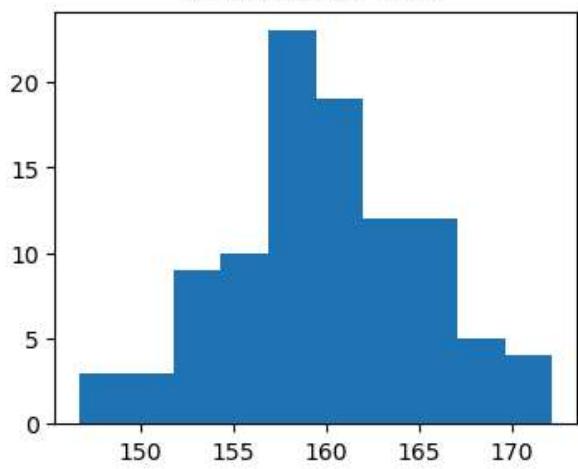
Uniforme: N = 318



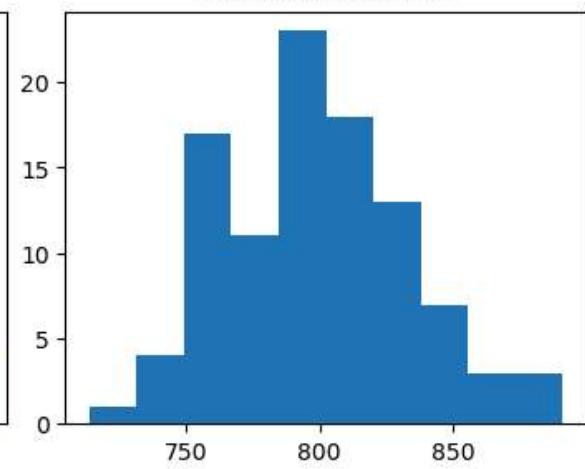
Bernoulli: N = 318



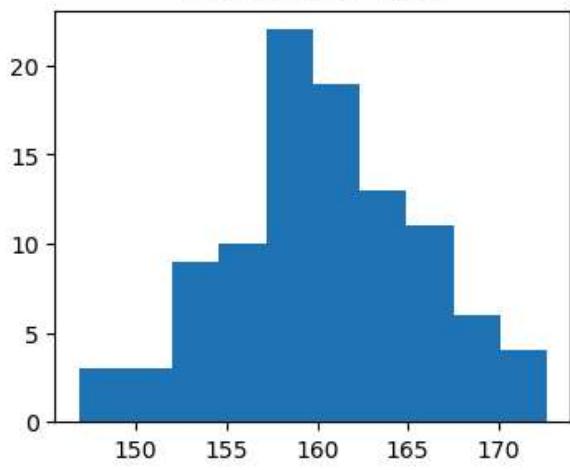
Uniforme: N = 319



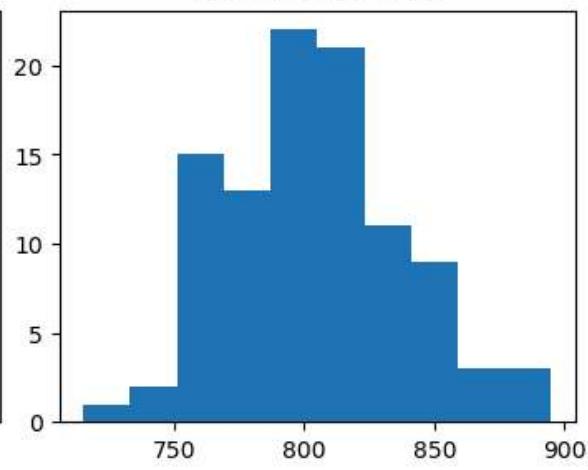
Bernoulli: N = 319



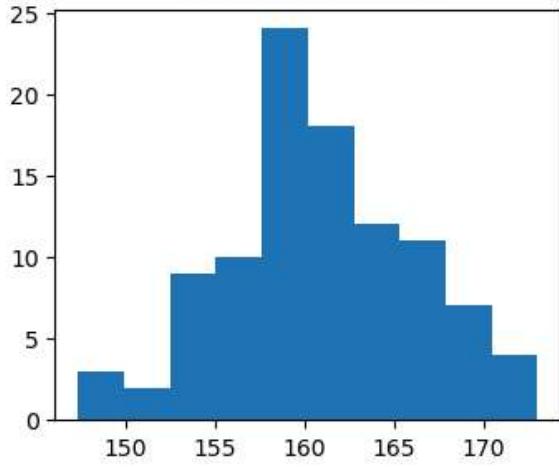
Uniforme: N = 320



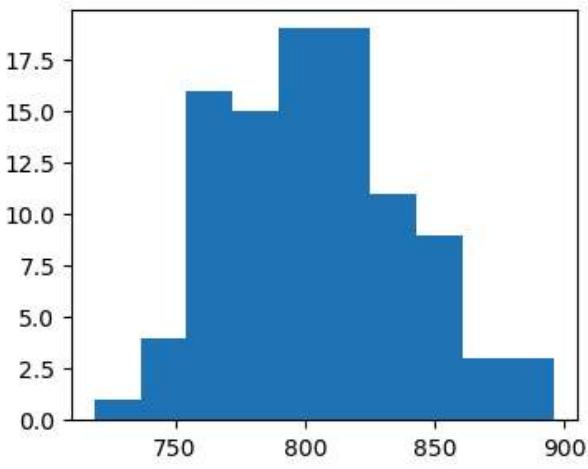
Bernoulli: N = 320



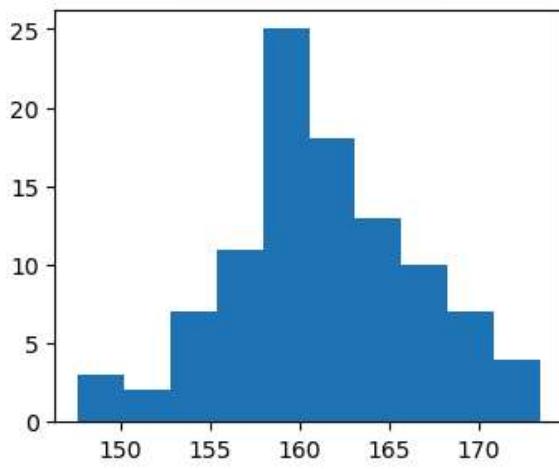
Uniforme: N = 321



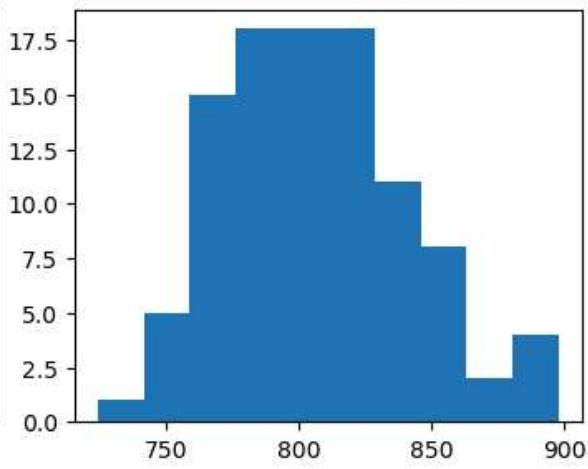
Bernoulli: N = 321



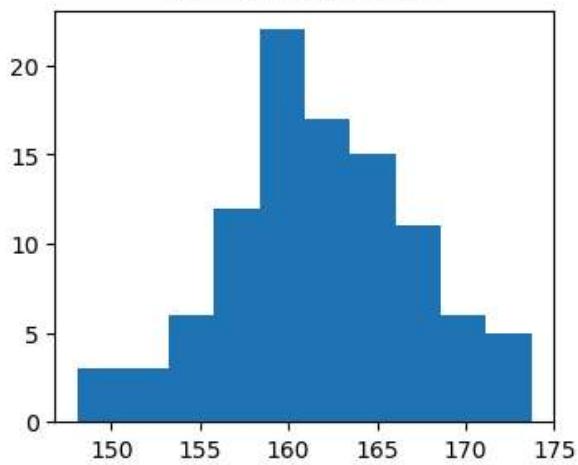
Uniforme: N = 322



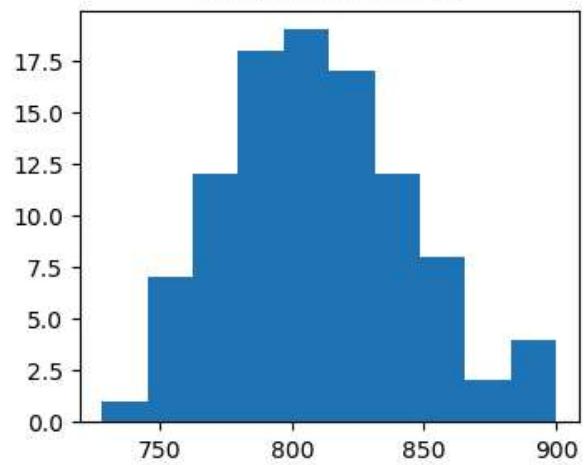
Bernoulli: N = 322



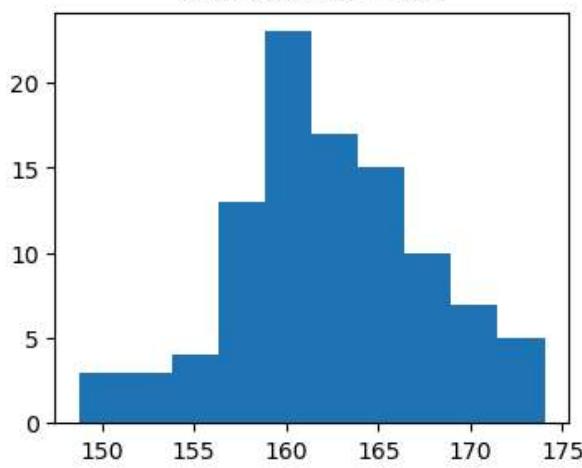
Uniforme: N = 323



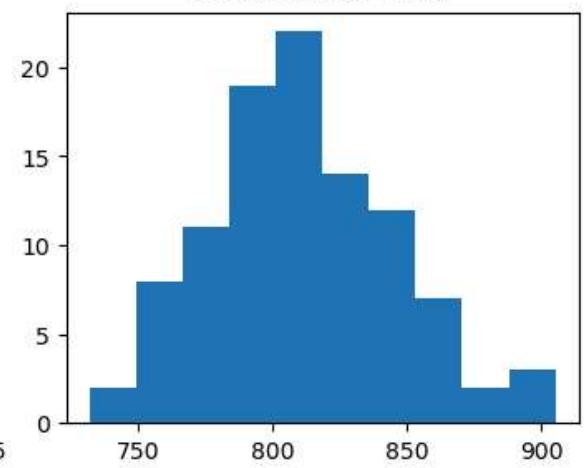
Bernoulli: N = 323



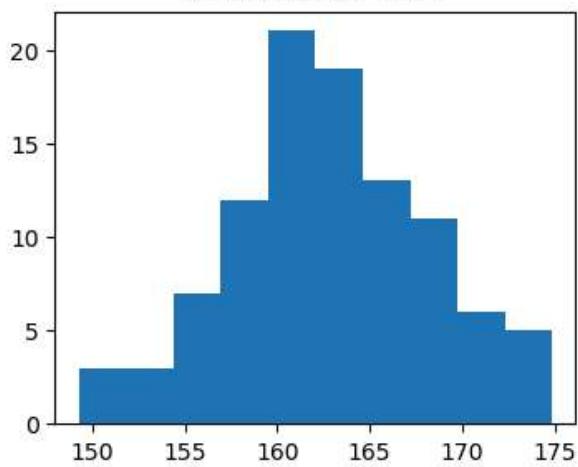
Uniforme: N = 324



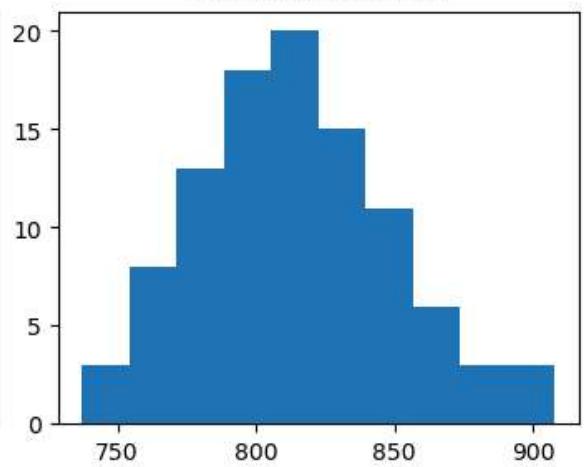
Bernoulli: N = 324



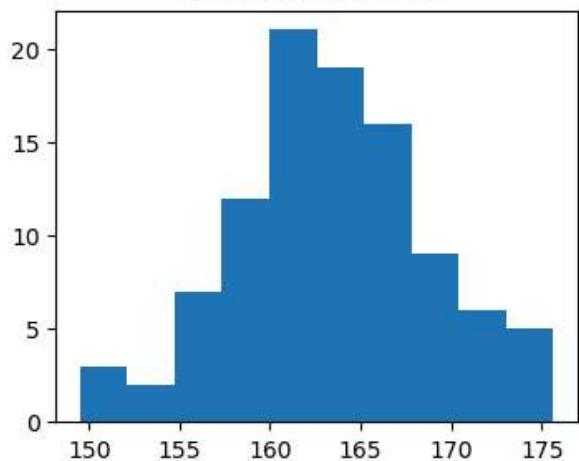
Uniforme: N = 325



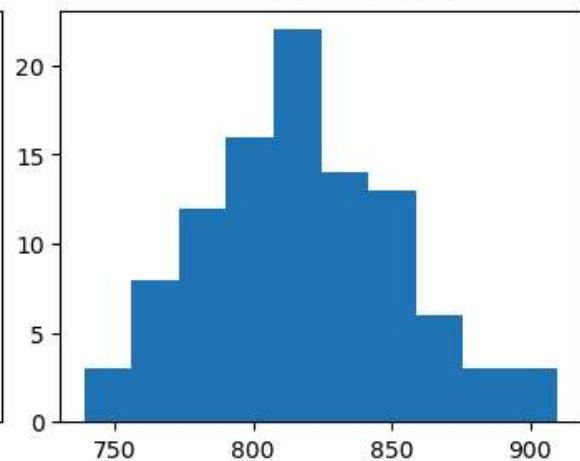
Bernoulli: N = 325



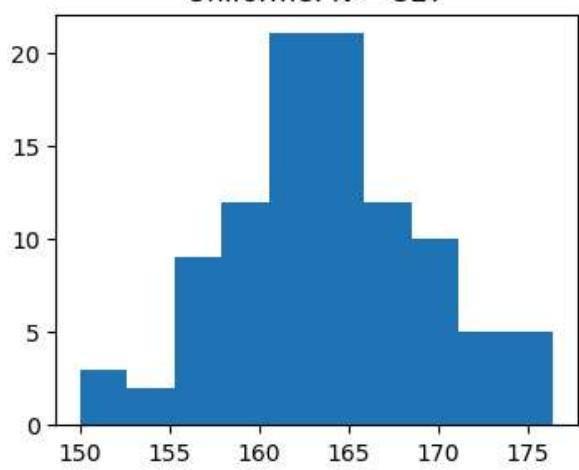
Uniforme: N = 326



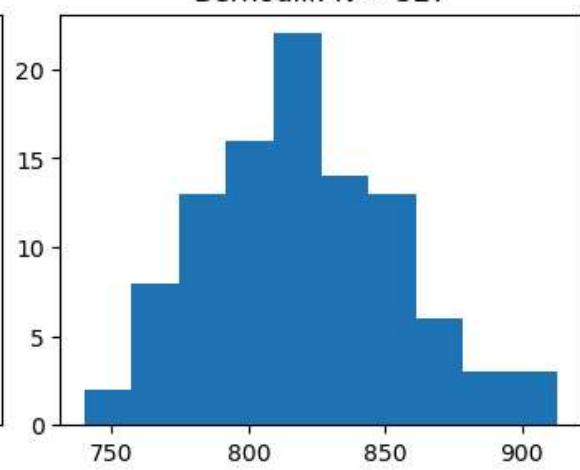
Bernoulli: N = 326



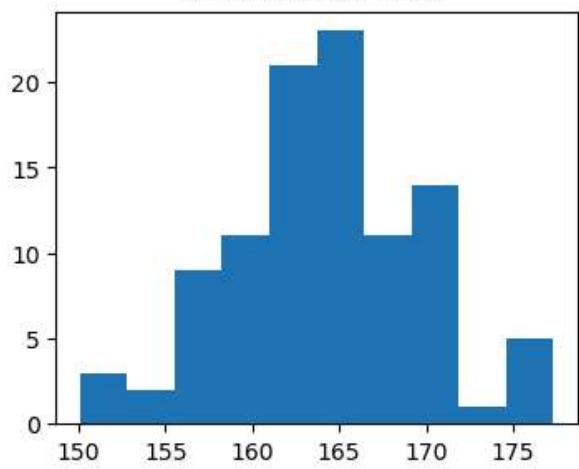
Uniforme: N = 327



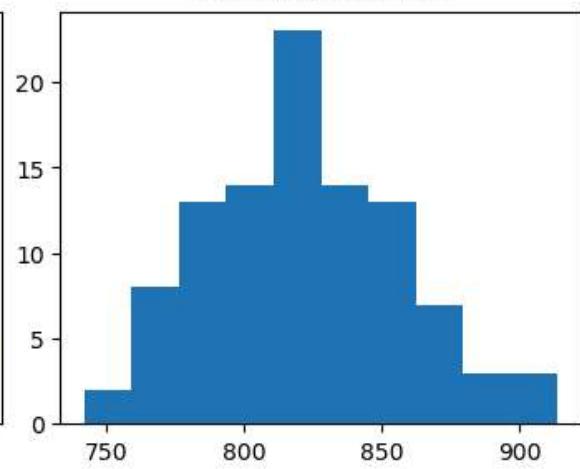
Bernoulli: N = 327

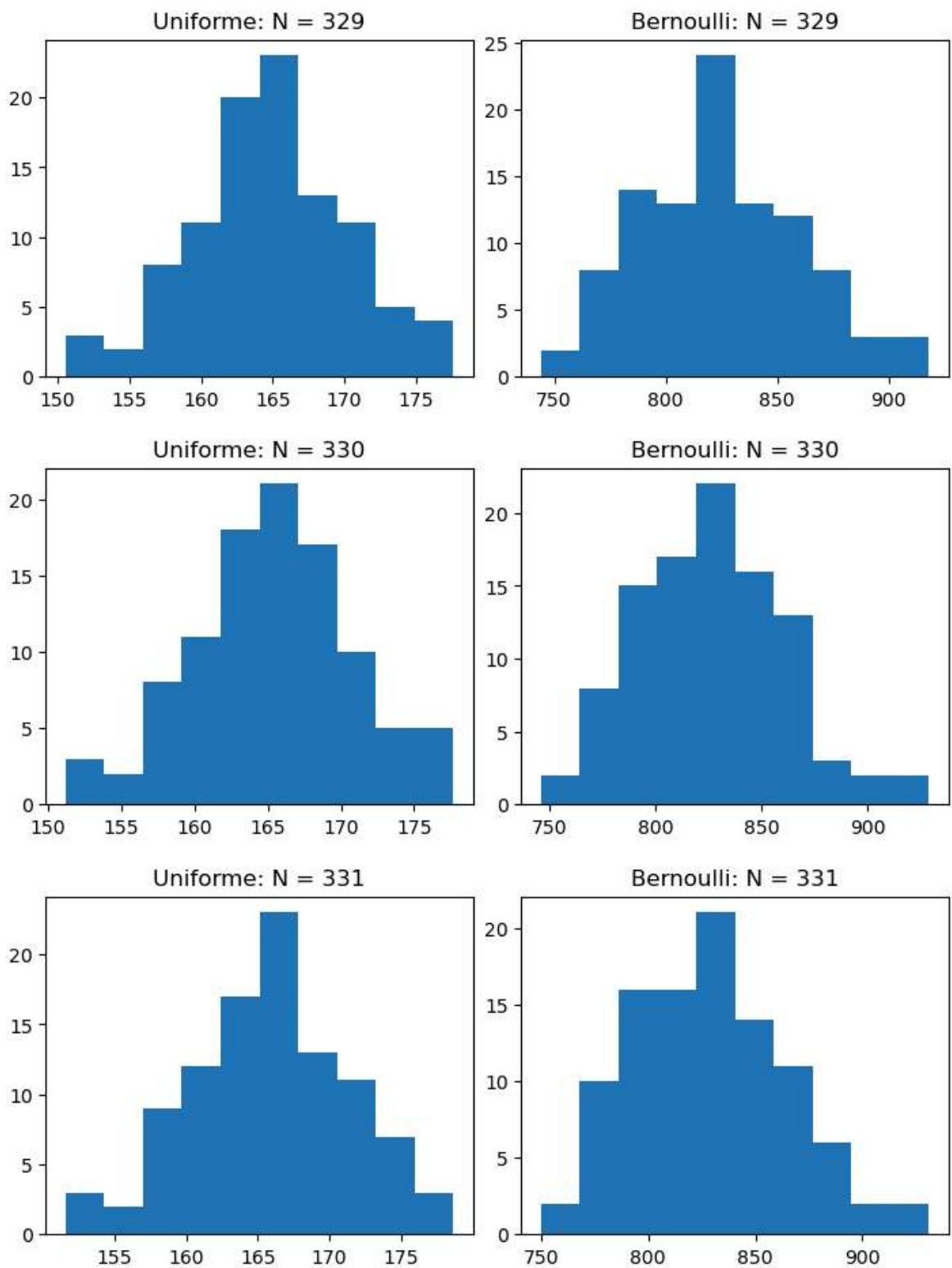


Uniforme: N = 328

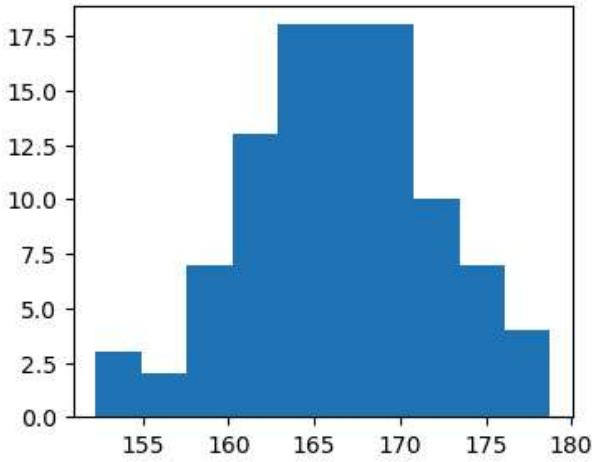


Bernoulli: N = 328

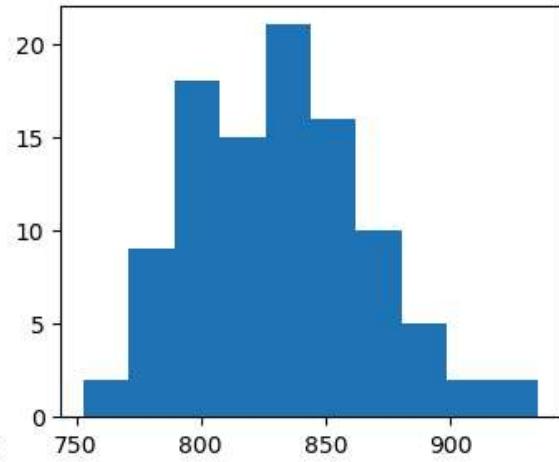




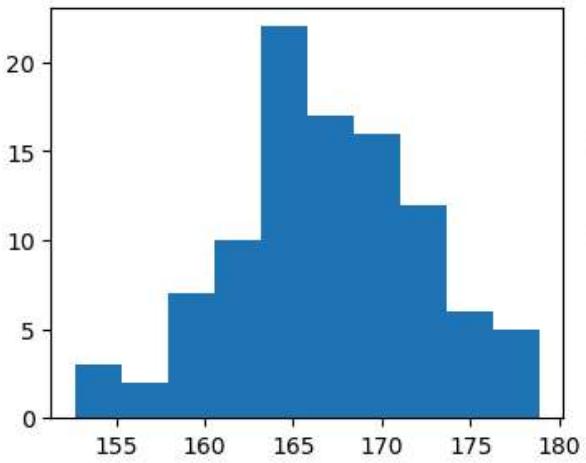
Uniforme: N = 332



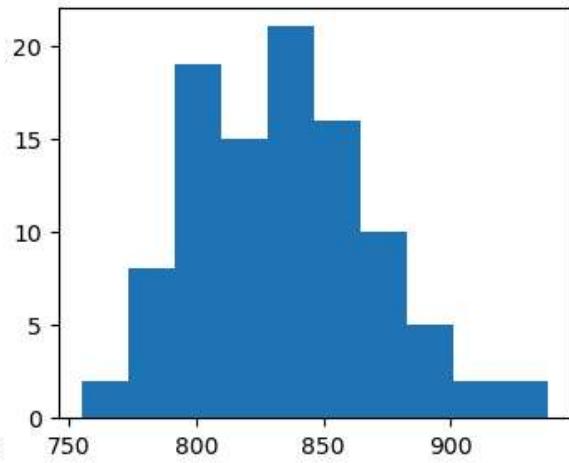
Bernoulli: N = 332



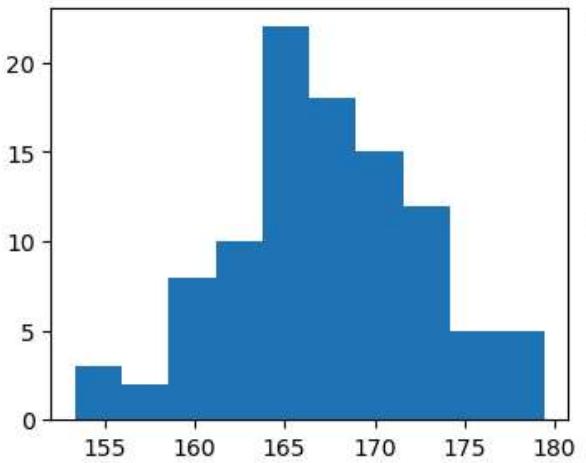
Uniforme: N = 333



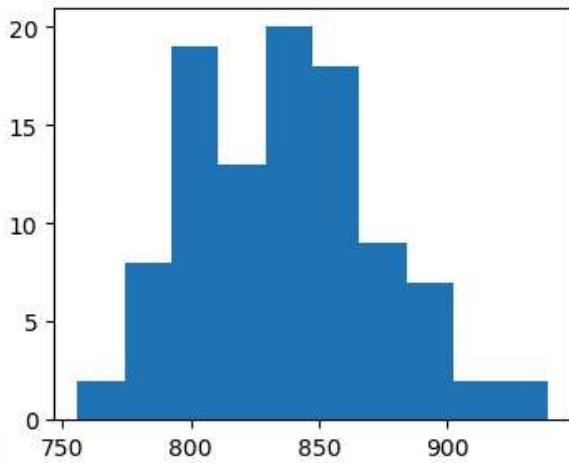
Bernoulli: N = 333



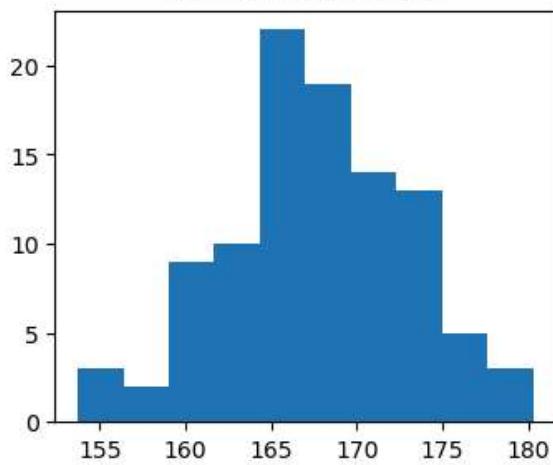
Uniforme: N = 334



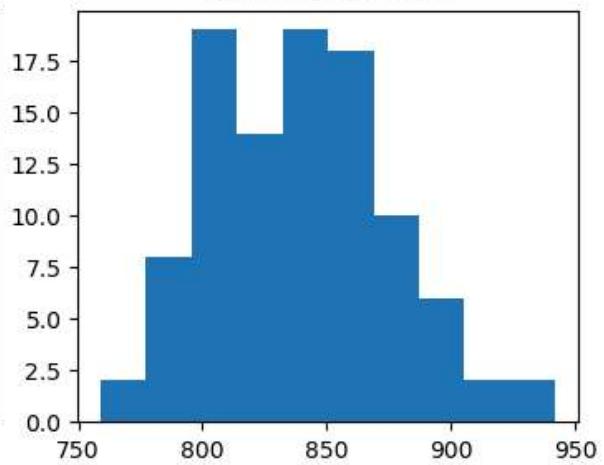
Bernoulli: N = 334



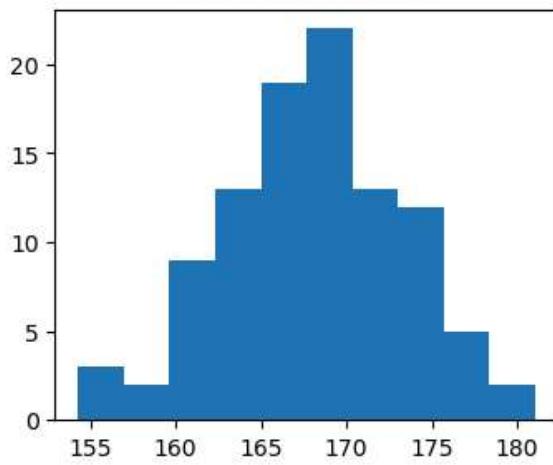
Uniforme: N = 335



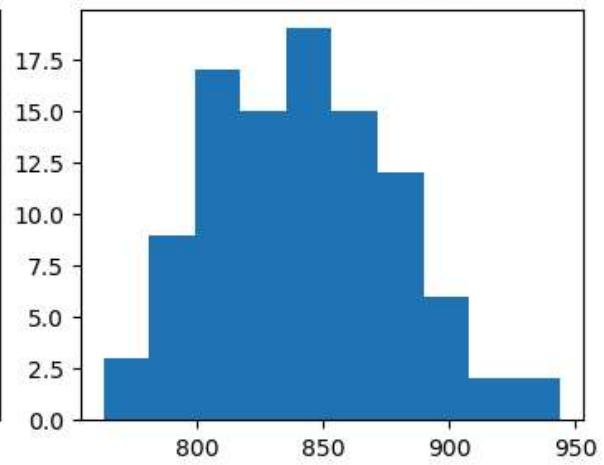
Bernoulli: N = 335



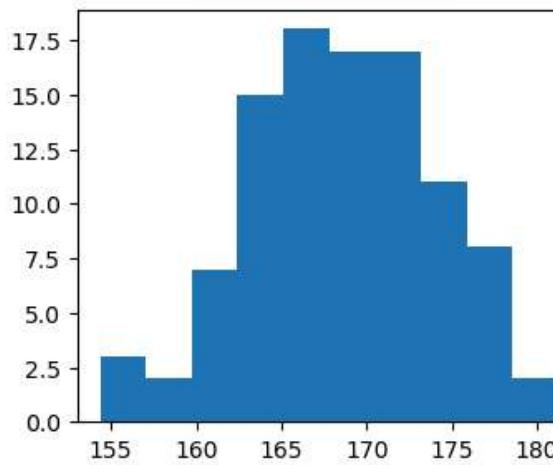
Uniforme: N = 336



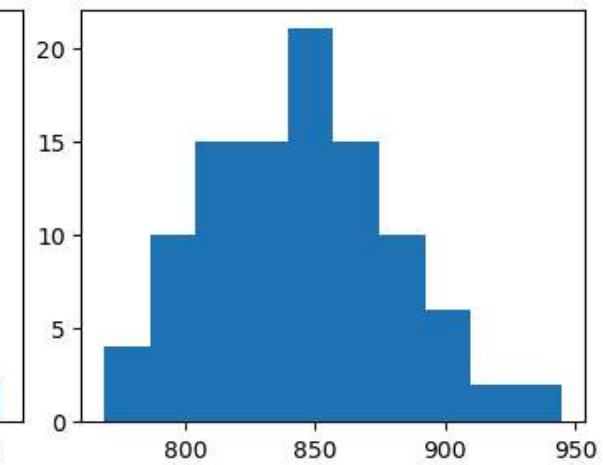
Bernoulli: N = 336

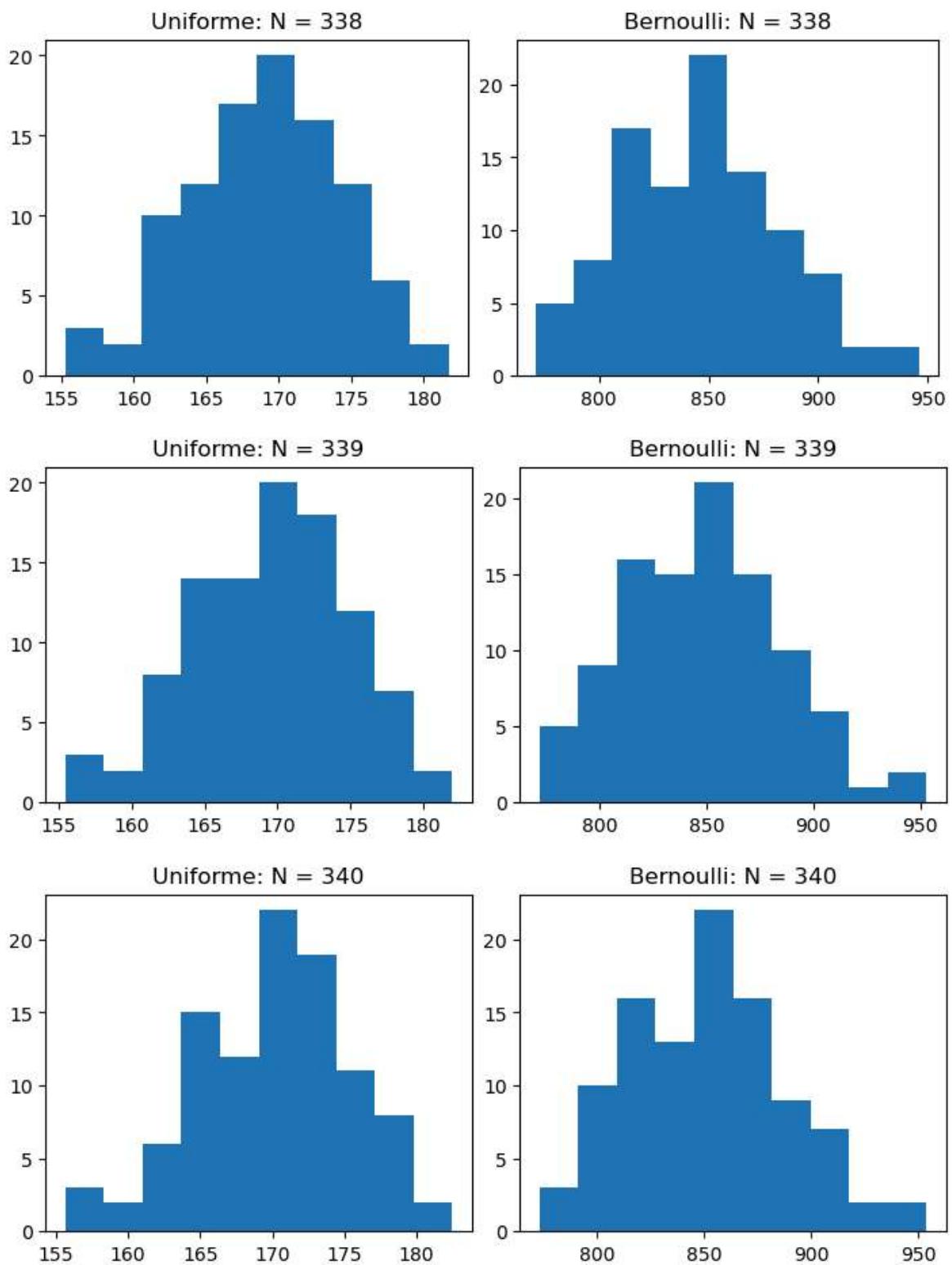


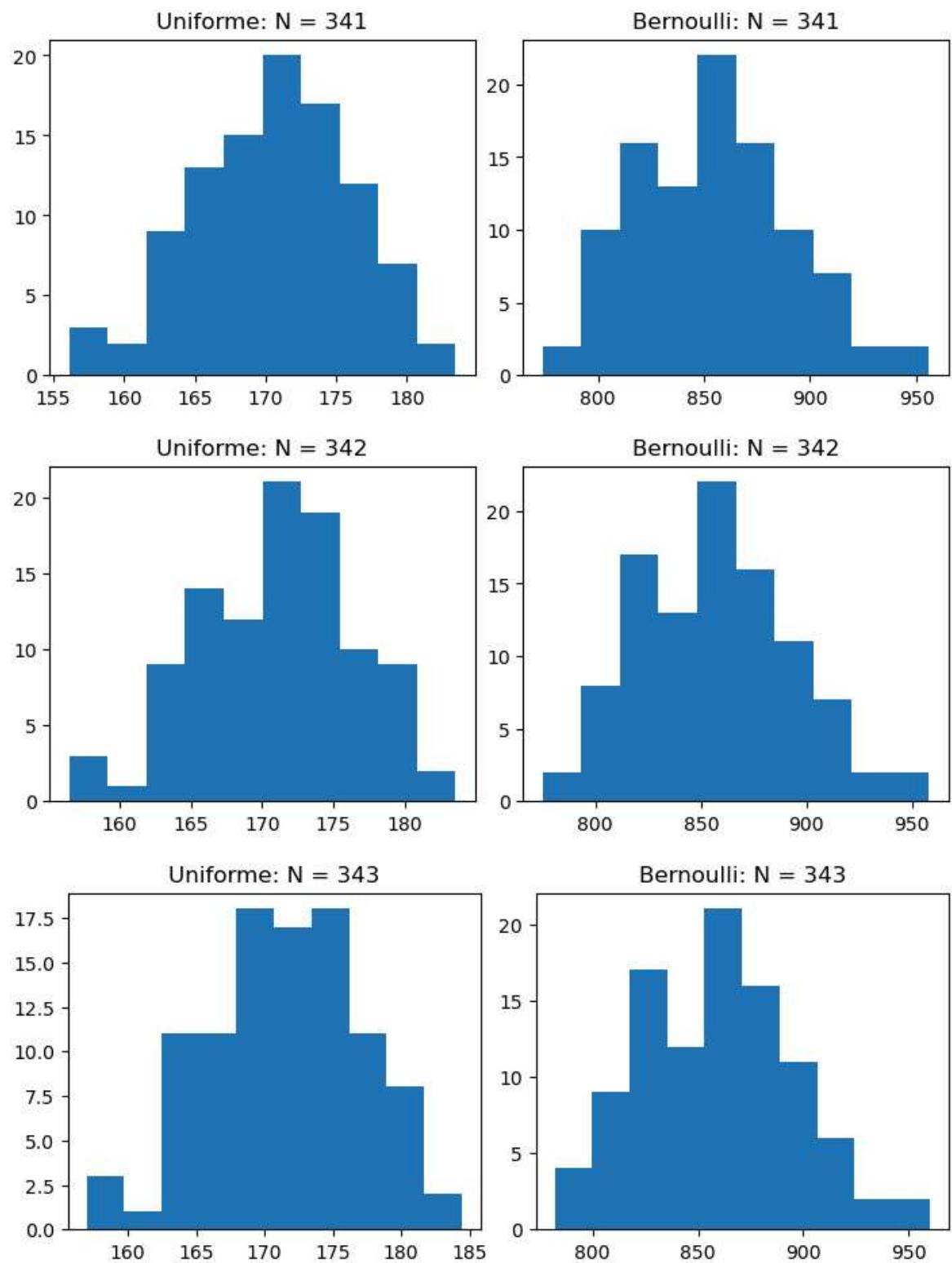
Uniforme: N = 337



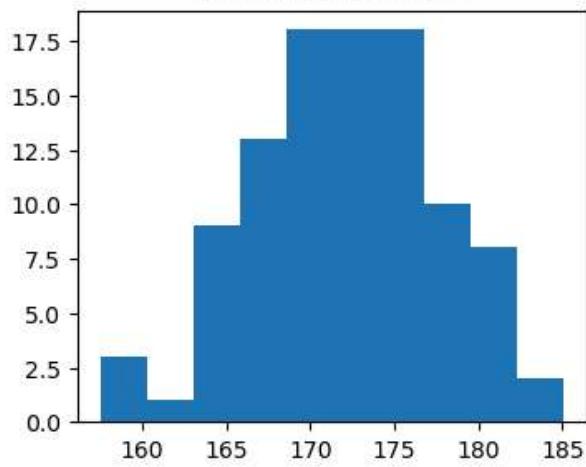
Bernoulli: N = 337



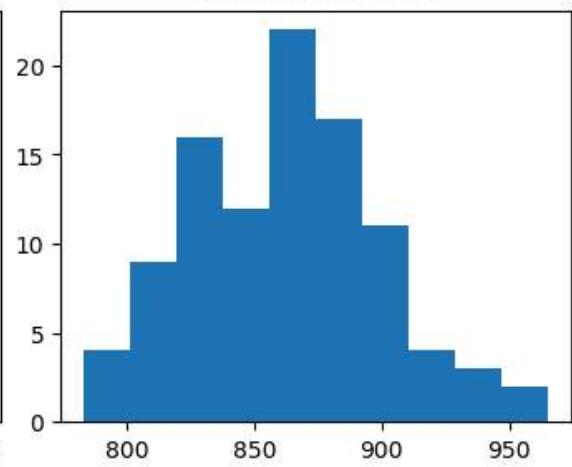




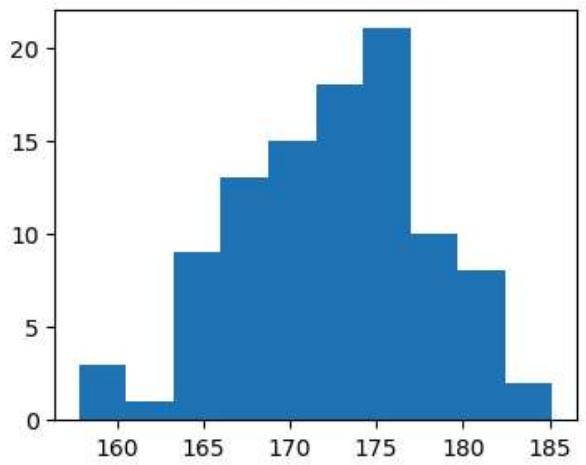
Uniforme: N = 344



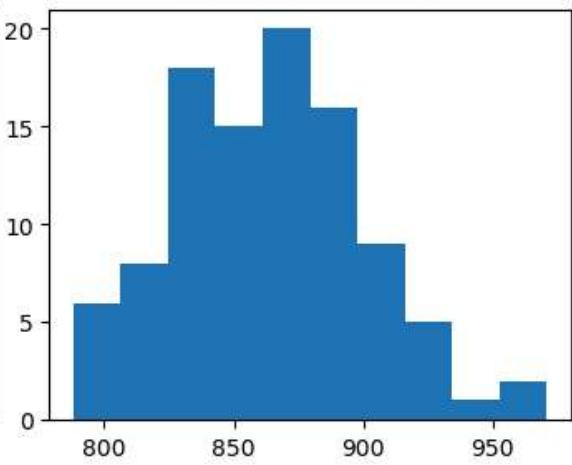
Bernoulli: N = 344



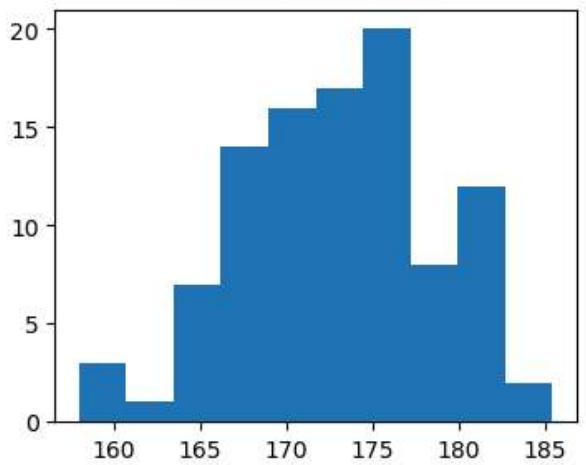
Uniforme: N = 345



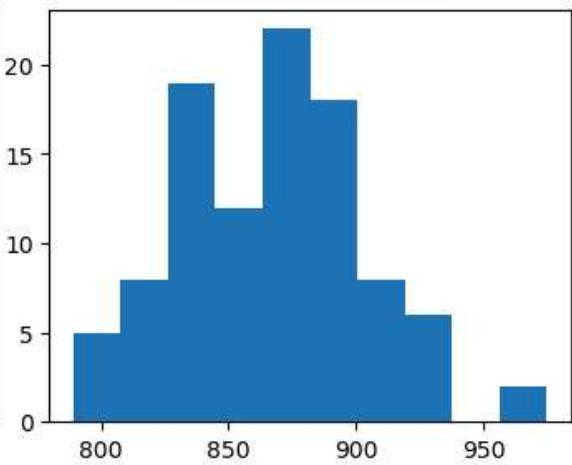
Bernoulli: N = 345



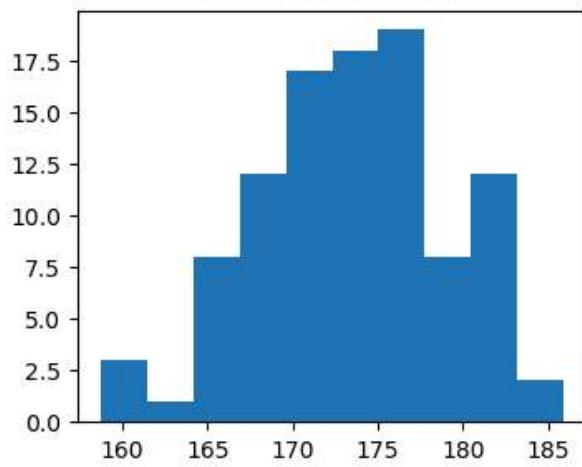
Uniforme: N = 346



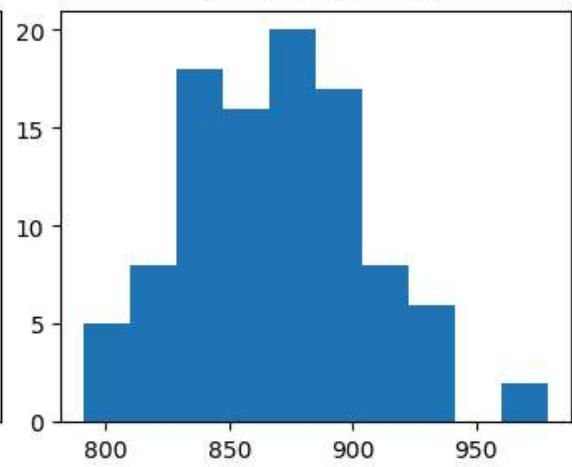
Bernoulli: N = 346



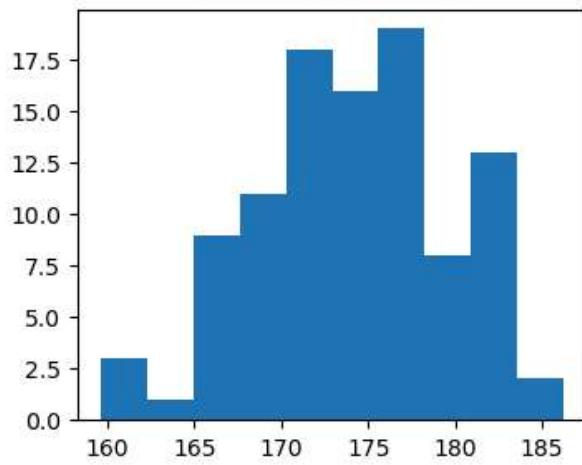
Uniforme: N = 347



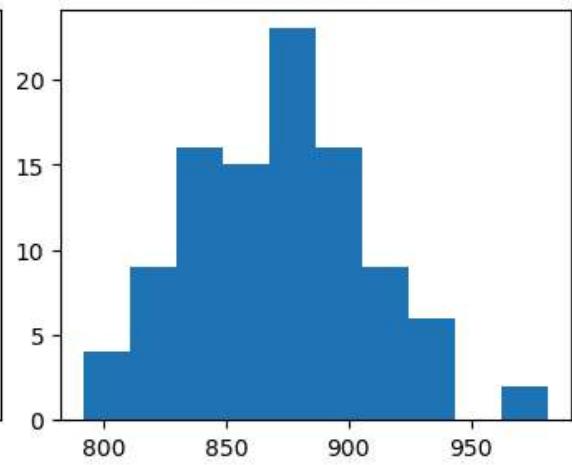
Bernoulli: N = 347



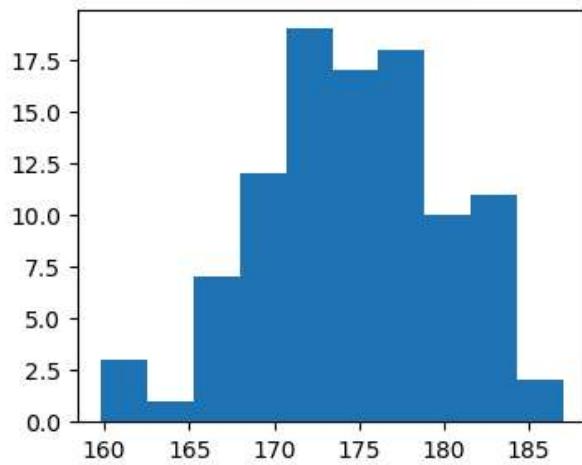
Uniforme: N = 348



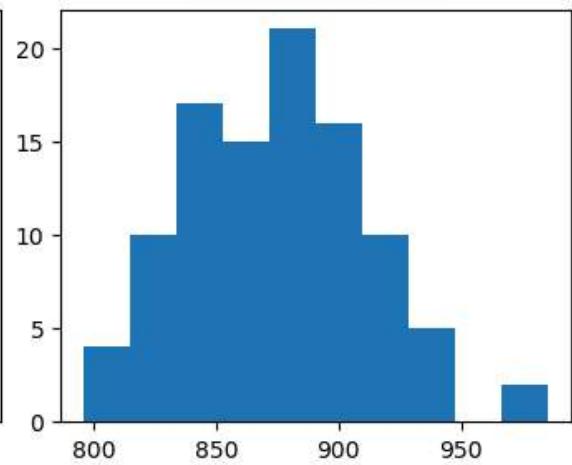
Bernoulli: N = 348



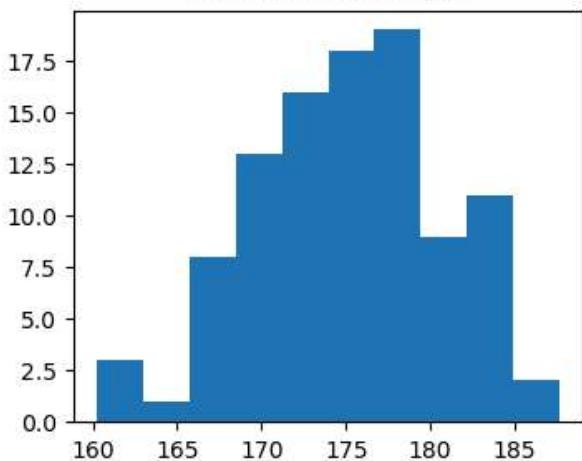
Uniforme: N = 349



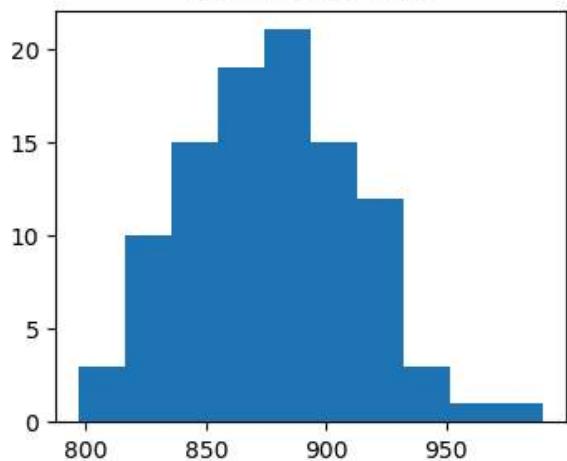
Bernoulli: N = 349



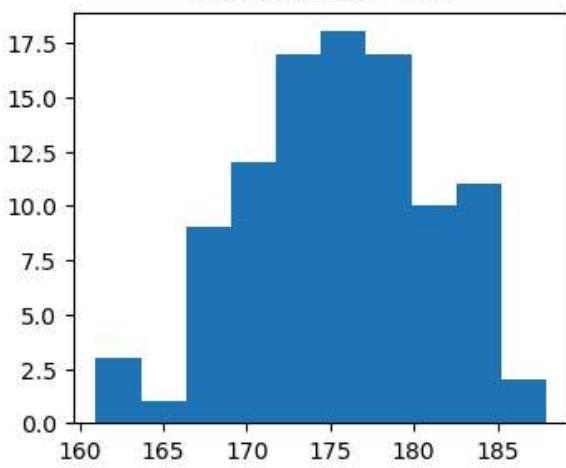
Uniforme: N = 350



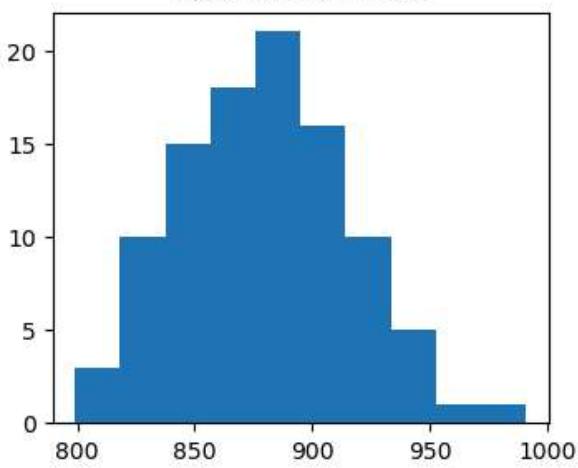
Bernoulli: N = 350



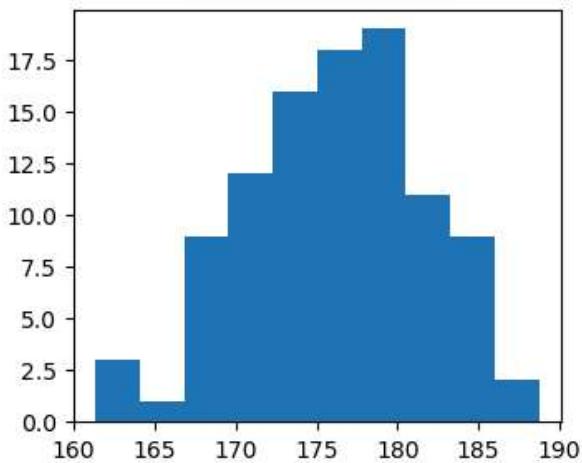
Uniforme: N = 351



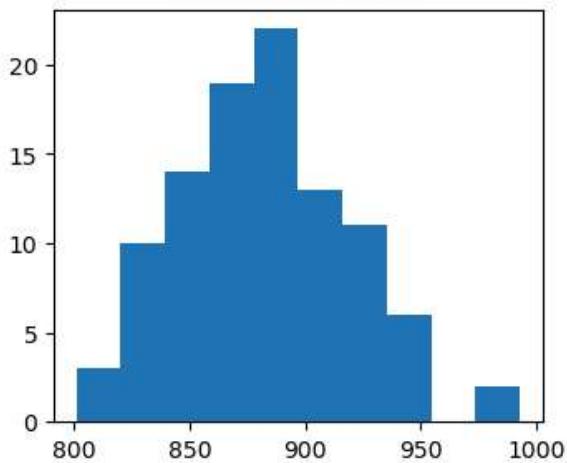
Bernoulli: N = 351

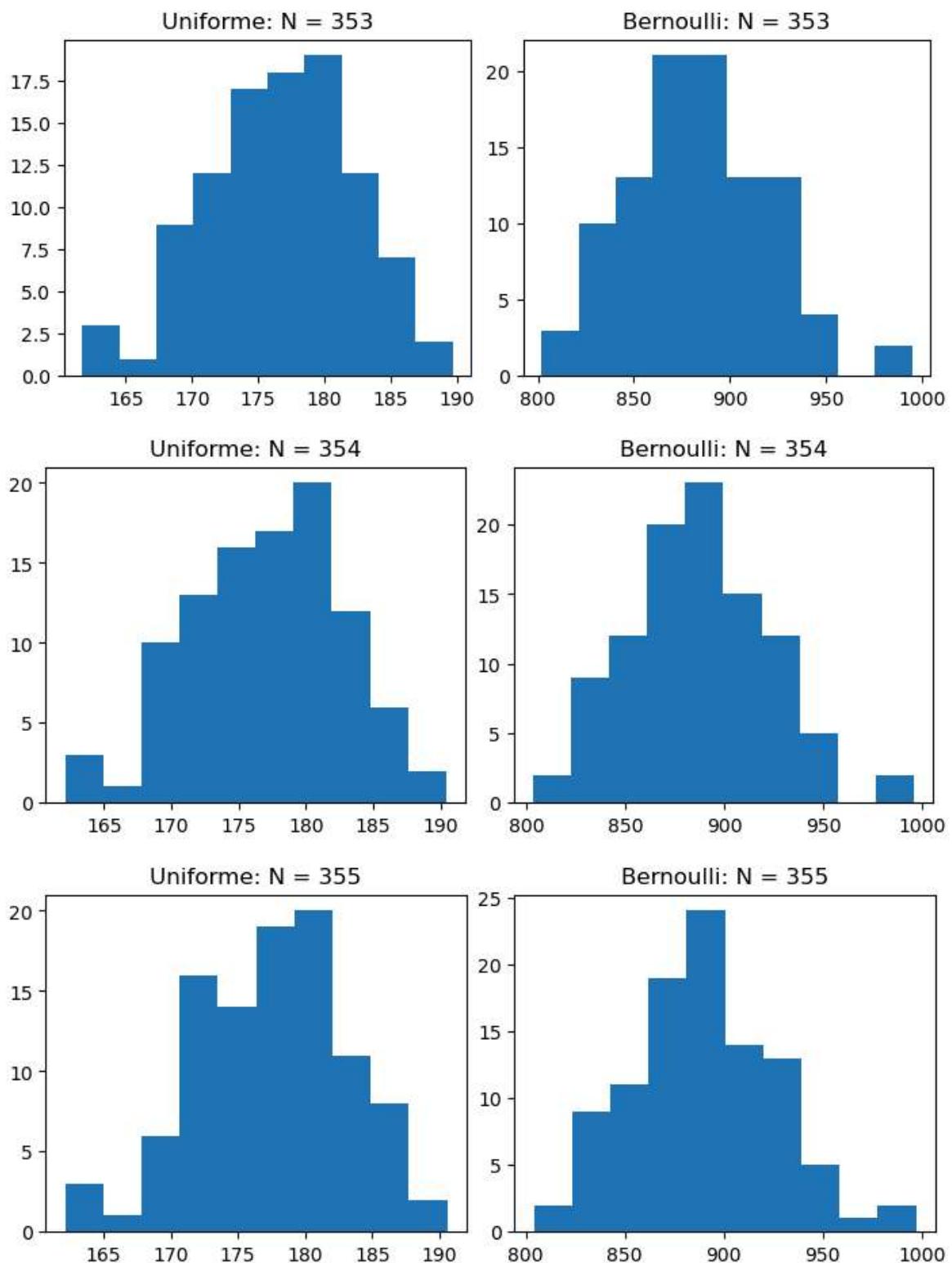


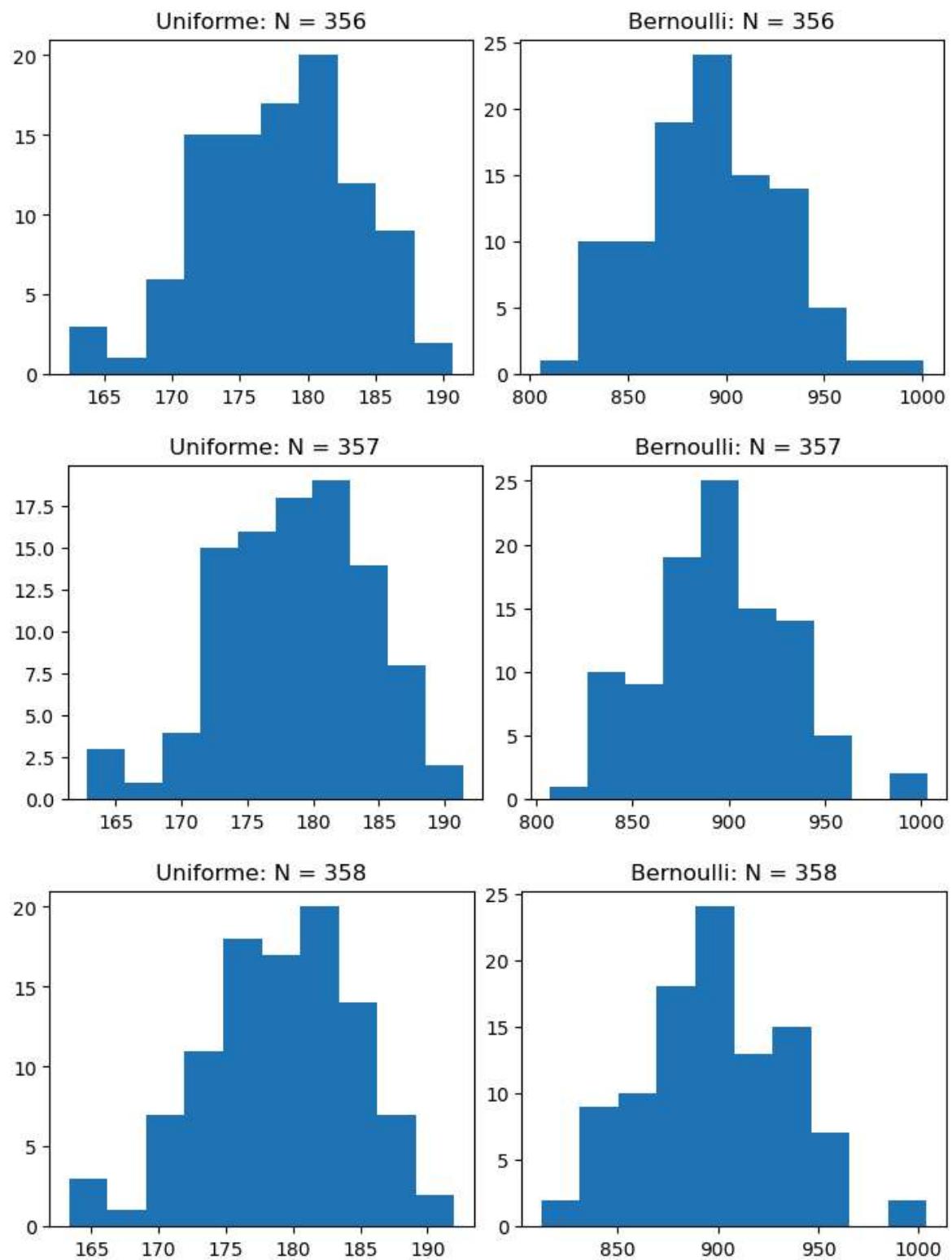
Uniforme: N = 352

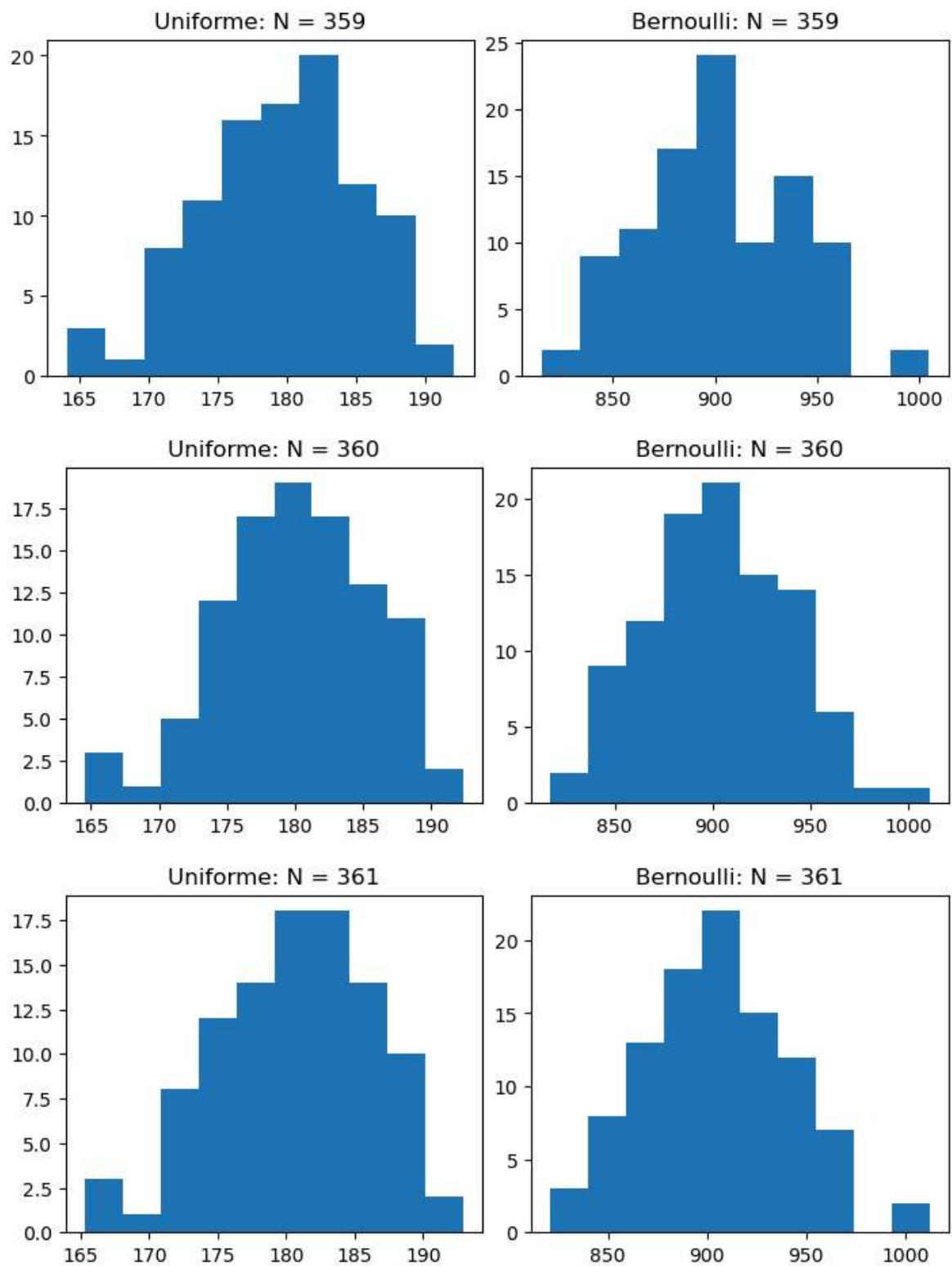


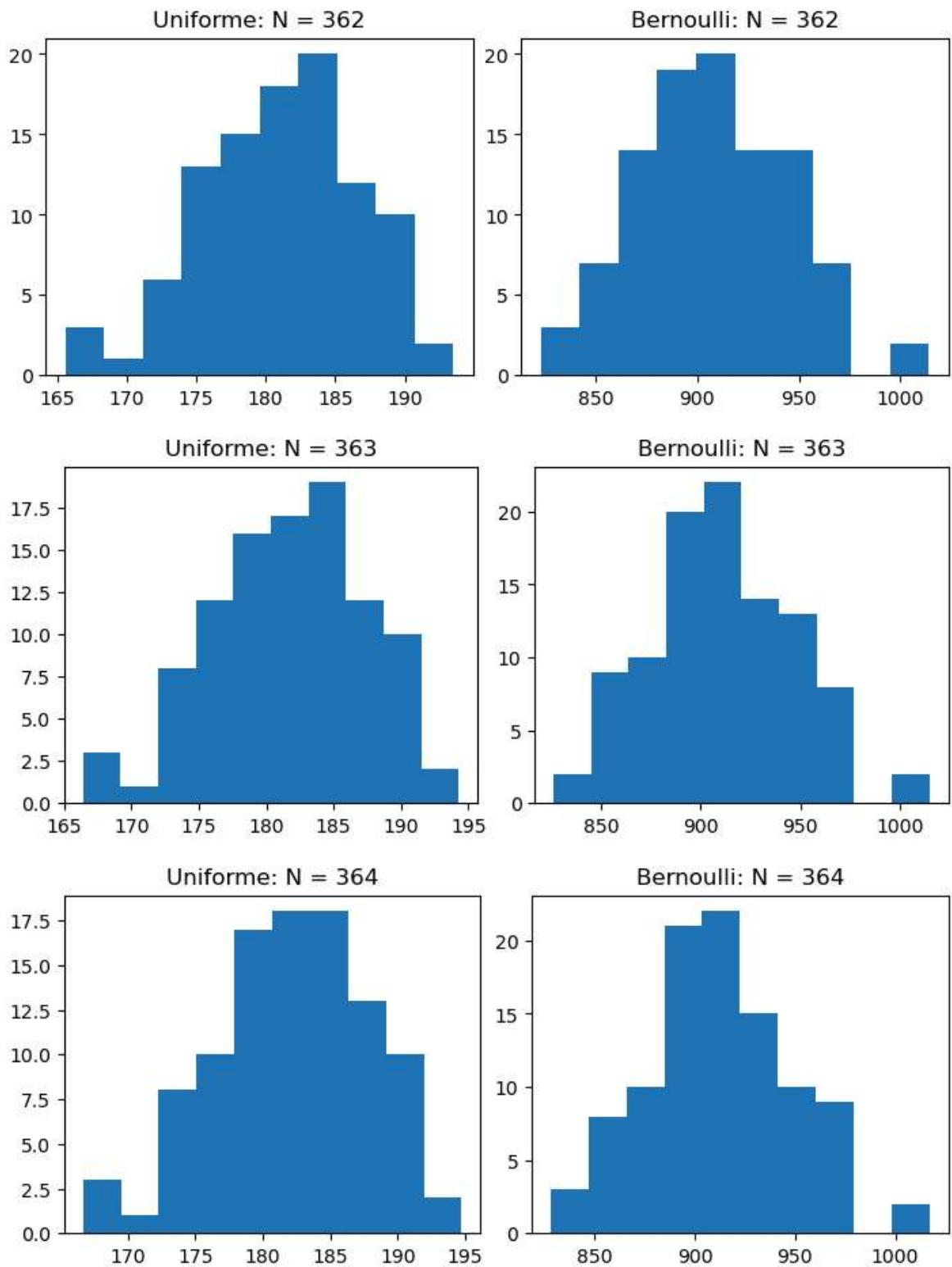
Bernoulli: N = 352

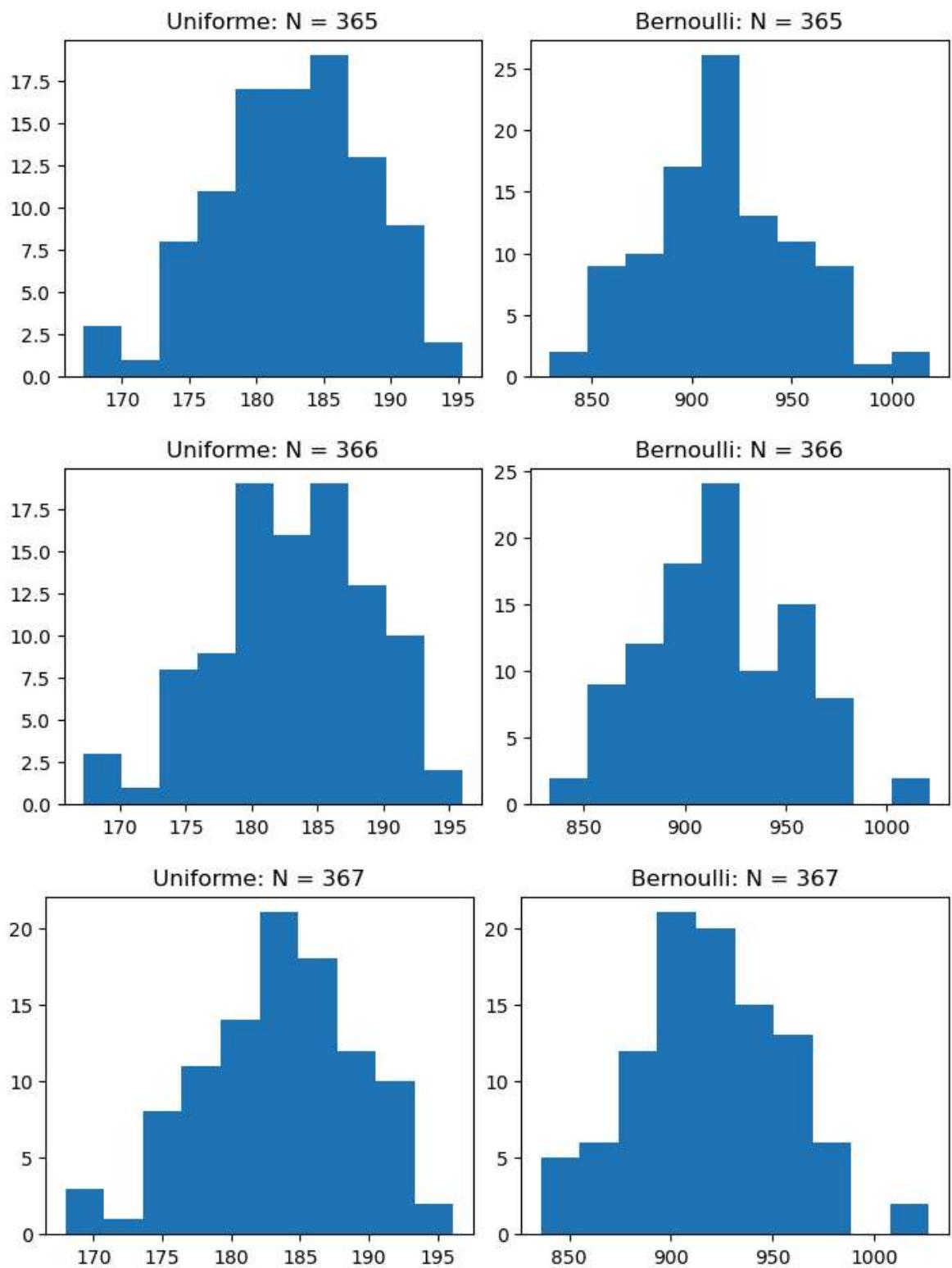




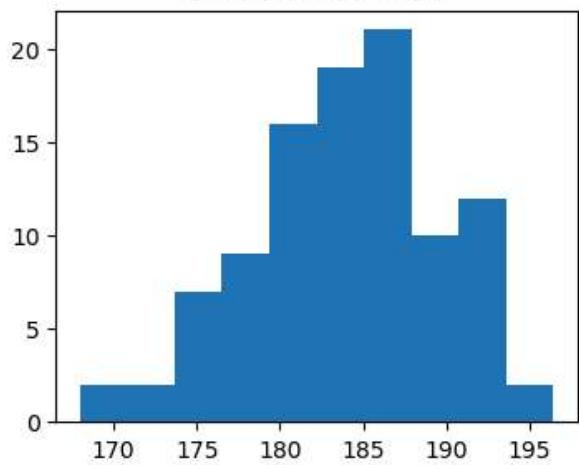




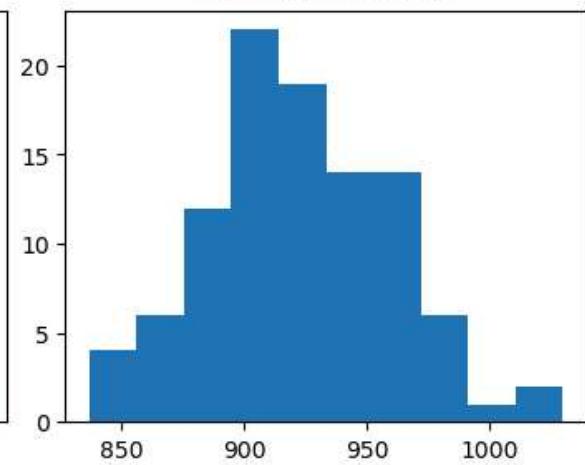




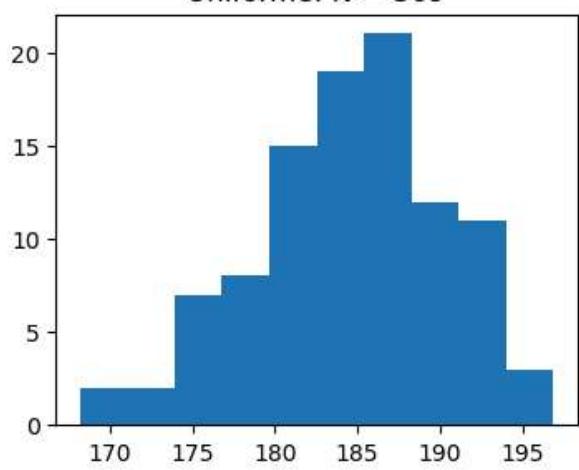
Uniforme: N = 368



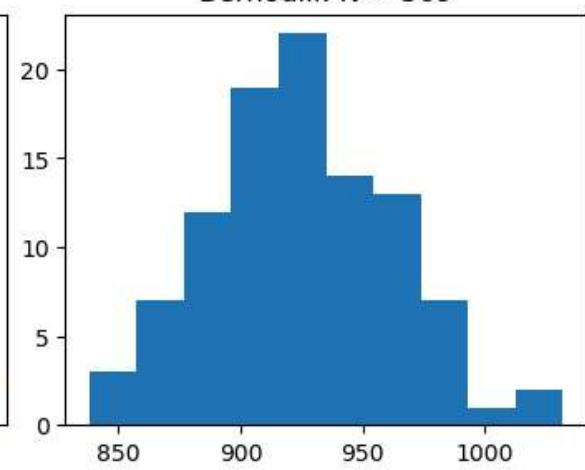
Bernoulli: N = 368



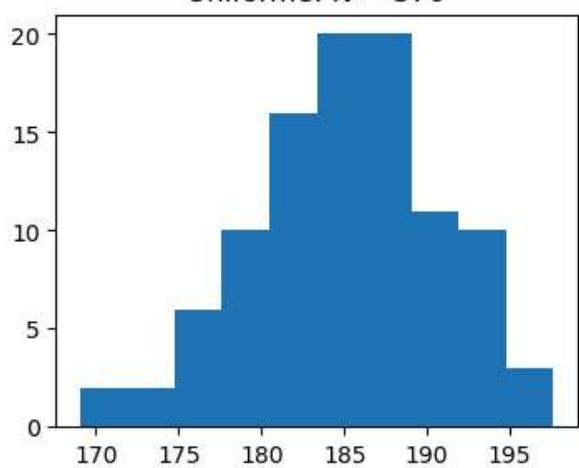
Uniforme: N = 369



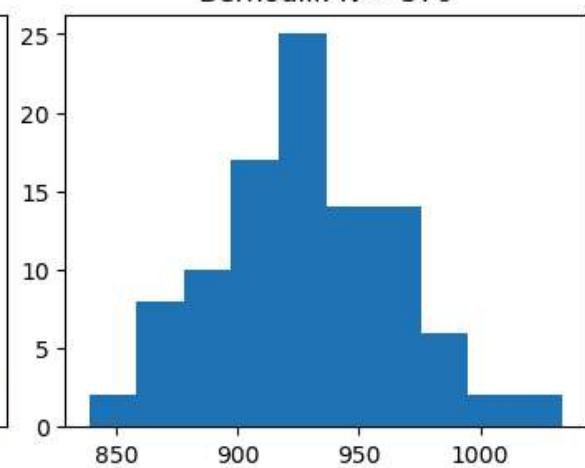
Bernoulli: N = 369



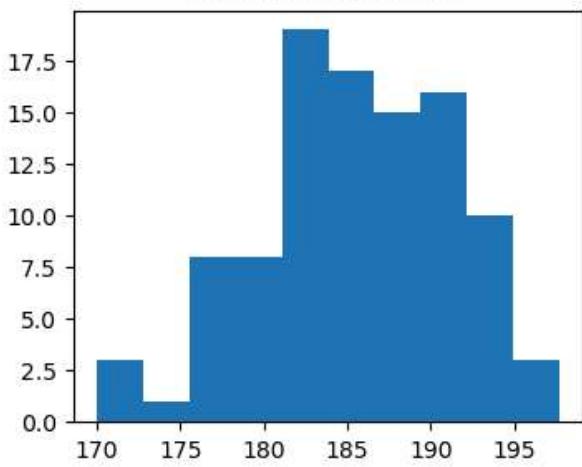
Uniforme: N = 370



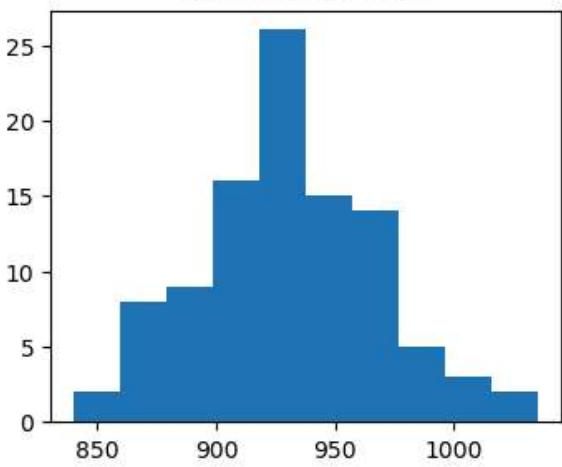
Bernoulli: N = 370



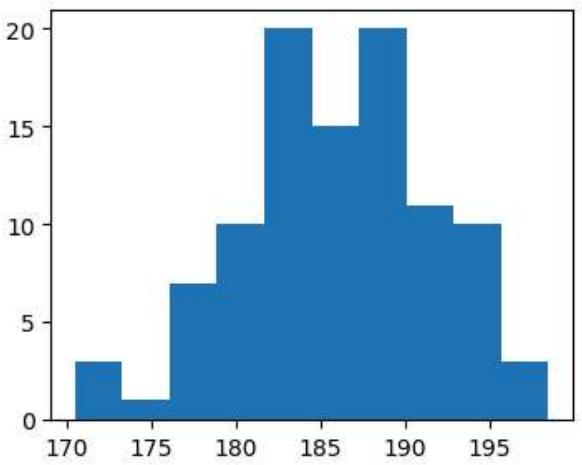
Uniforme: N = 371



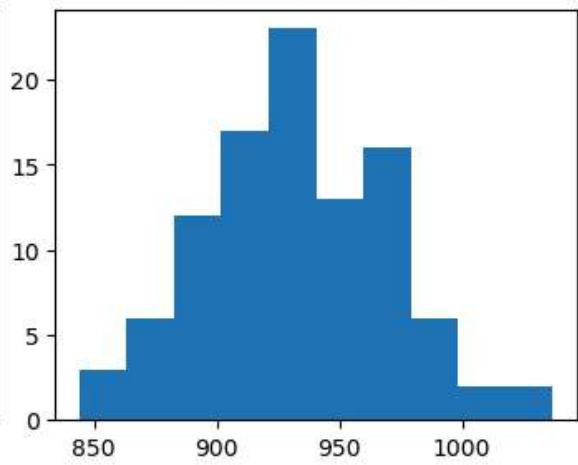
Bernoulli: N = 371



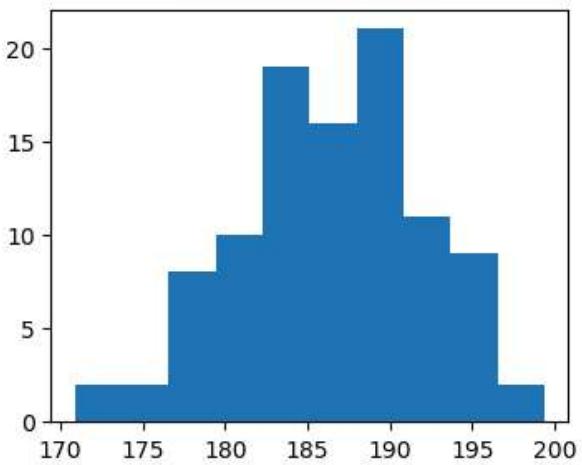
Uniforme: N = 372



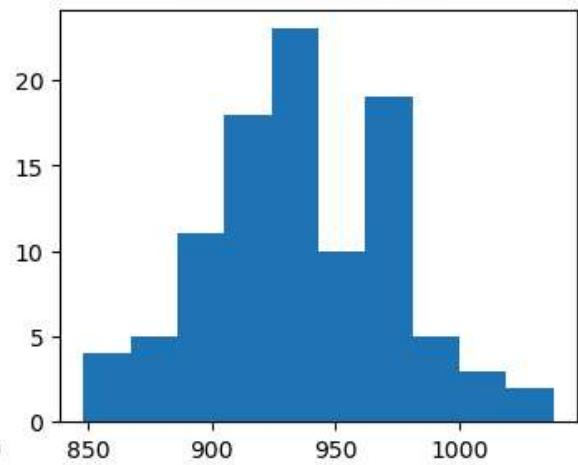
Bernoulli: N = 372

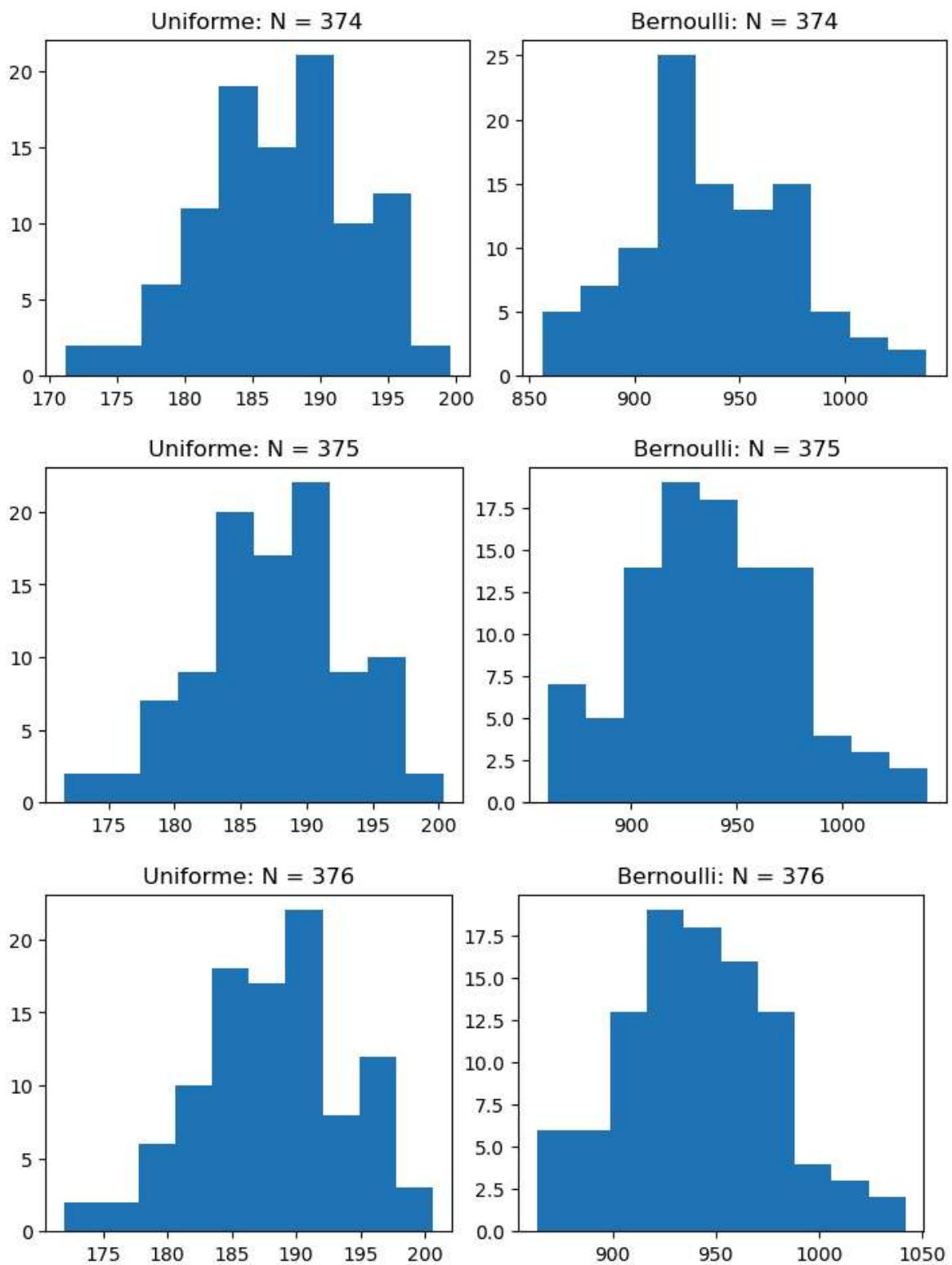


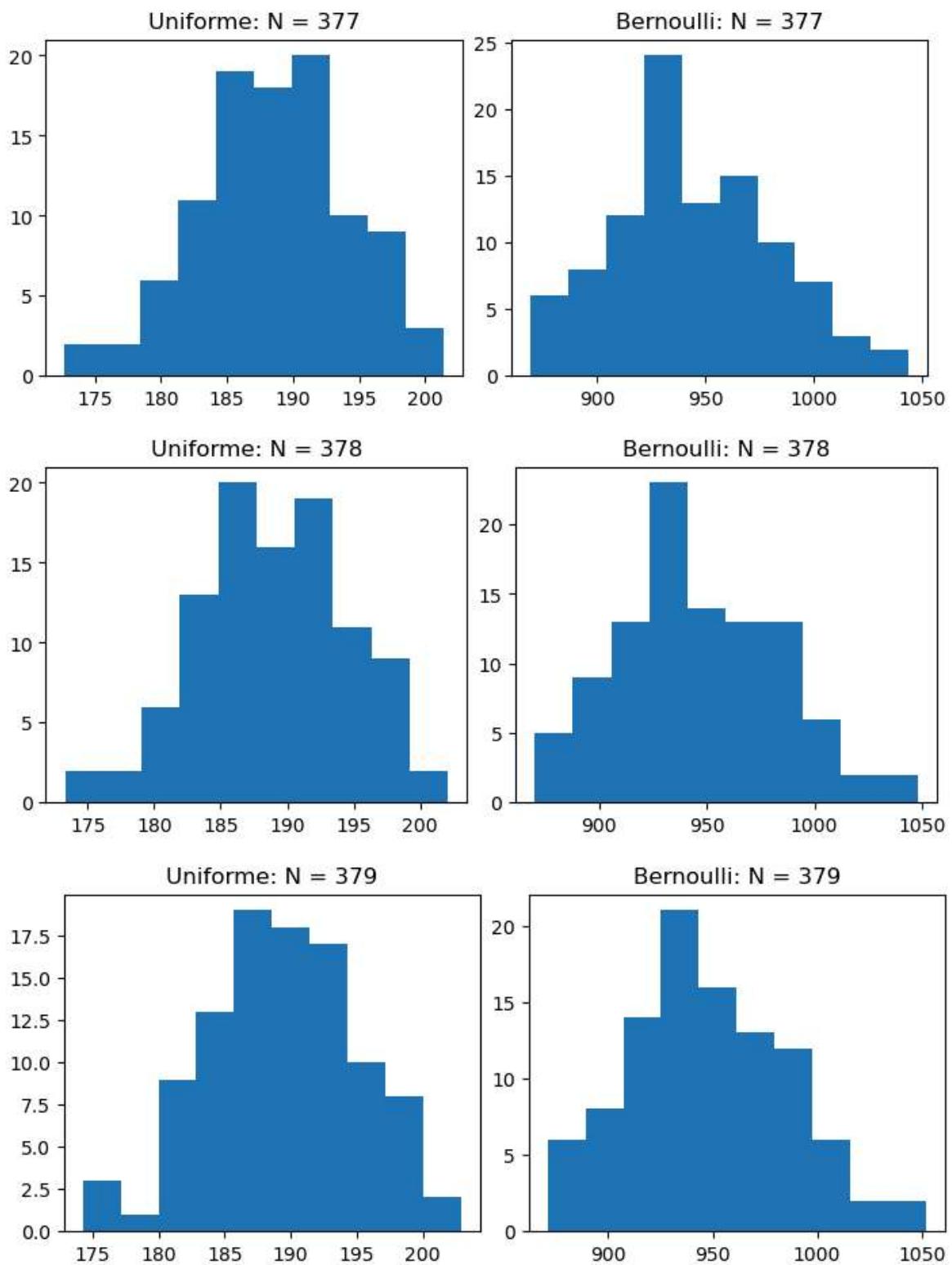
Uniforme: N = 373



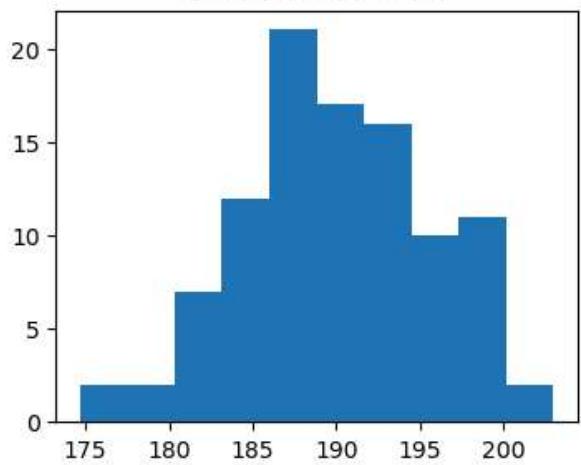
Bernoulli: N = 373



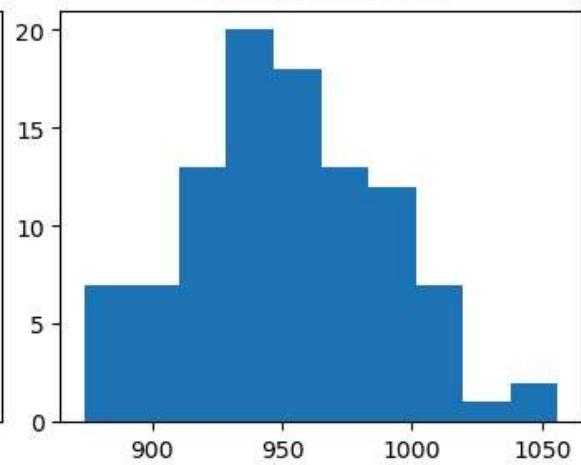




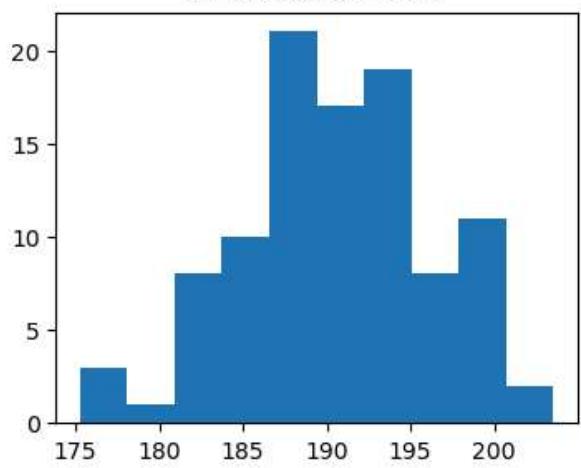
Uniforme: N = 380



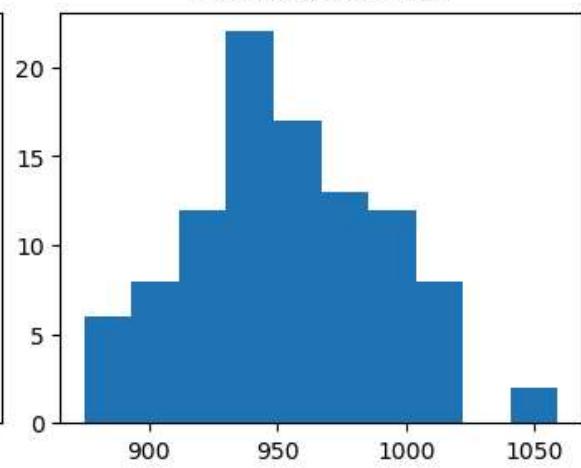
Bernoulli: N = 380



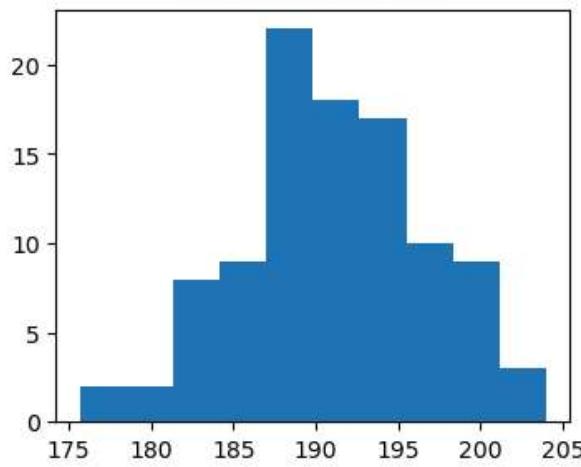
Uniforme: N = 381



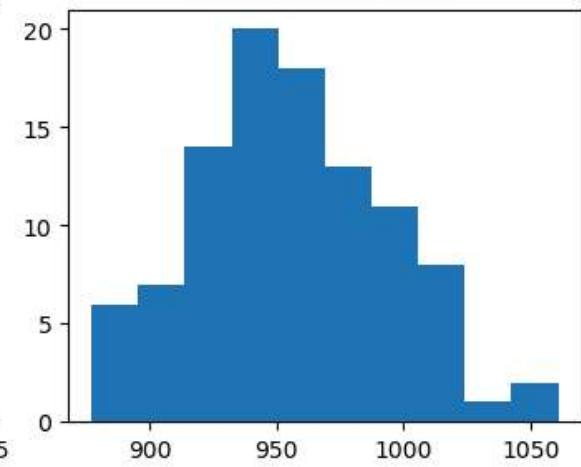
Bernoulli: N = 381



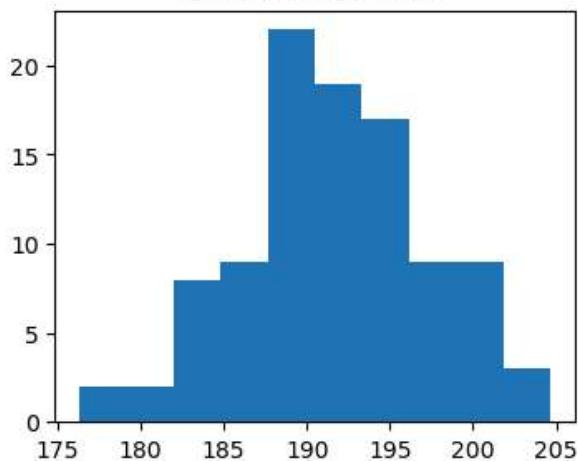
Uniforme: N = 382



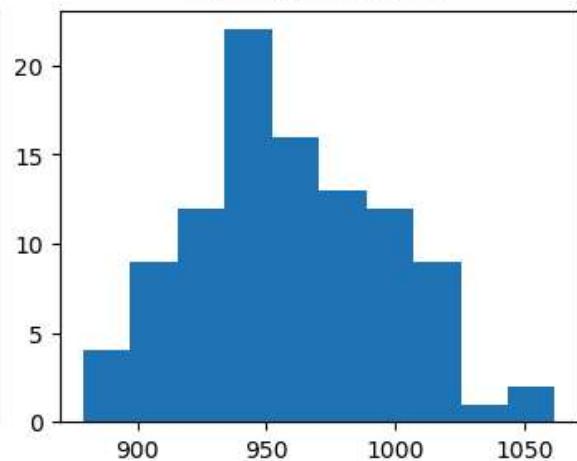
Bernoulli: N = 382



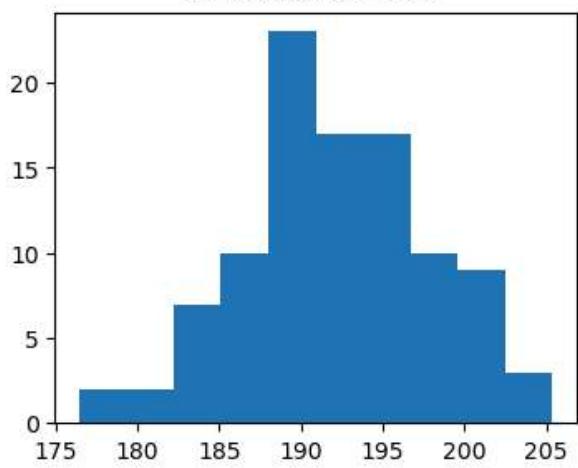
Uniforme: N = 383



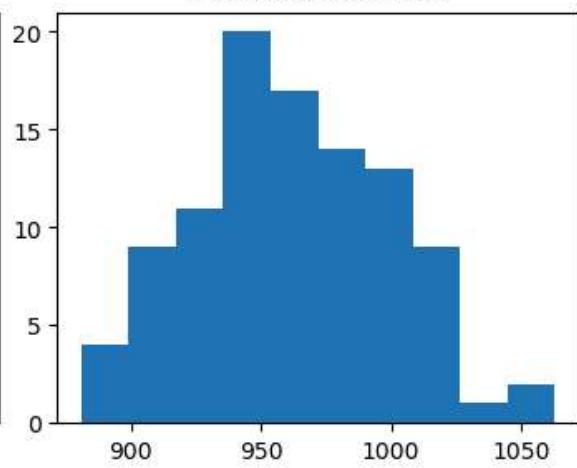
Bernoulli: N = 383



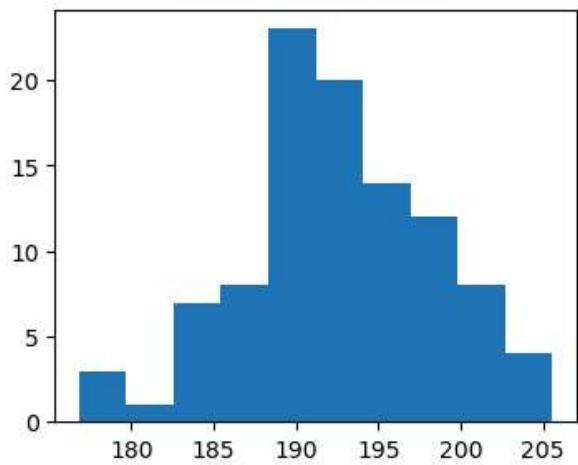
Uniforme: N = 384



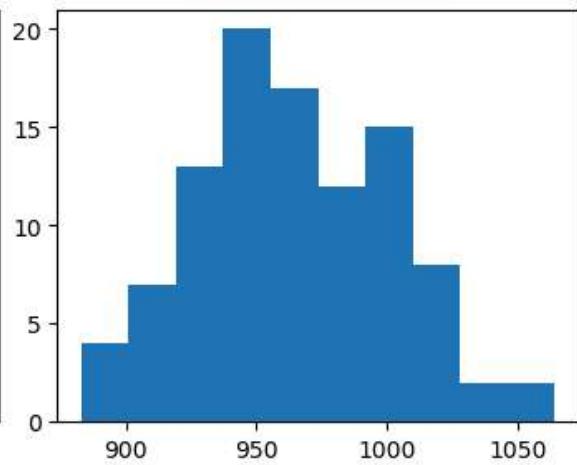
Bernoulli: N = 384



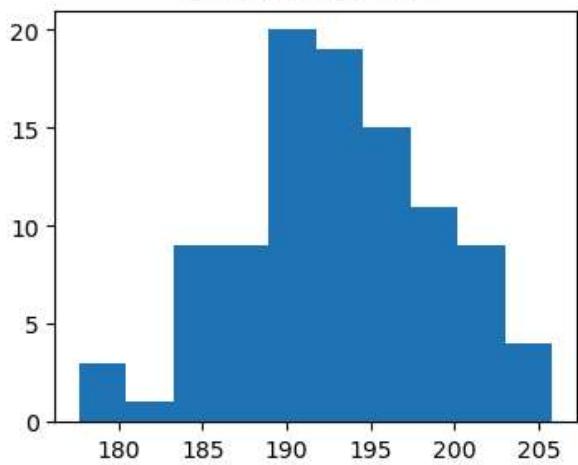
Uniforme: N = 385



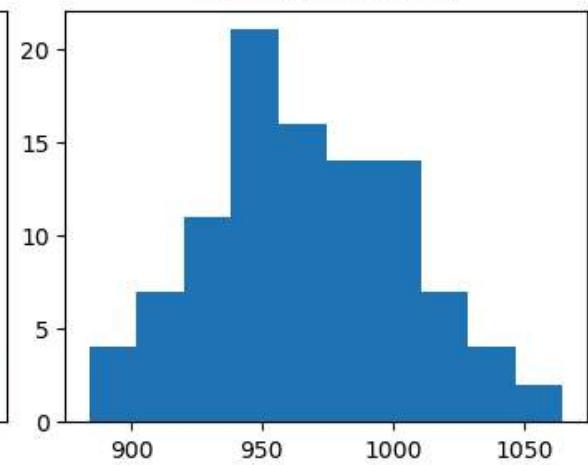
Bernoulli: N = 385



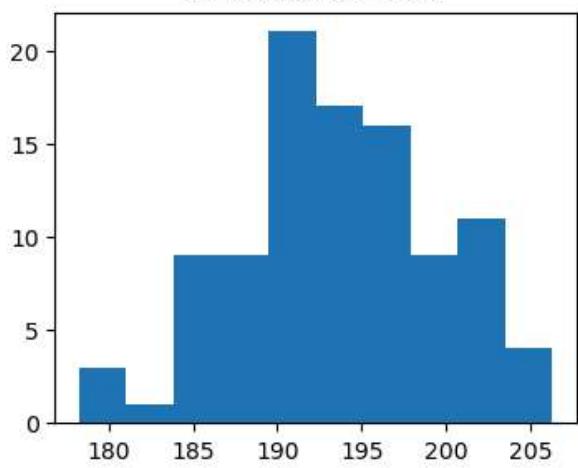
Uniforme: N = 386



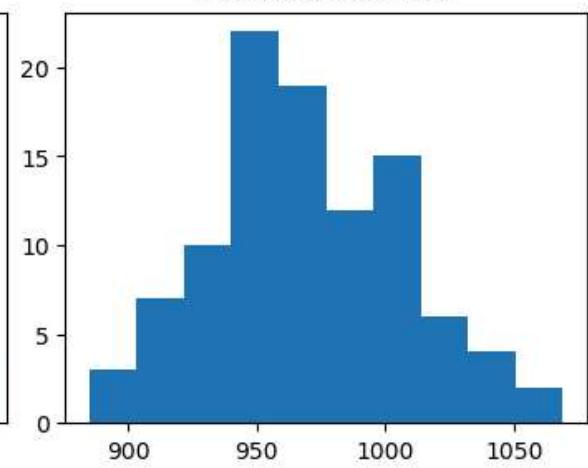
Bernoulli: N = 386



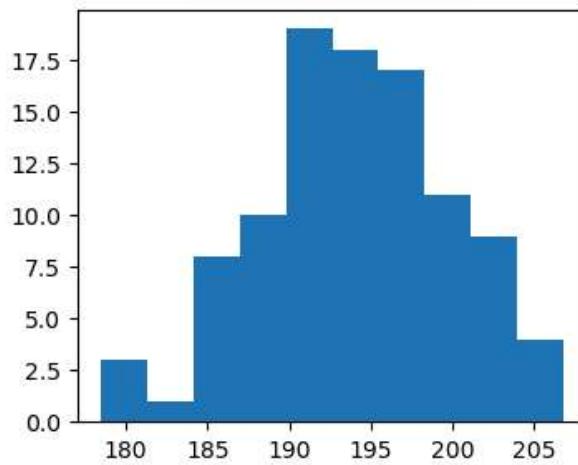
Uniforme: N = 387



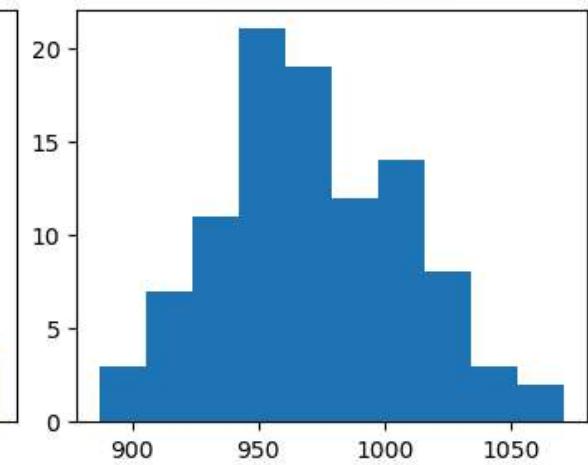
Bernoulli: N = 387



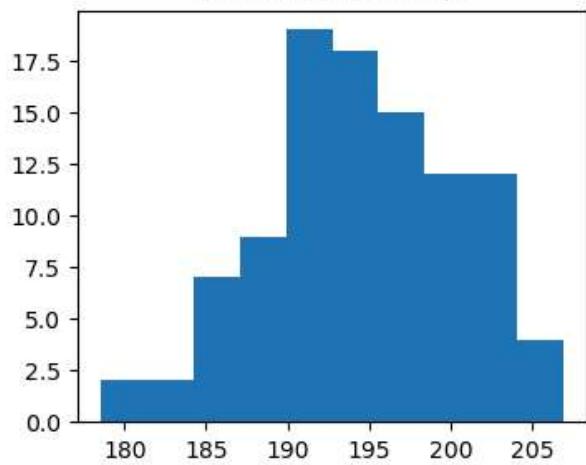
Uniforme: N = 388



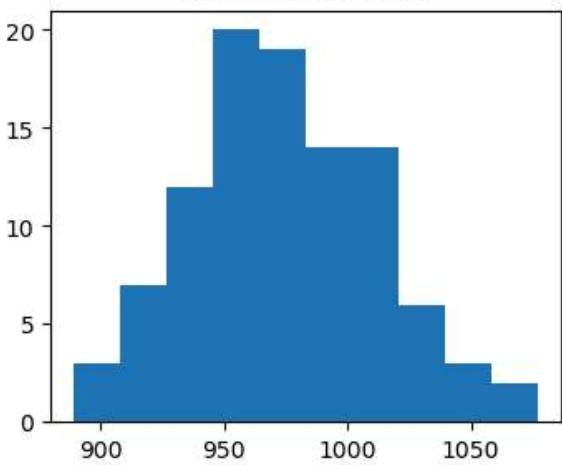
Bernoulli: N = 388



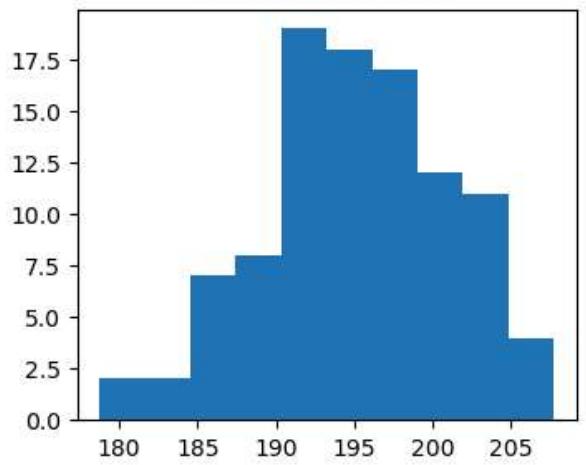
Uniforme: N = 389



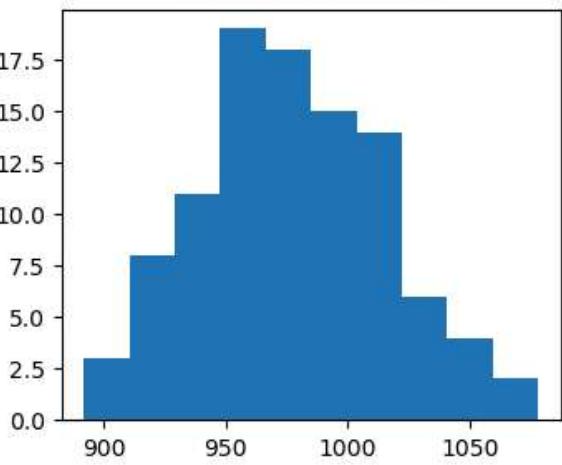
Bernoulli: N = 389



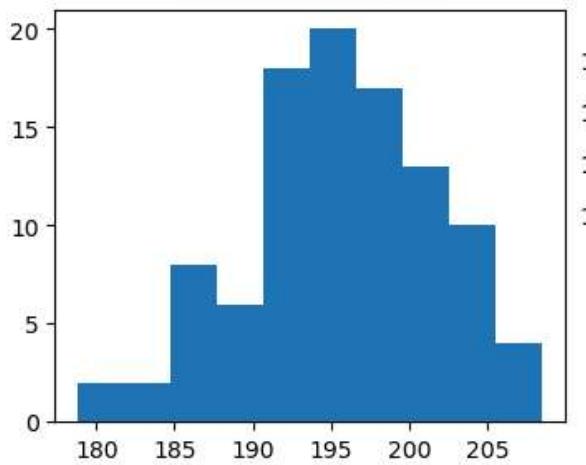
Uniforme: N = 390



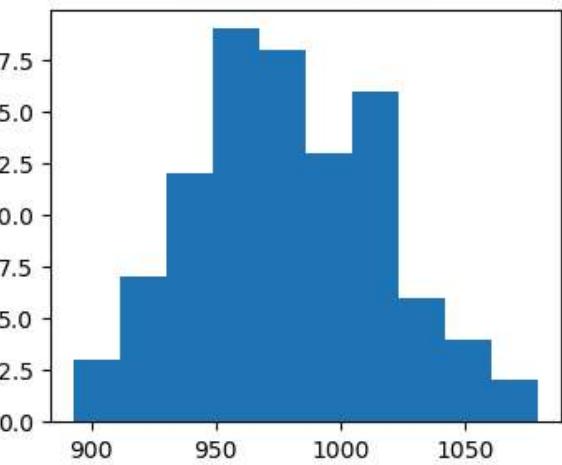
Bernoulli: N = 390

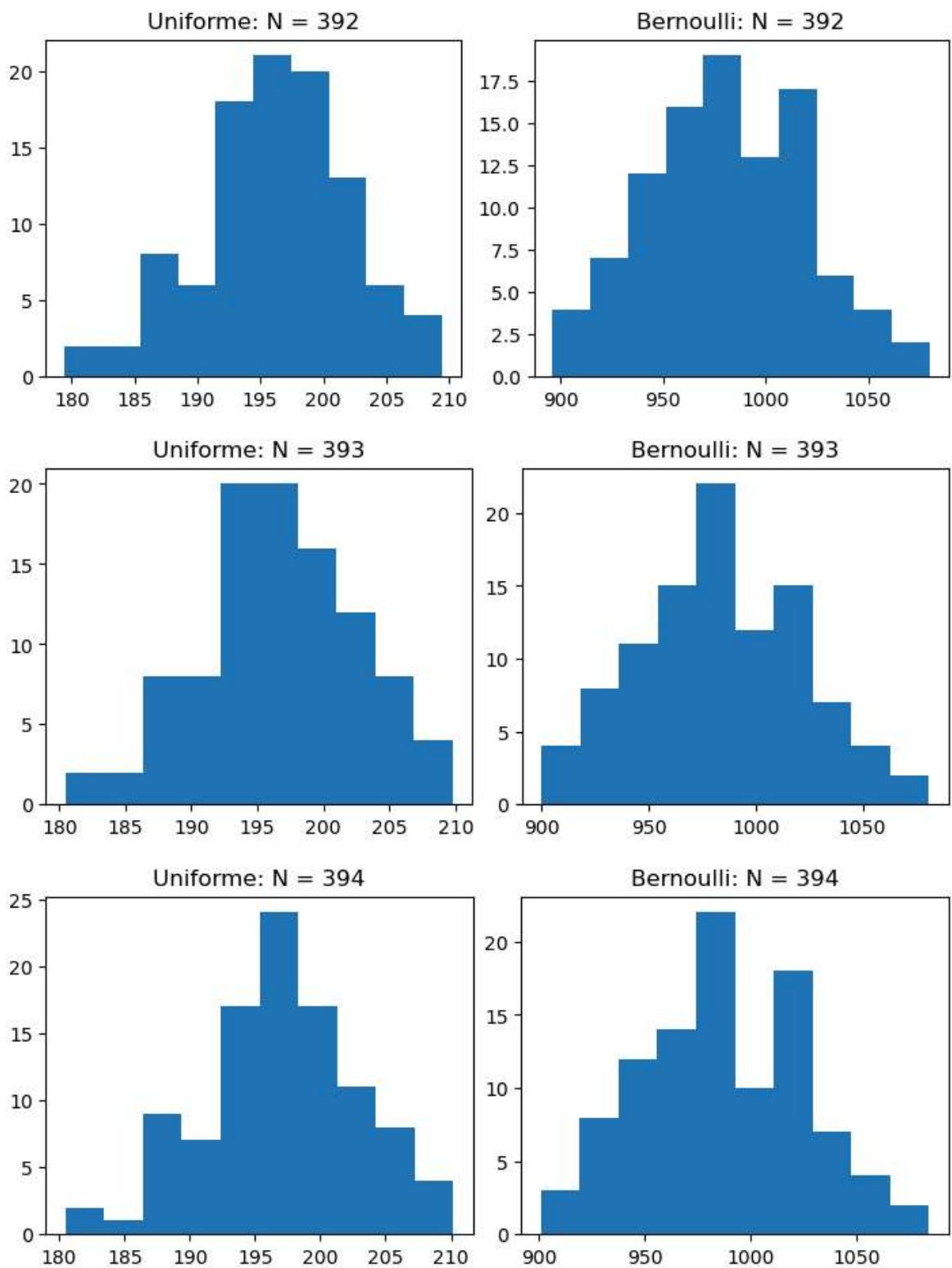


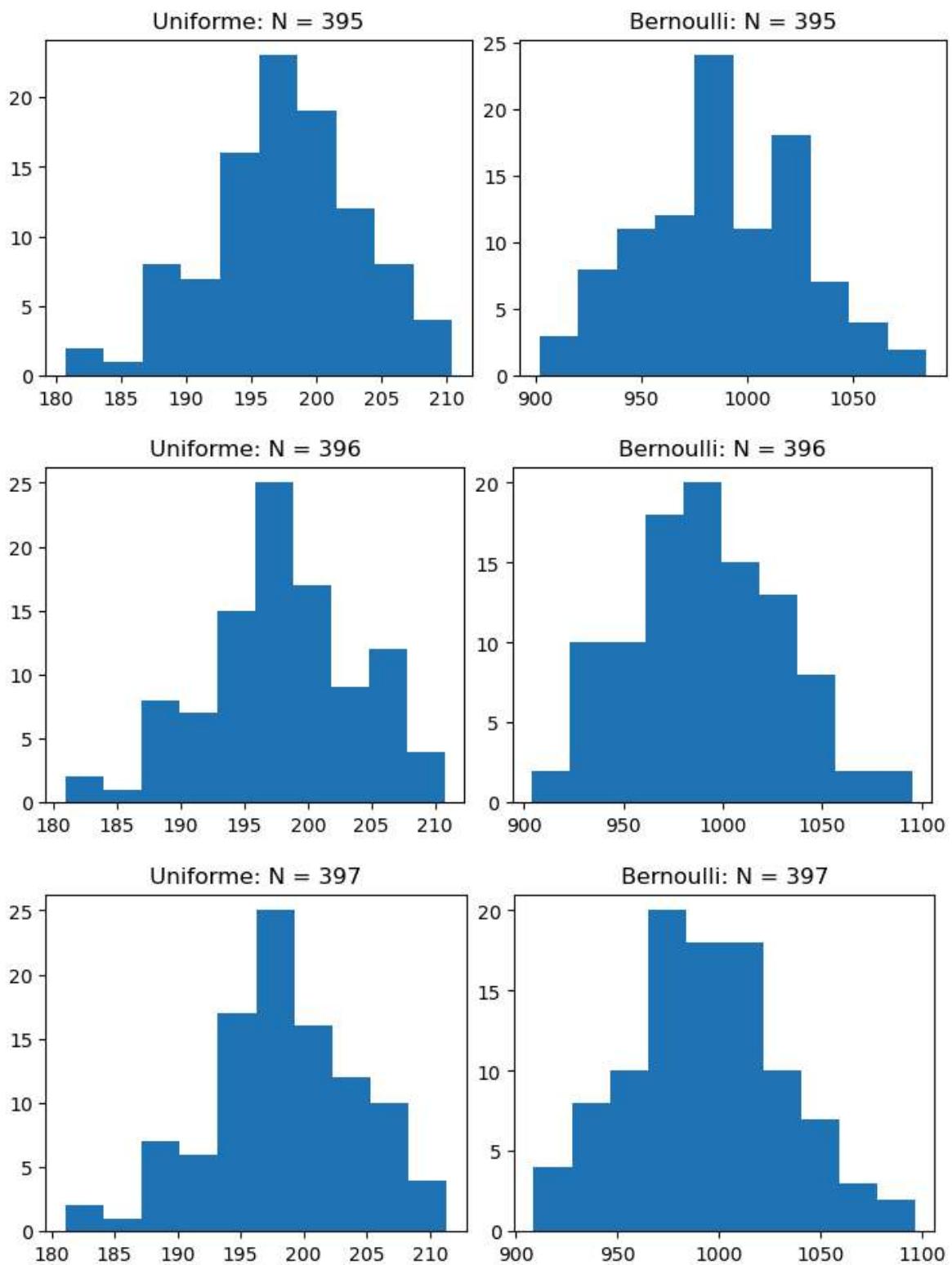
Uniforme: N = 391



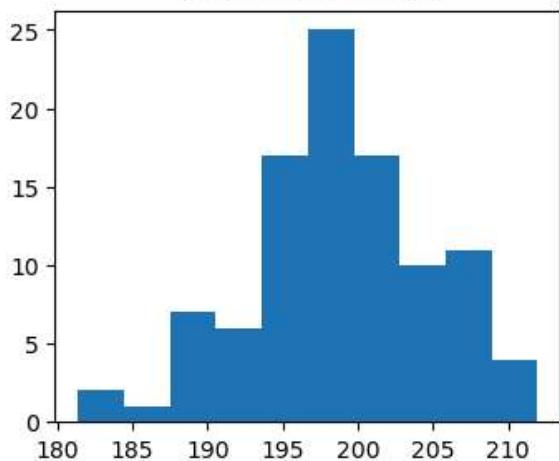
Bernoulli: N = 391



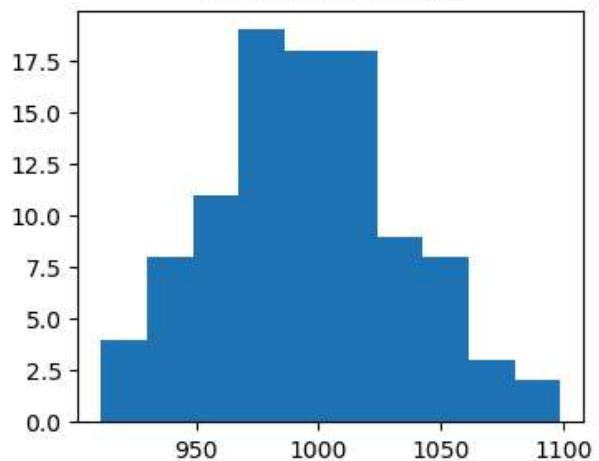




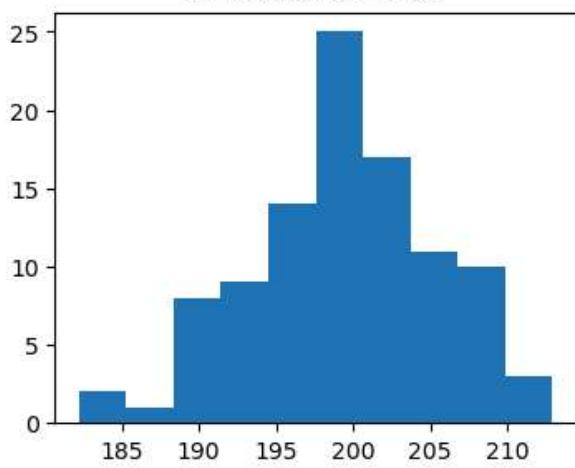
Uniforme: N = 398



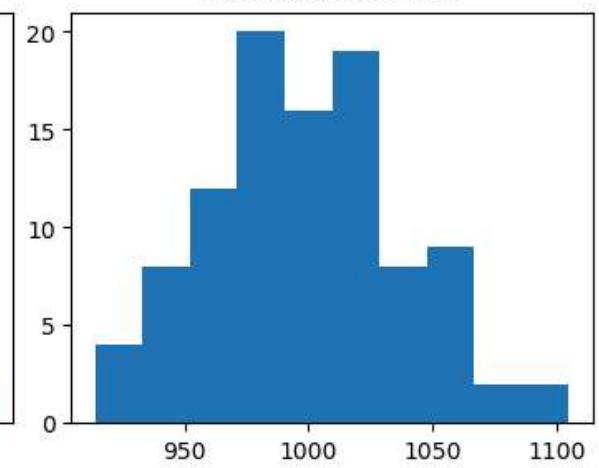
Bernoulli: N = 398



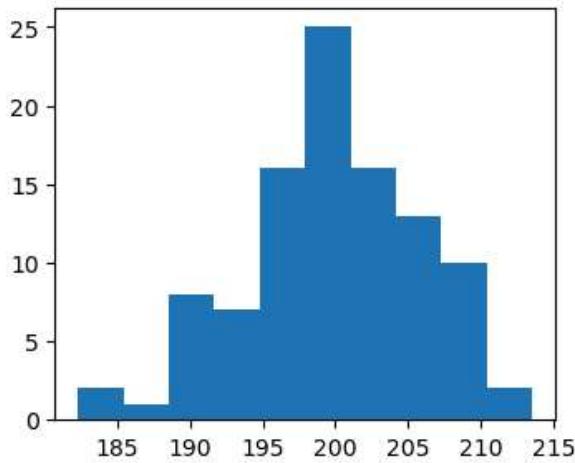
Uniforme: N = 399



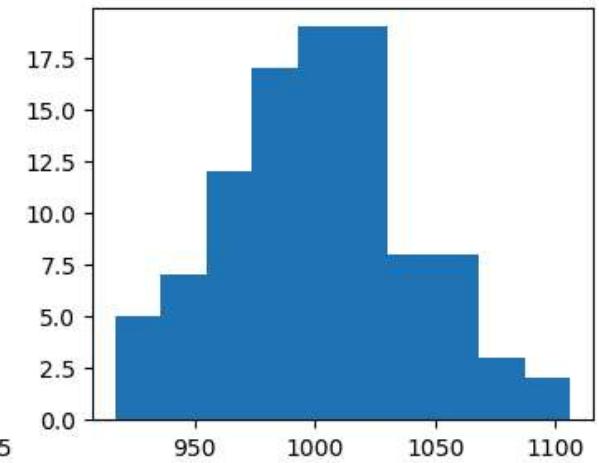
Bernoulli: N = 399

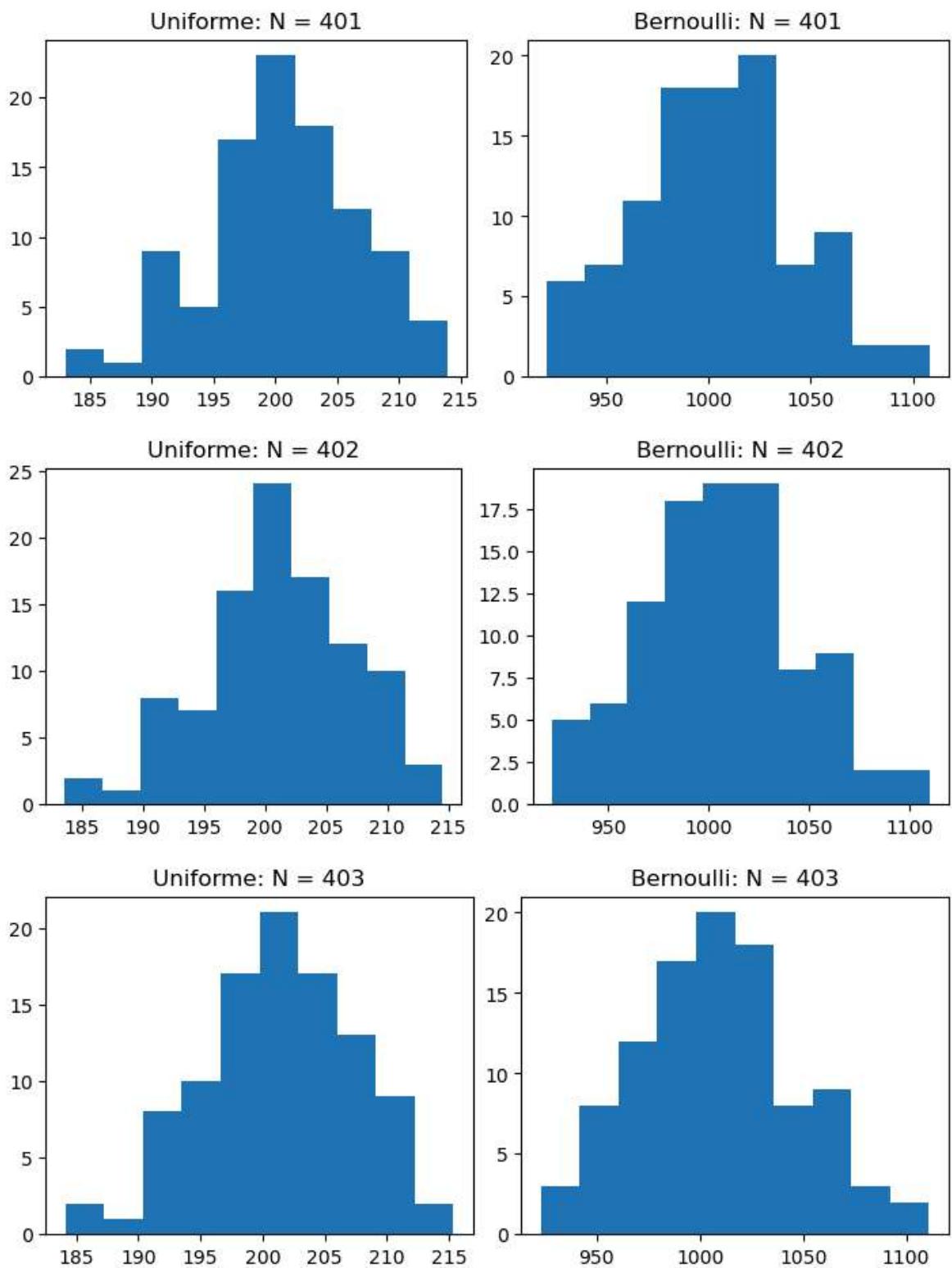


Uniforme: N = 400

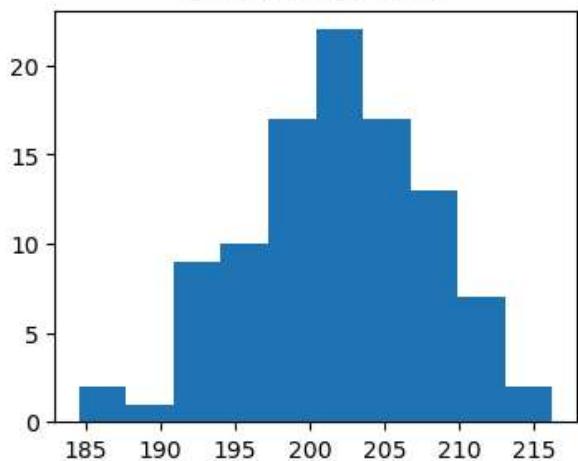


Bernoulli: N = 400

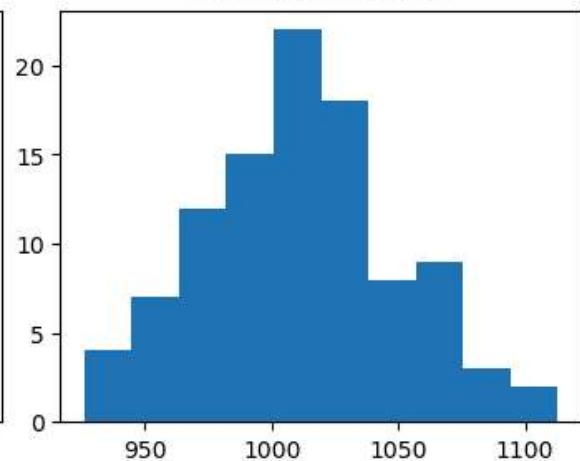




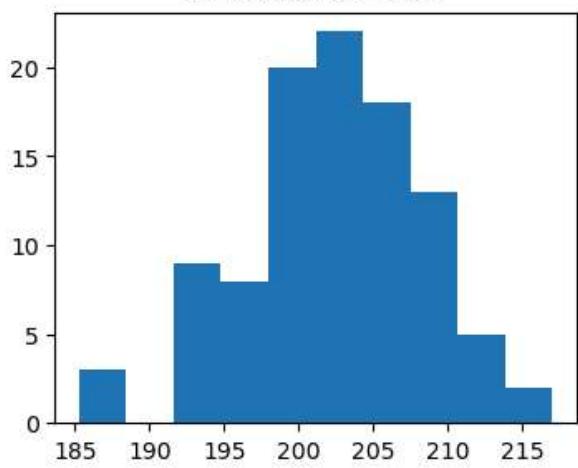
Uniforme: N = 404



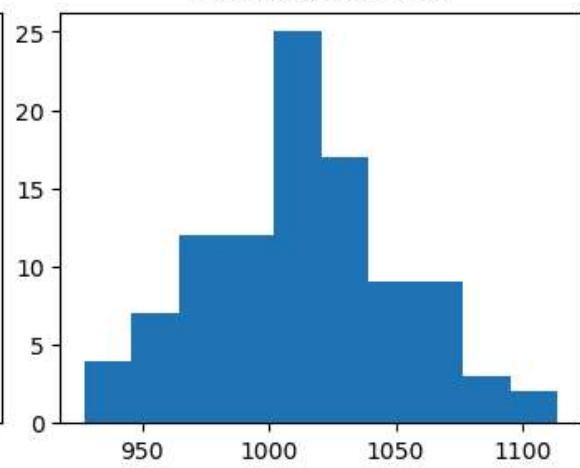
Bernoulli: N = 404



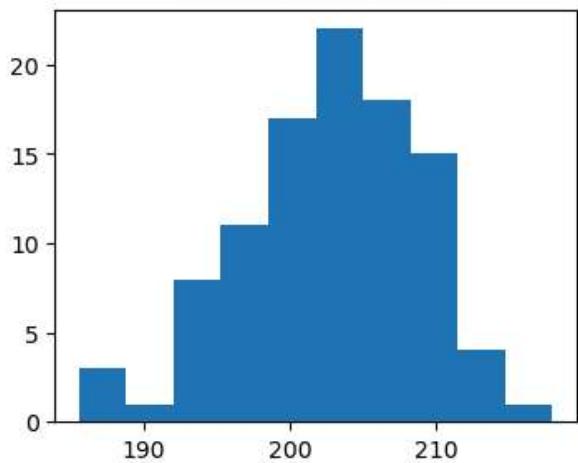
Uniforme: N = 405



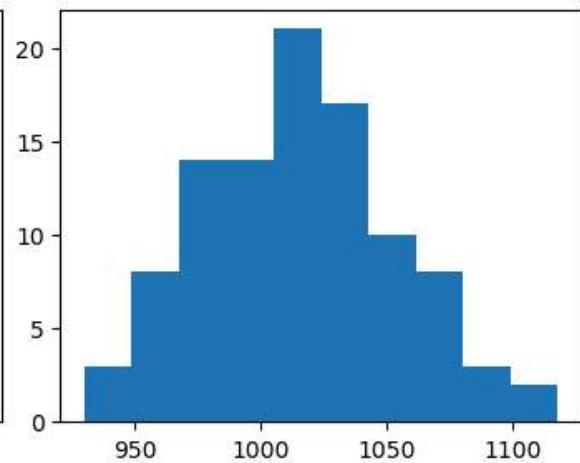
Bernoulli: N = 405



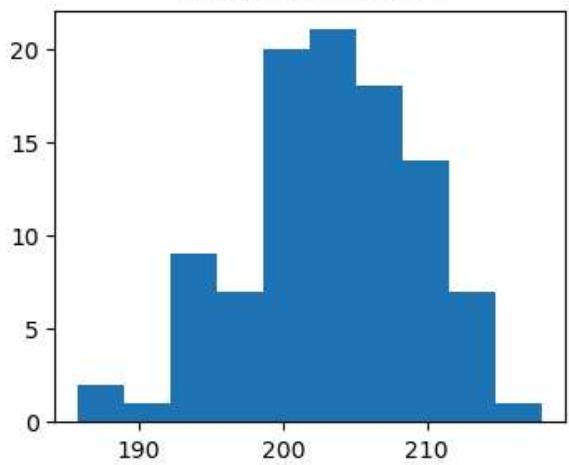
Uniforme: N = 406



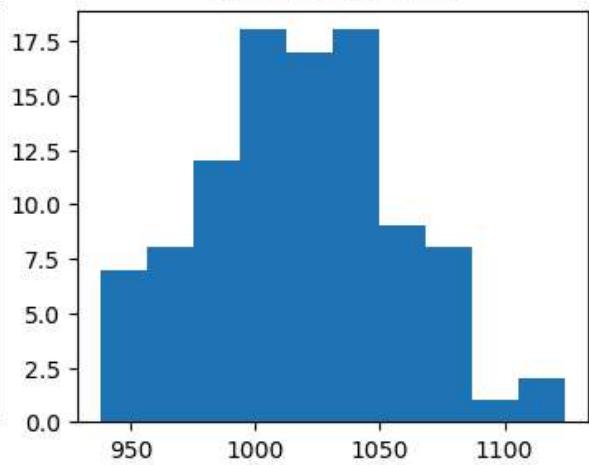
Bernoulli: N = 406



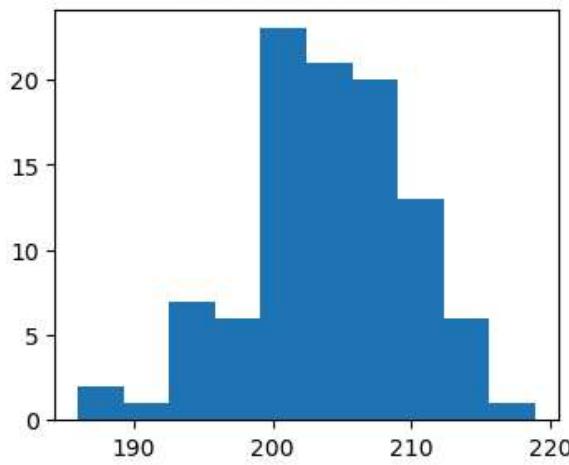
Uniforme: N = 407



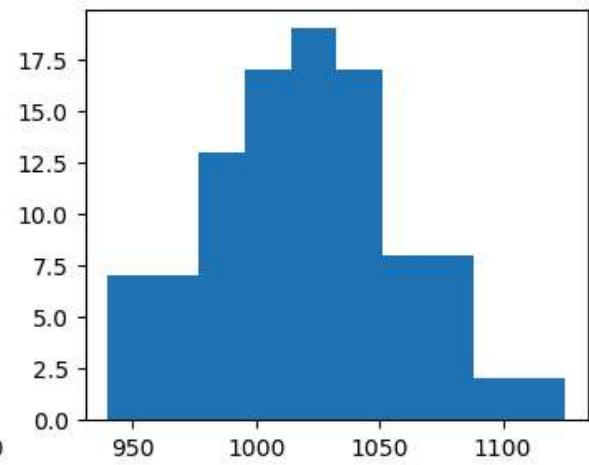
Bernoulli: N = 407



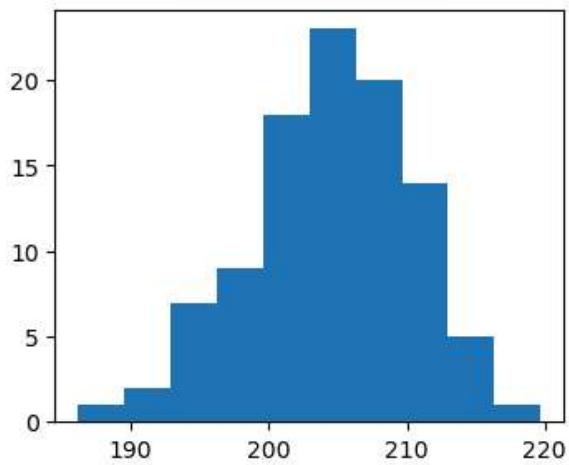
Uniforme: N = 408



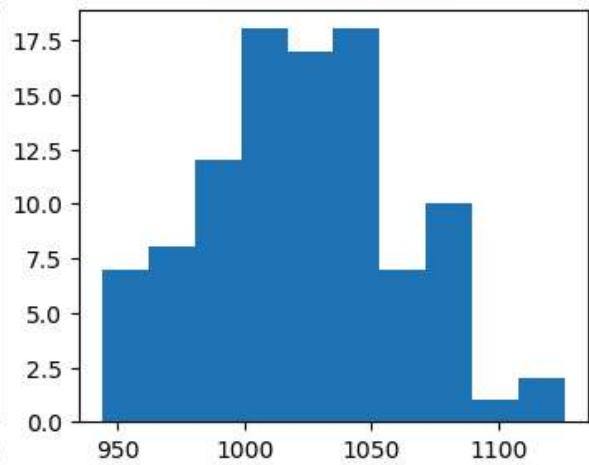
Bernoulli: N = 408

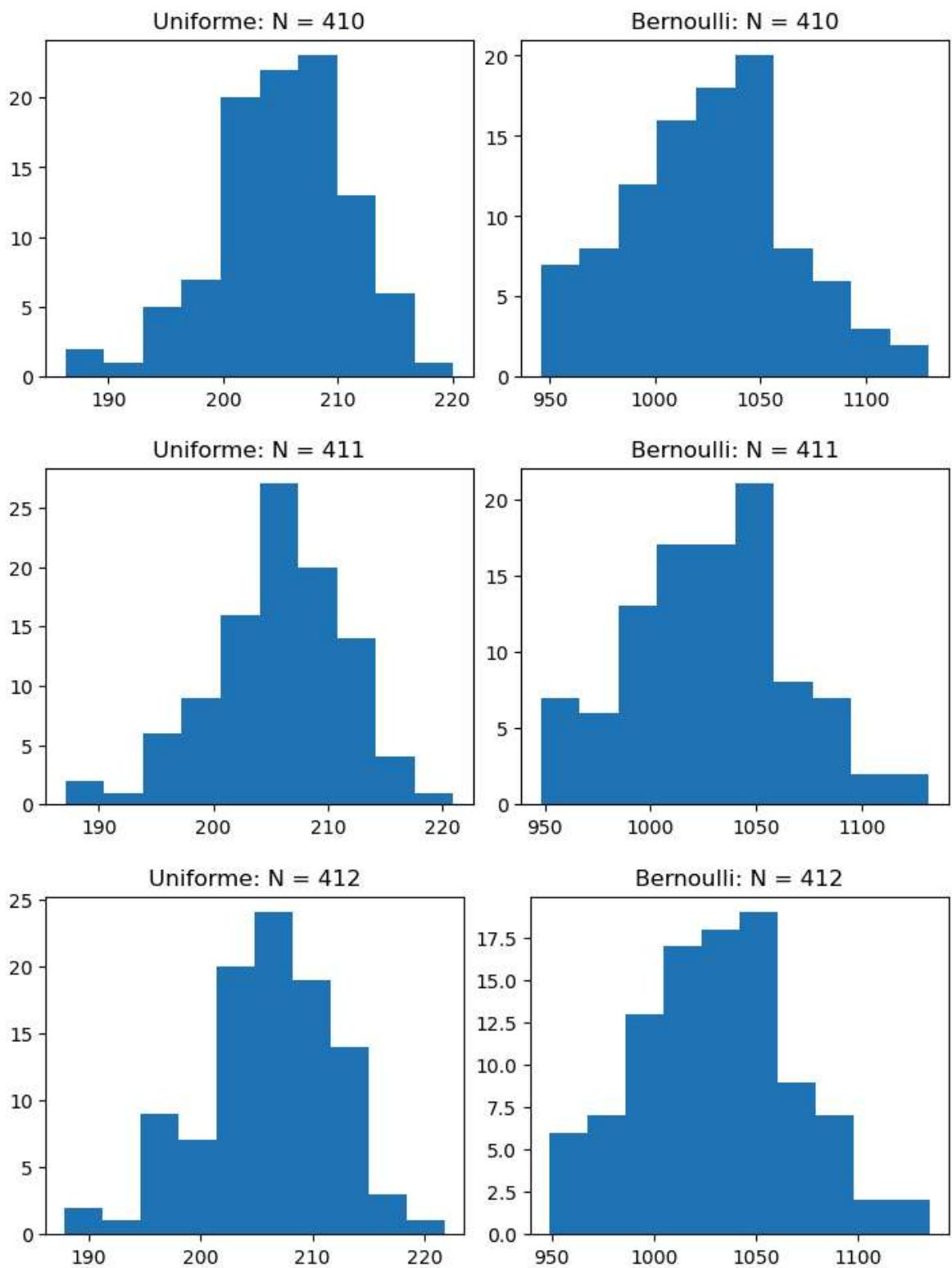


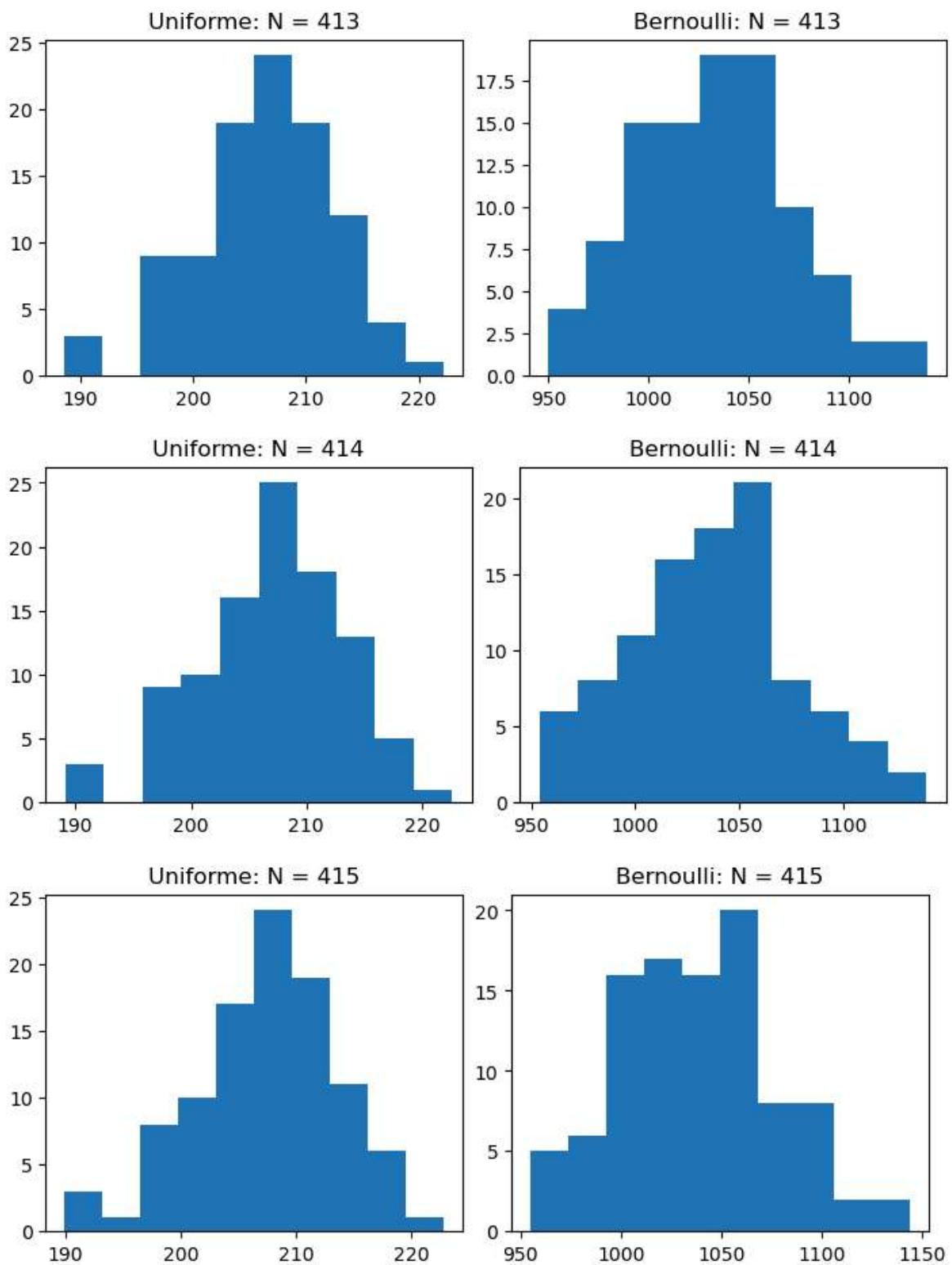
Uniforme: N = 409

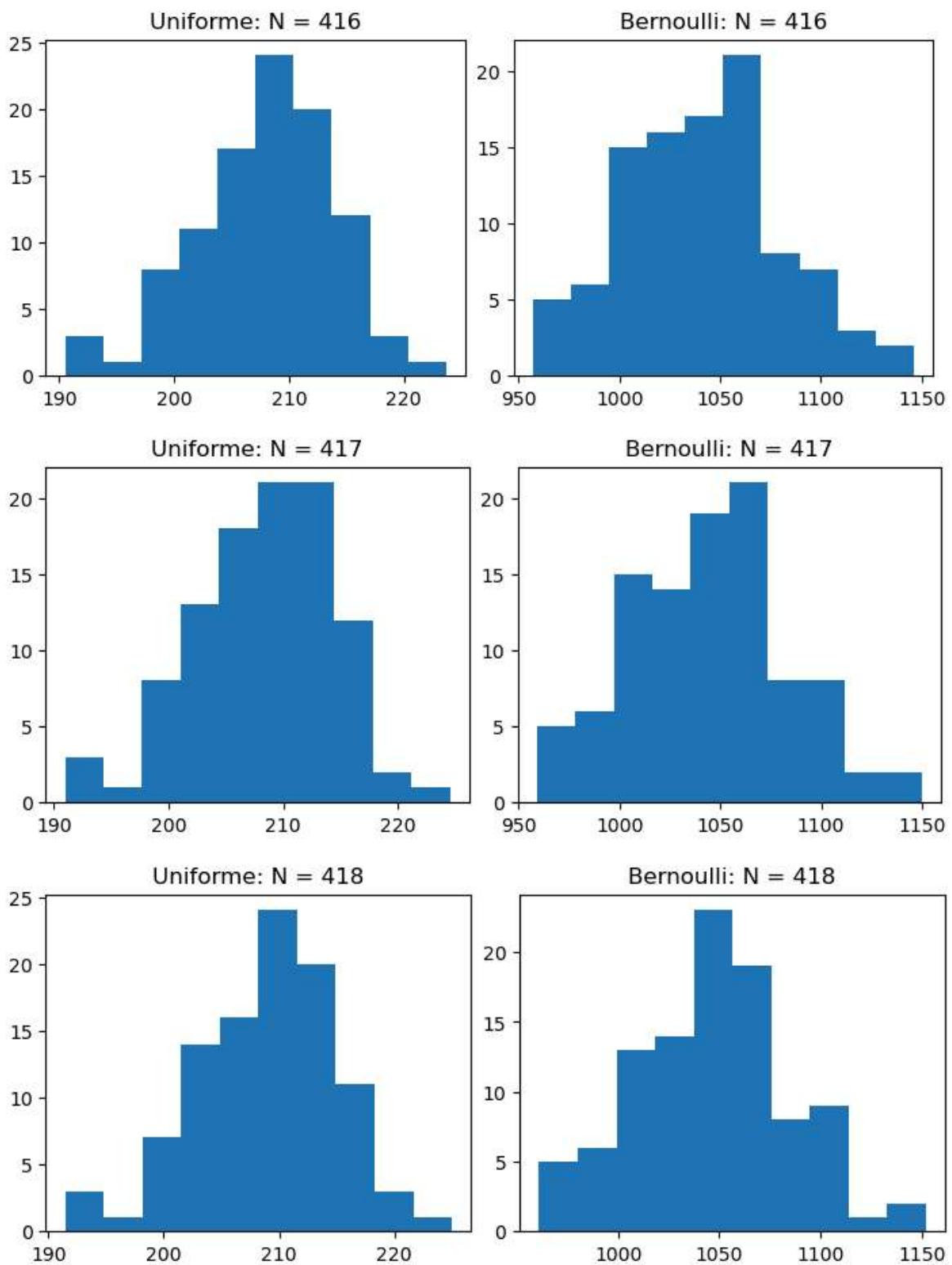


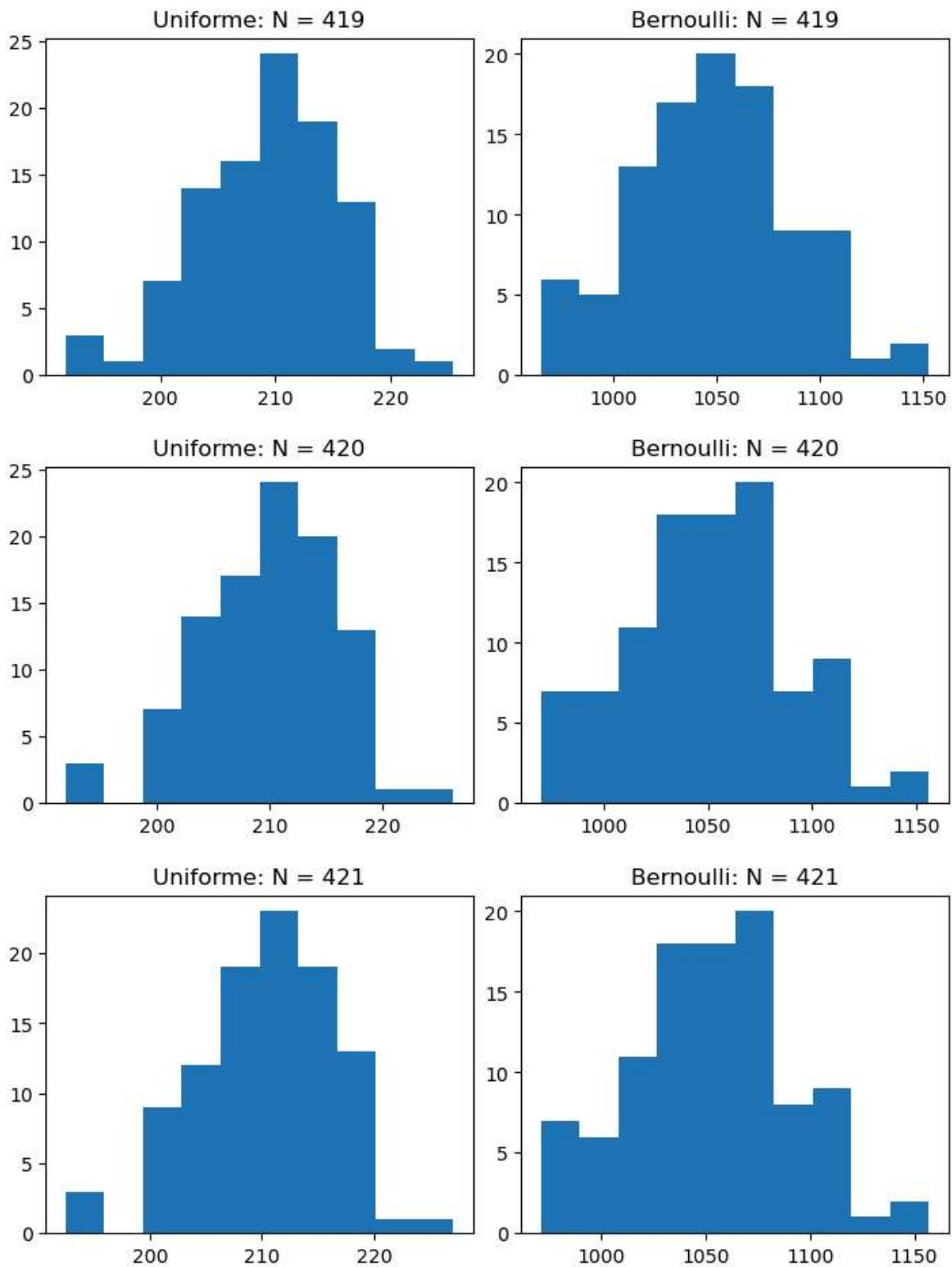
Bernoulli: N = 409



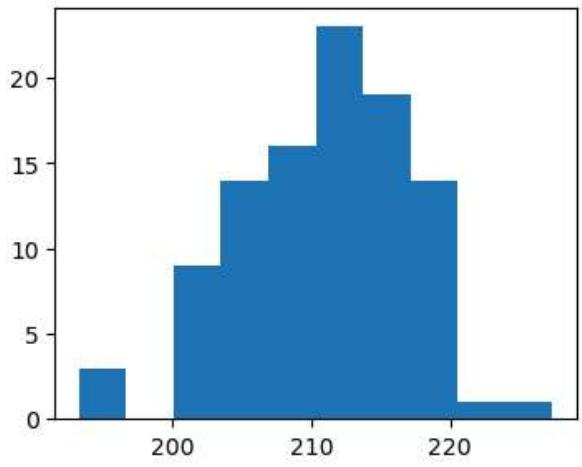




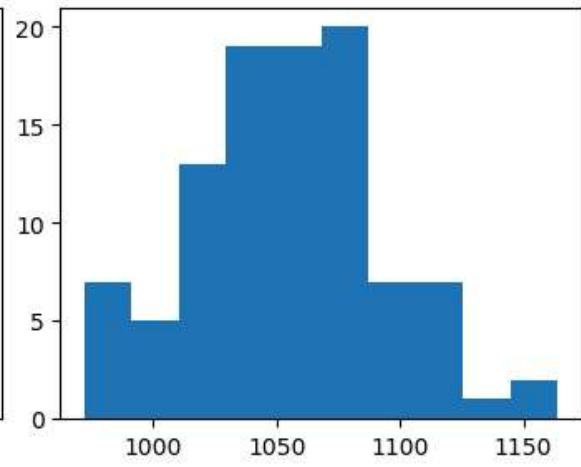




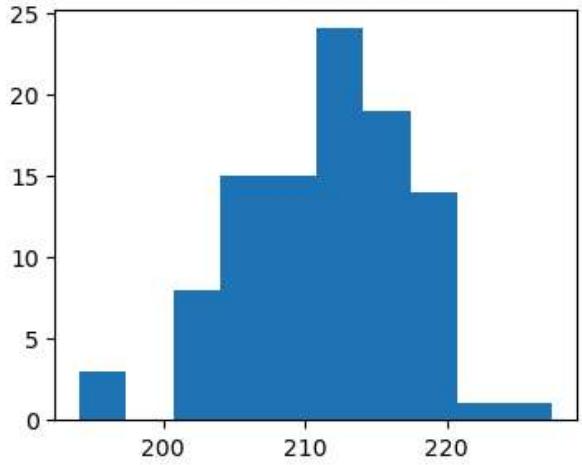
Uniforme: N = 422



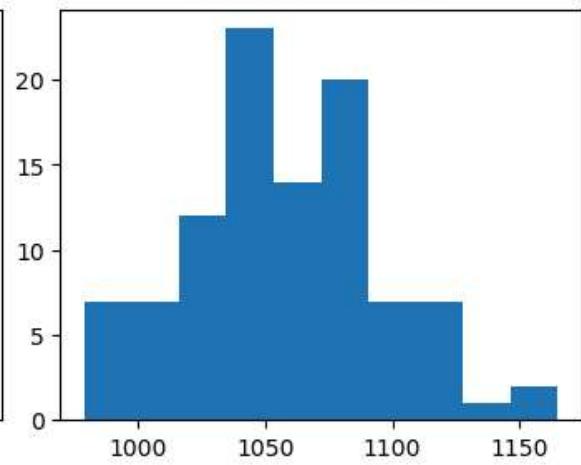
Bernoulli: N = 422



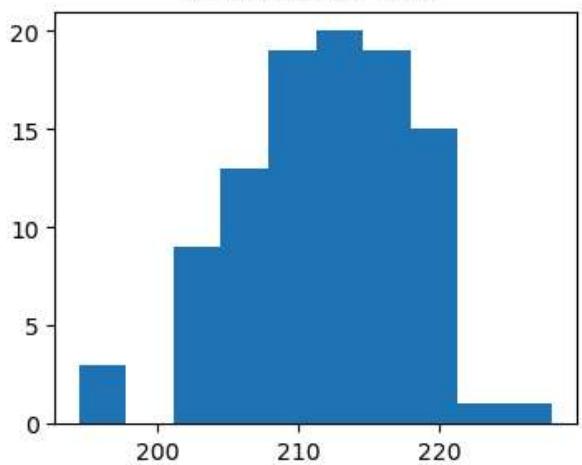
Uniforme: N = 423



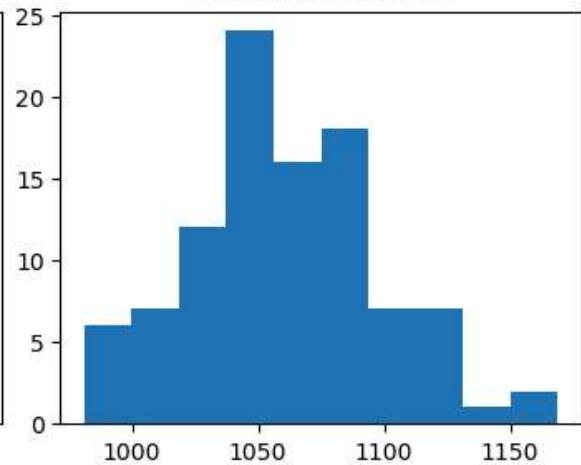
Bernoulli: N = 423

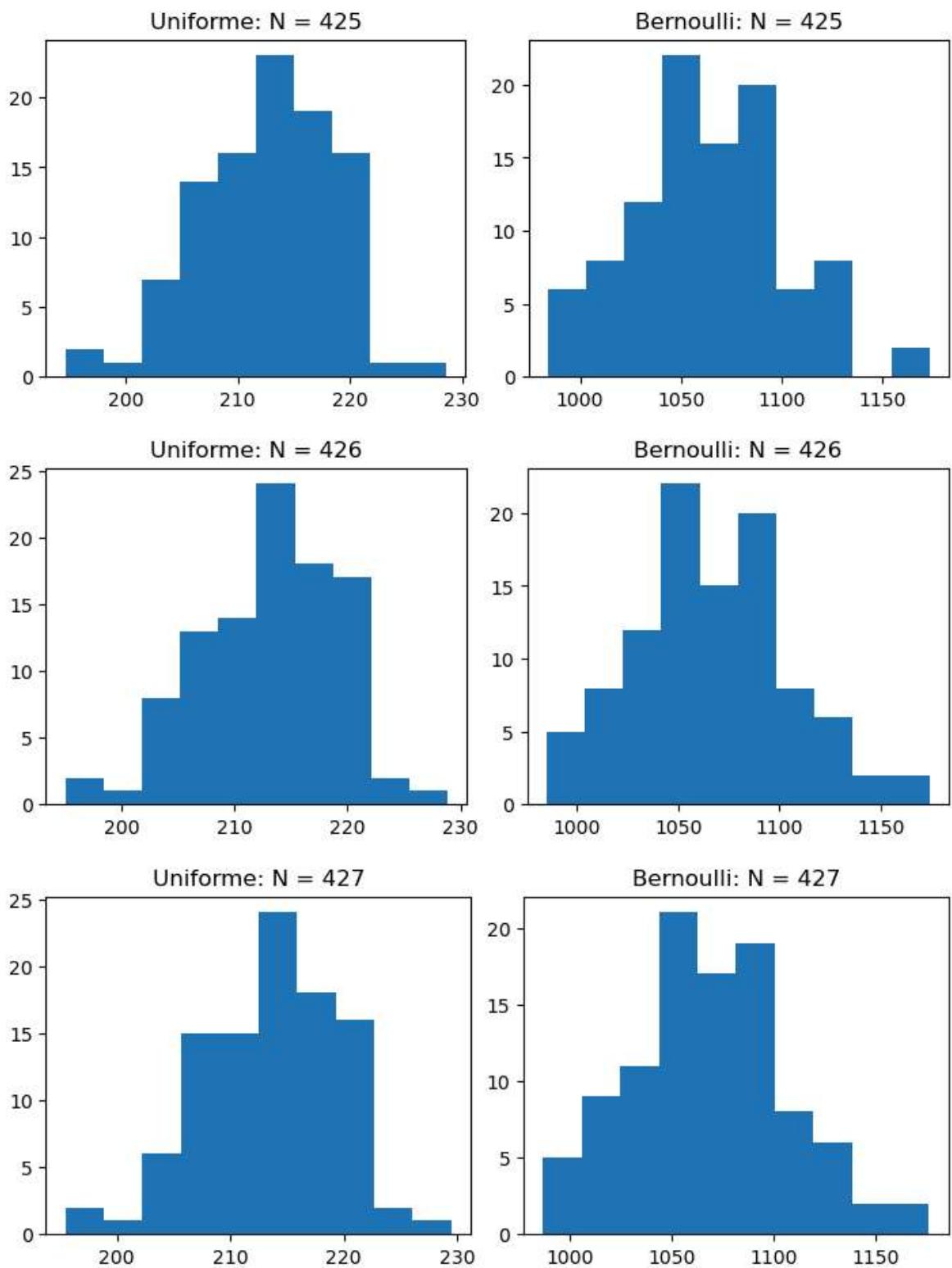


Uniforme: N = 424

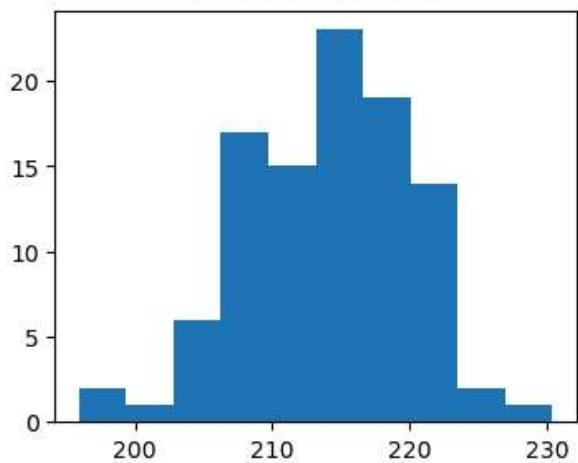


Bernoulli: N = 424

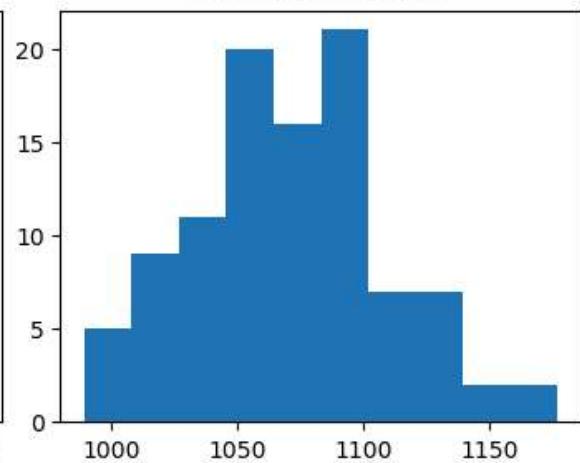




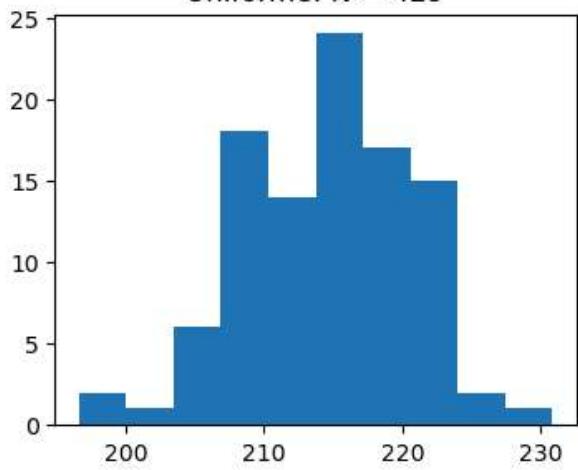
Uniforme: N = 428



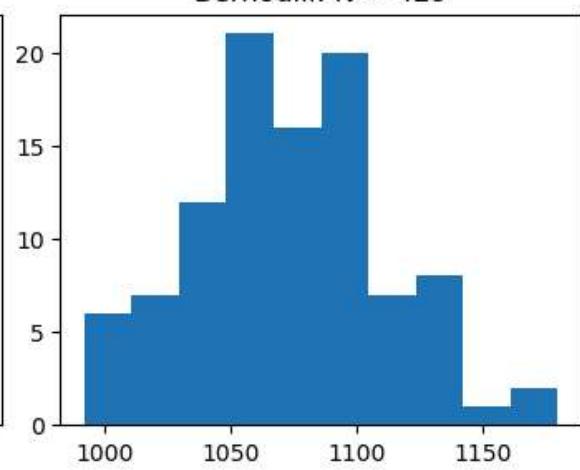
Bernoulli: N = 428



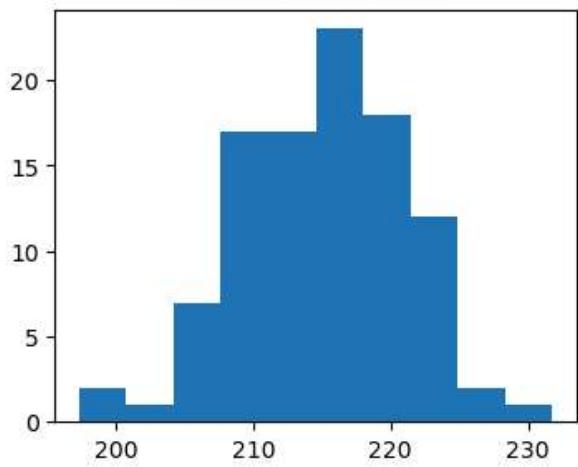
Uniforme: N = 429



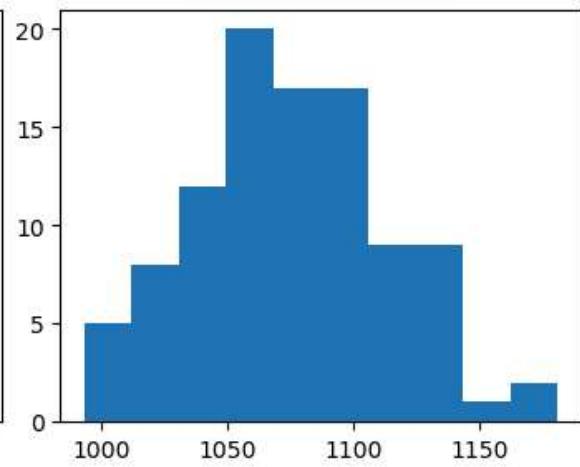
Bernoulli: N = 429



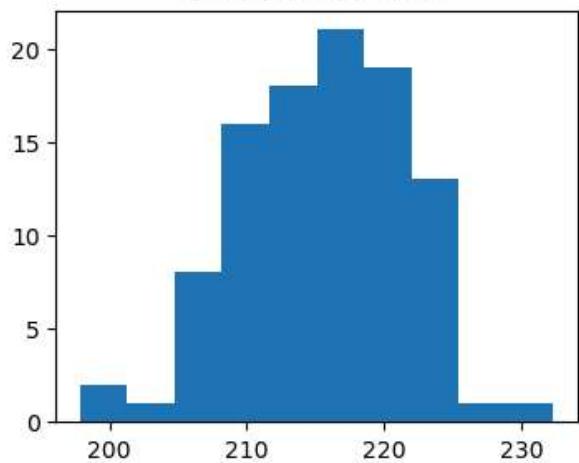
Uniforme: N = 430



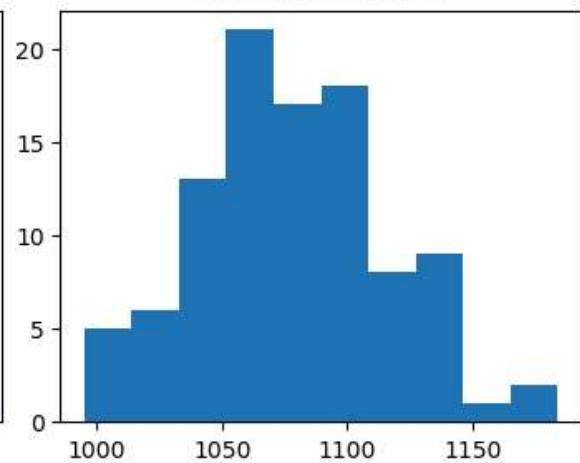
Bernoulli: N = 430



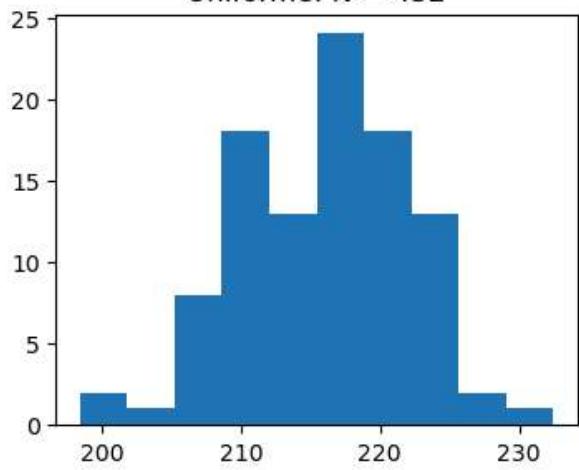
Uniforme: N = 431



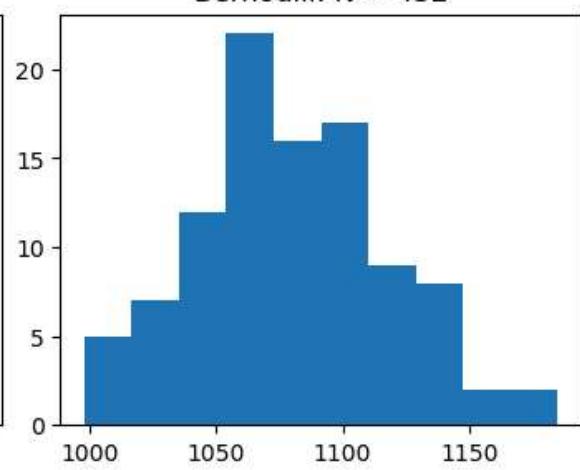
Bernoulli: N = 431



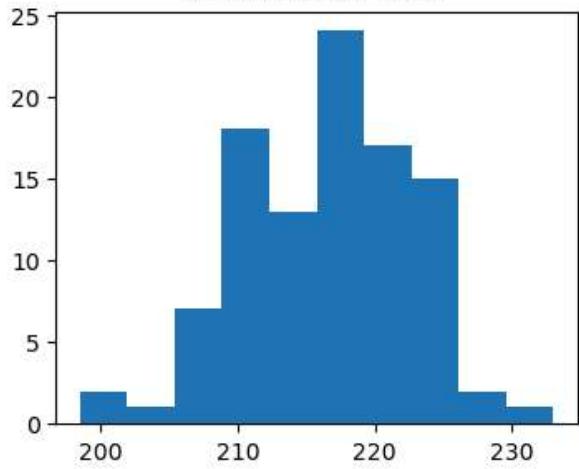
Uniforme: N = 432



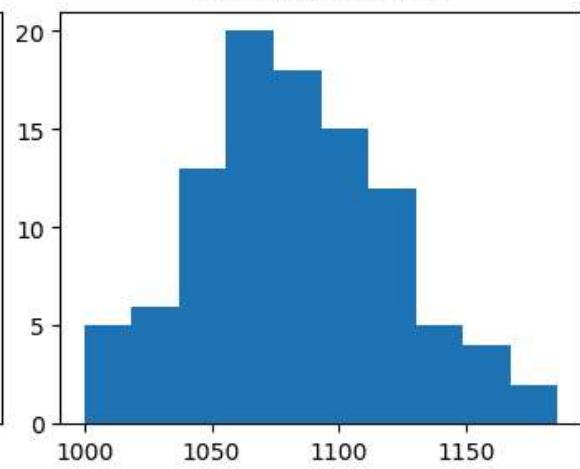
Bernoulli: N = 432



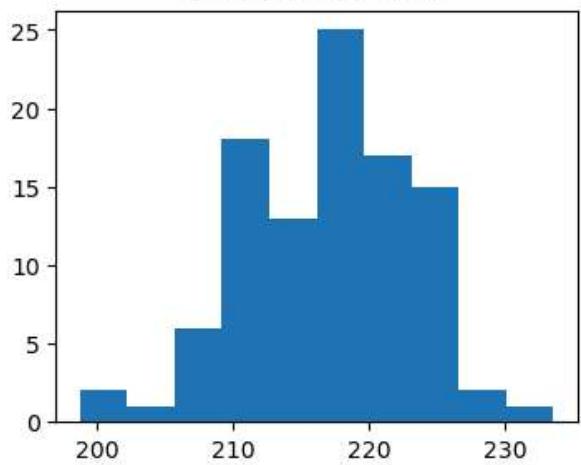
Uniforme: N = 433



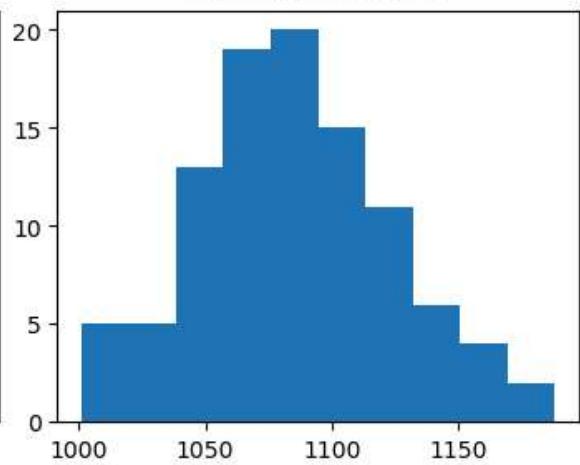
Bernoulli: N = 433



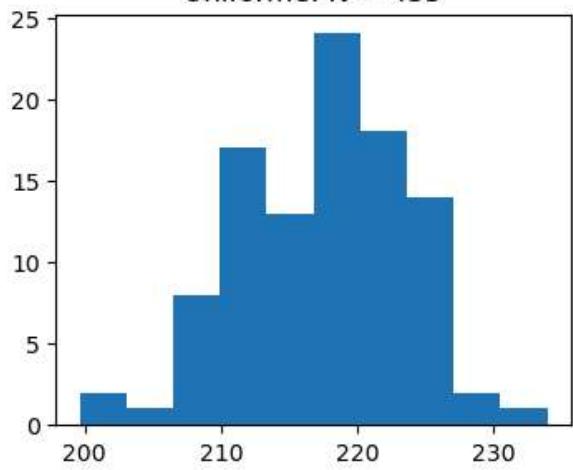
Uniforme: N = 434



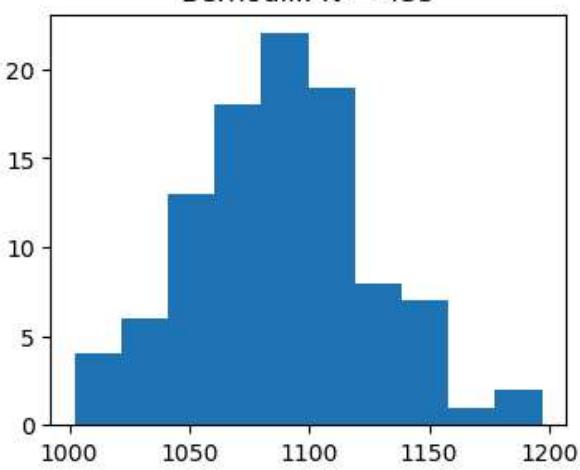
Bernoulli: N = 434



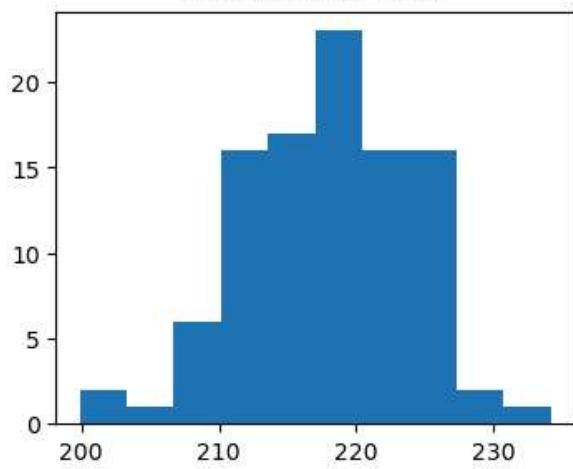
Uniforme: N = 435



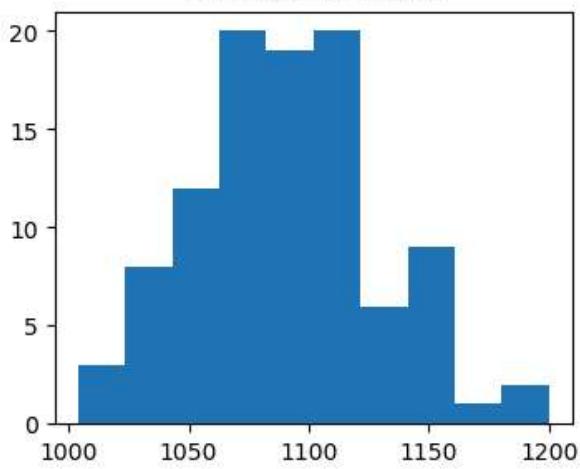
Bernoulli: N = 435



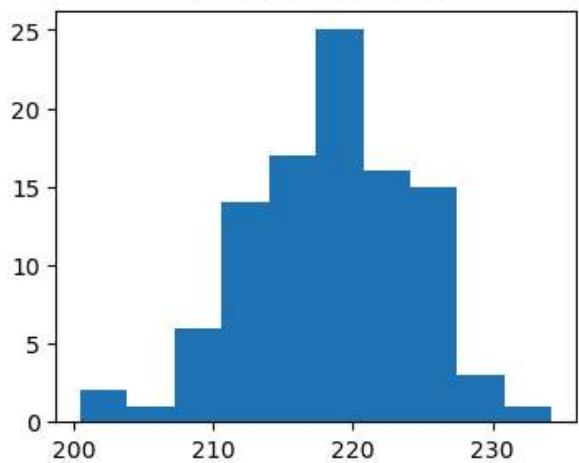
Uniforme: N = 436



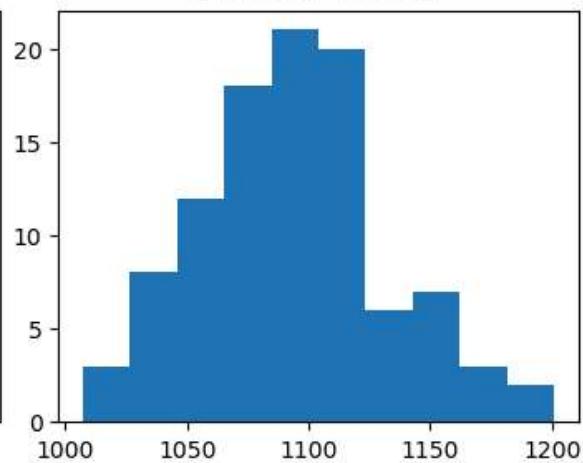
Bernoulli: N = 436



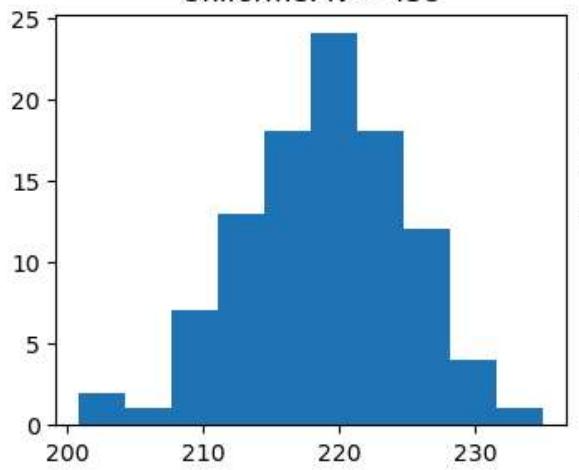
Uniforme: N = 437



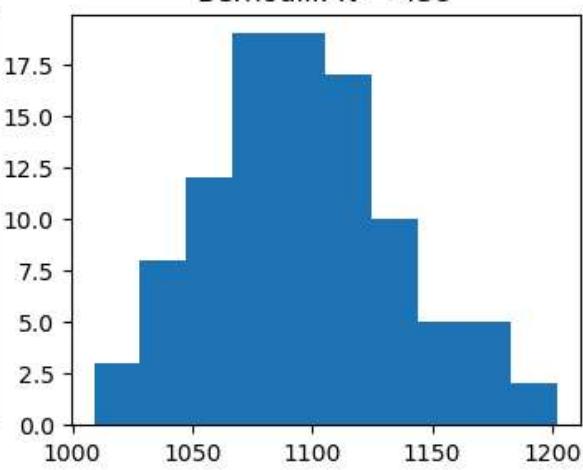
Bernoulli: N = 437



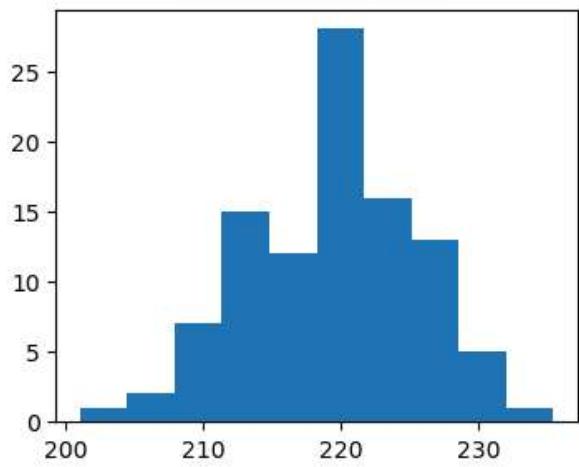
Uniforme: N = 438



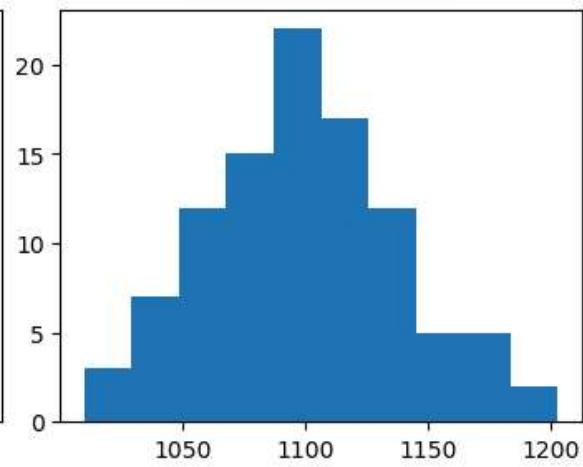
Bernoulli: N = 438



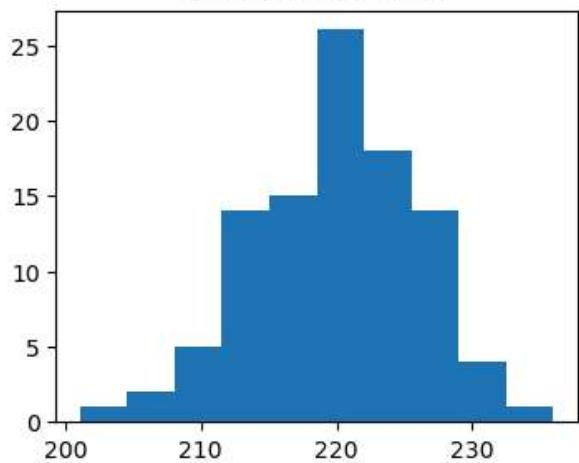
Uniforme: N = 439



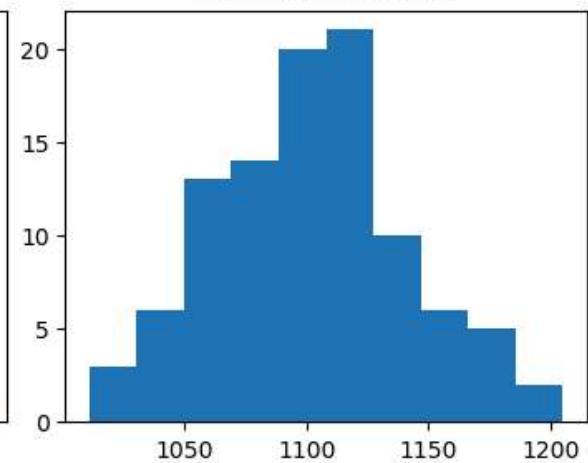
Bernoulli: N = 439



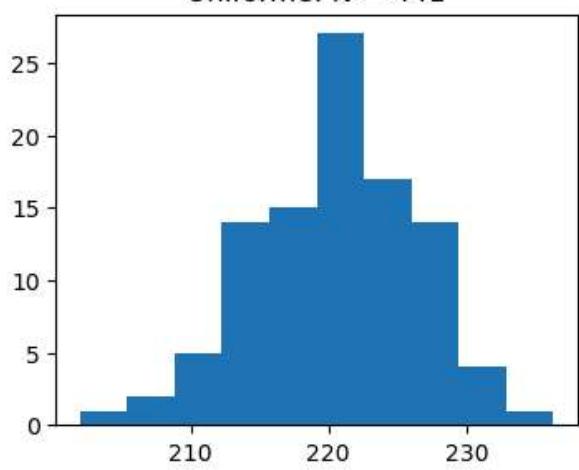
Uniforme: N = 440



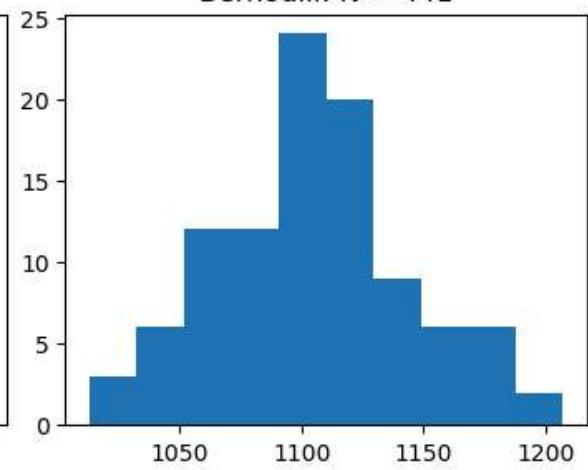
Bernoulli: N = 440



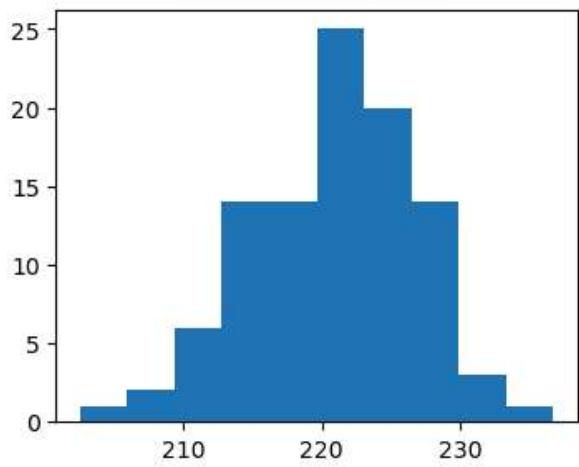
Uniforme: N = 441



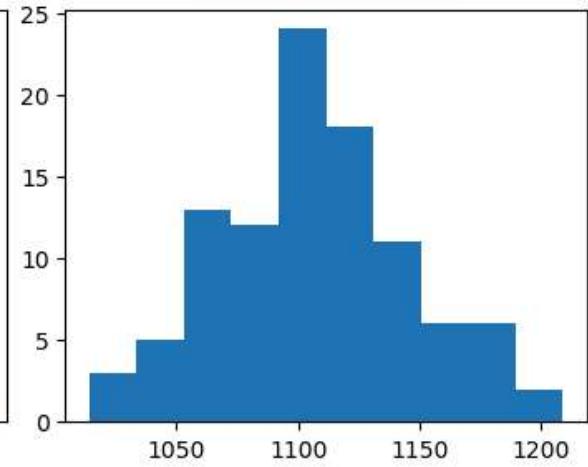
Bernoulli: N = 441



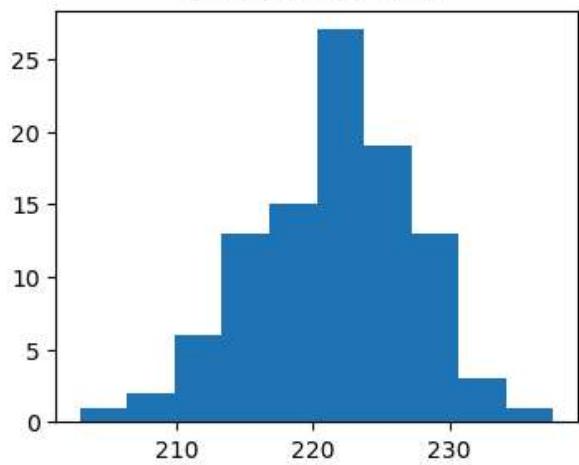
Uniforme: N = 442



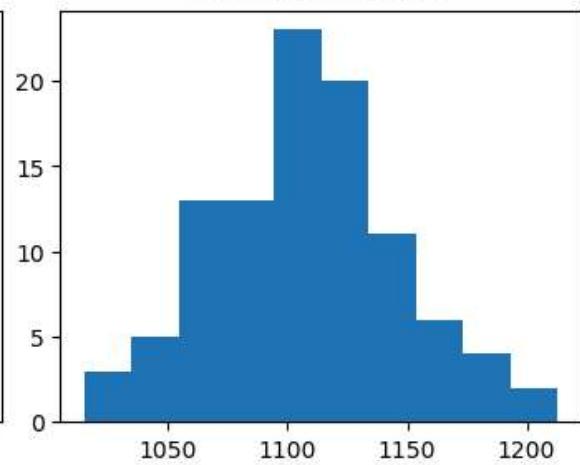
Bernoulli: N = 442



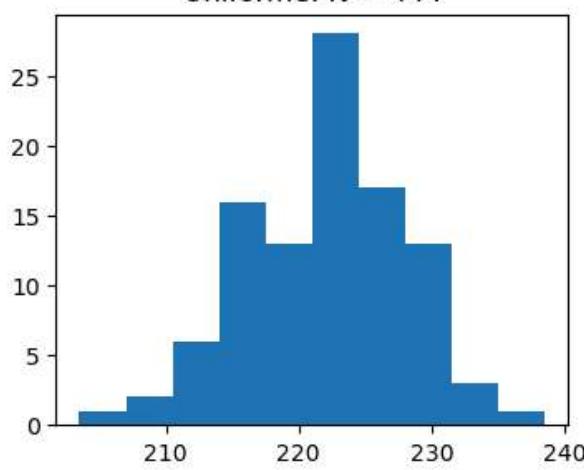
Uniforme: N = 443



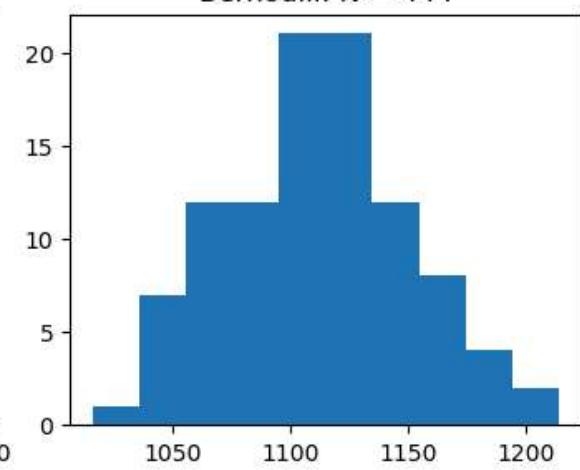
Bernoulli: N = 443



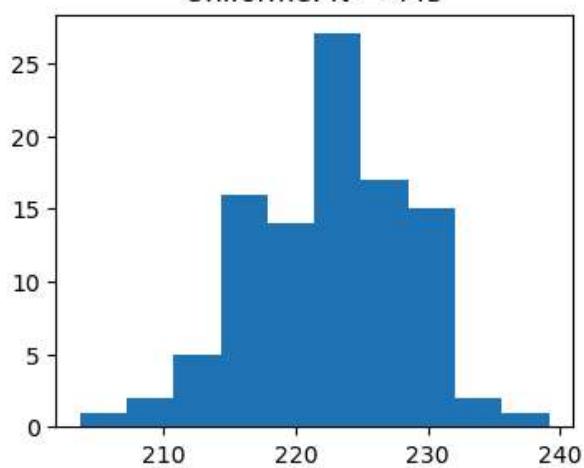
Uniforme: N = 444



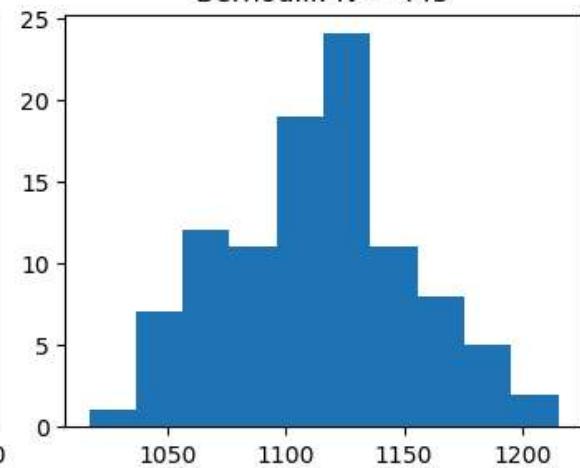
Bernoulli: N = 444



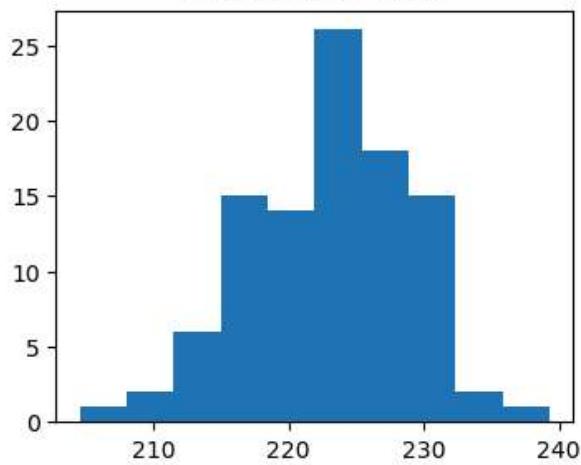
Uniforme: N = 445



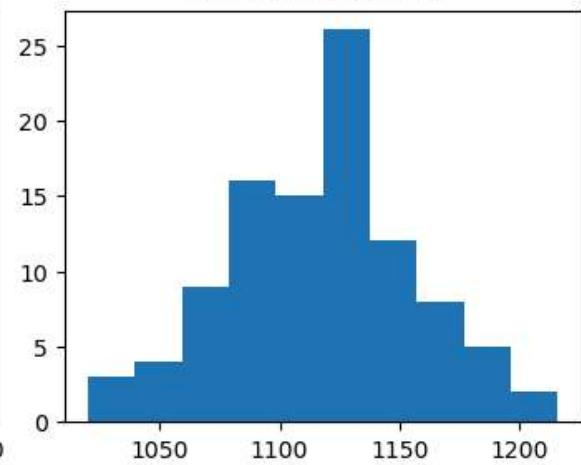
Bernoulli: N = 445



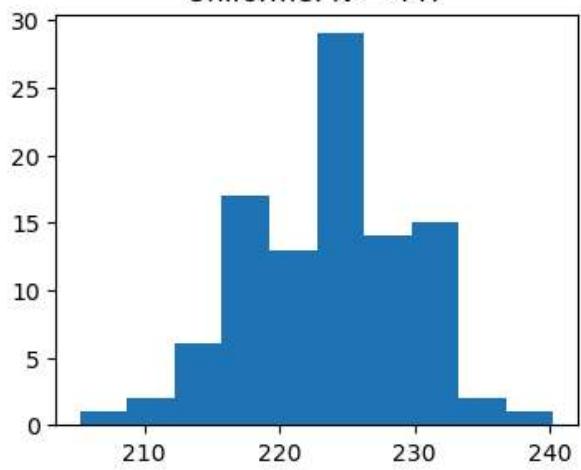
Uniforme: N = 446



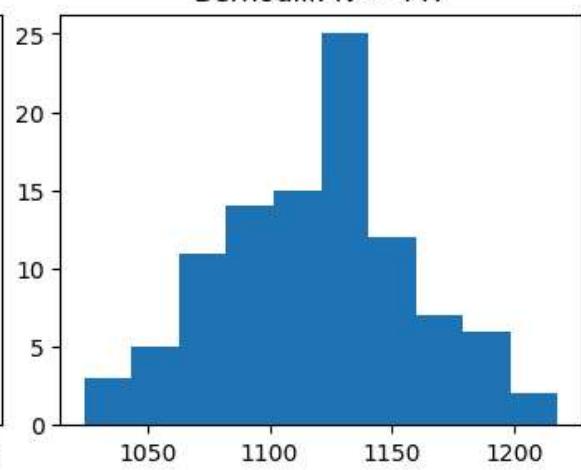
Bernoulli: N = 446



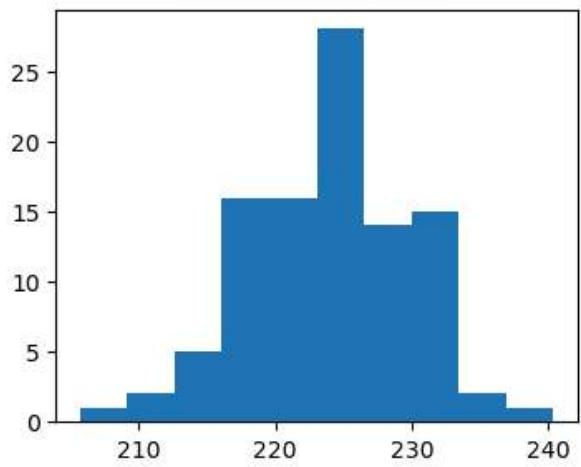
Uniforme: N = 447



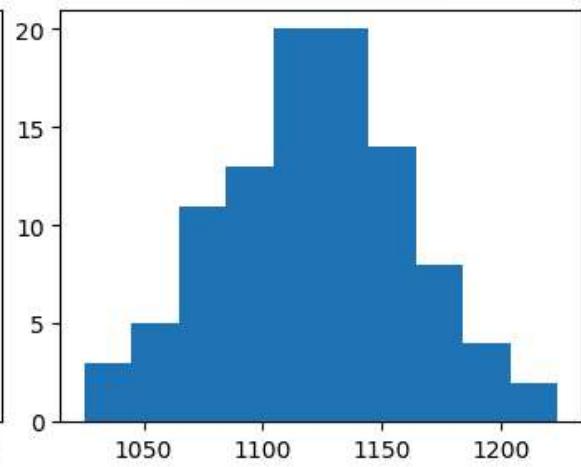
Bernoulli: N = 447



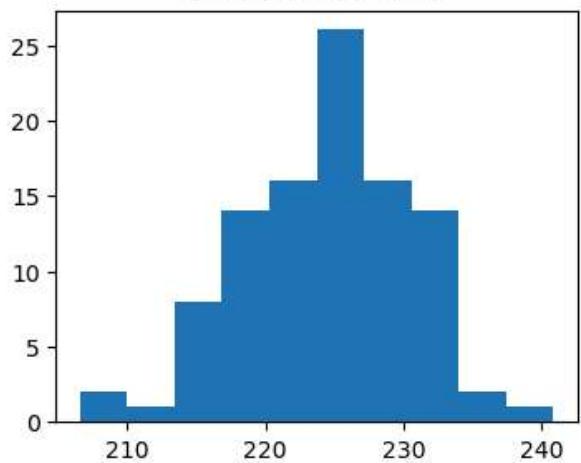
Uniforme: N = 448



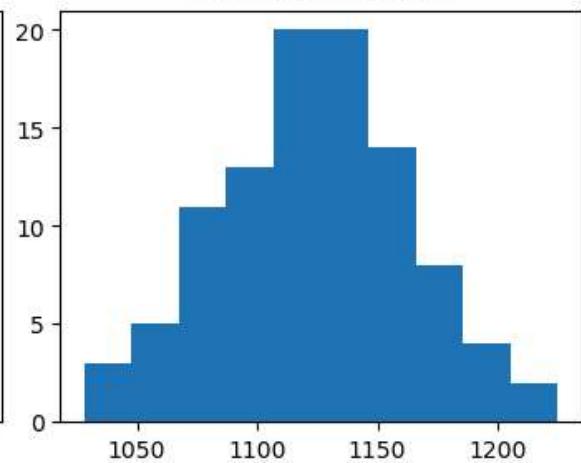
Bernoulli: N = 448



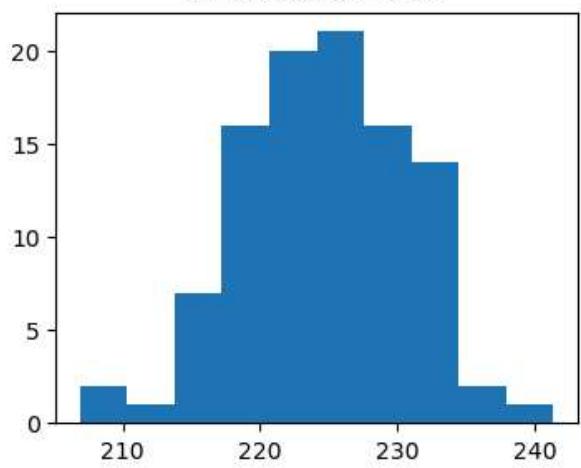
Uniforme: N = 449



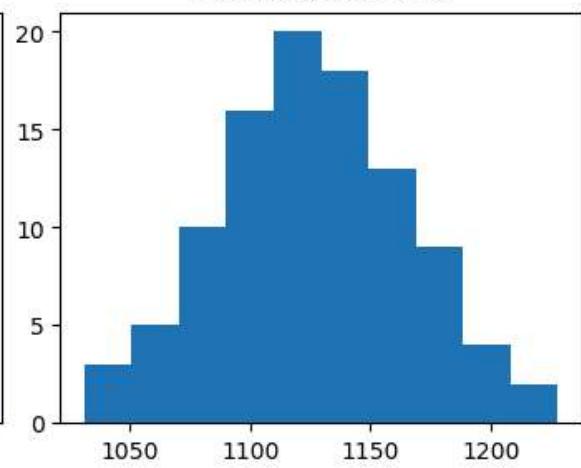
Bernoulli: N = 449



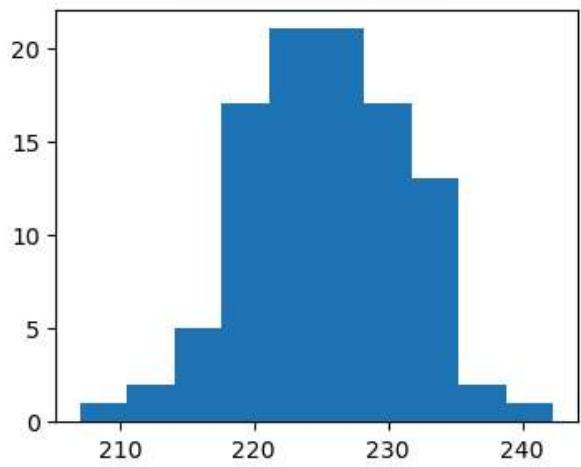
Uniforme: N = 450



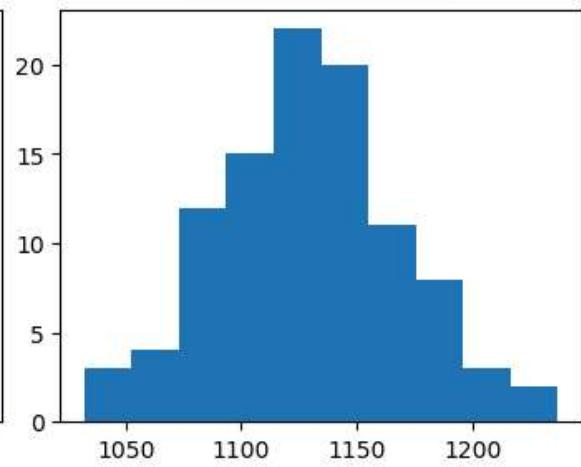
Bernoulli: N = 450

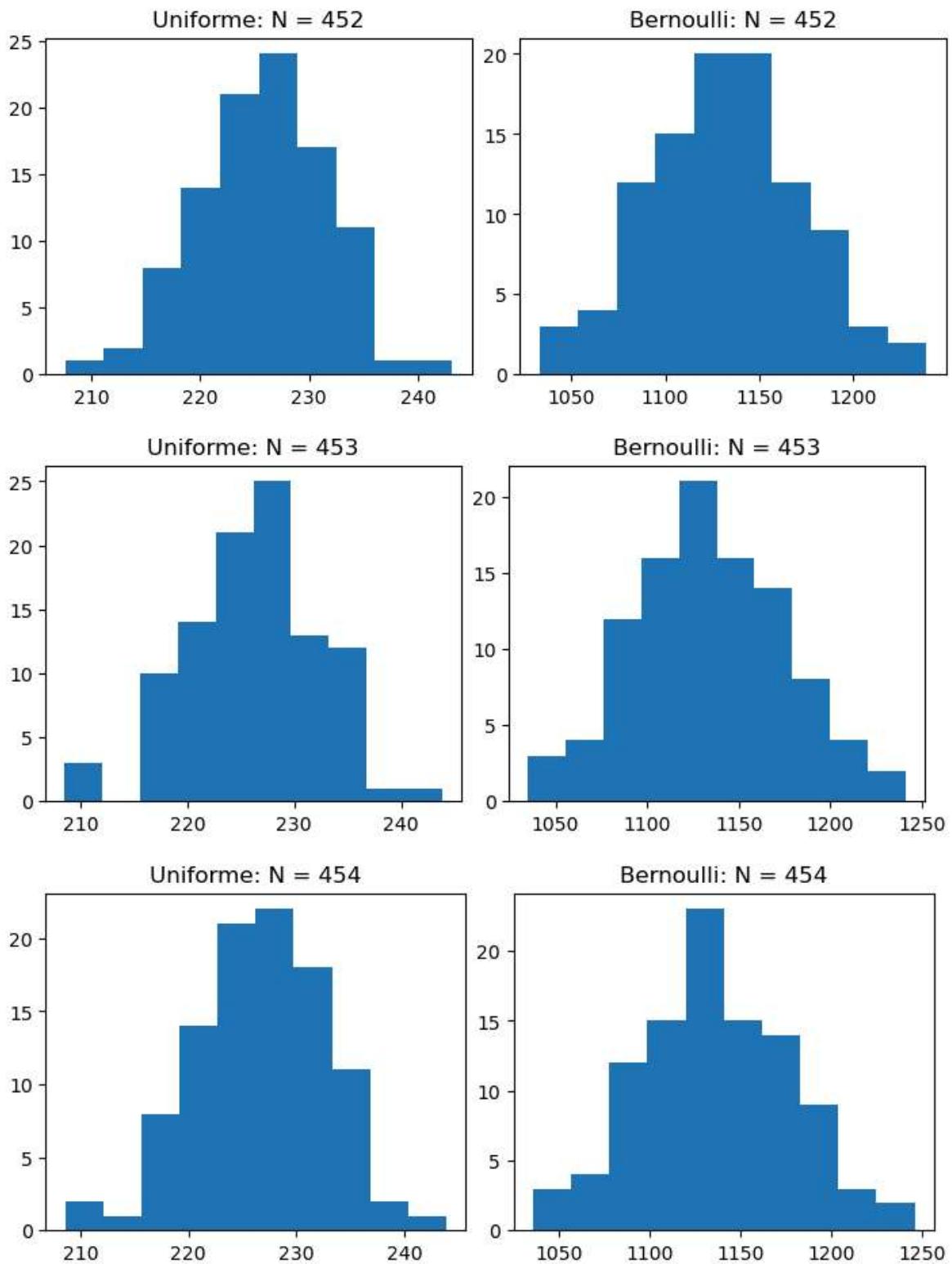


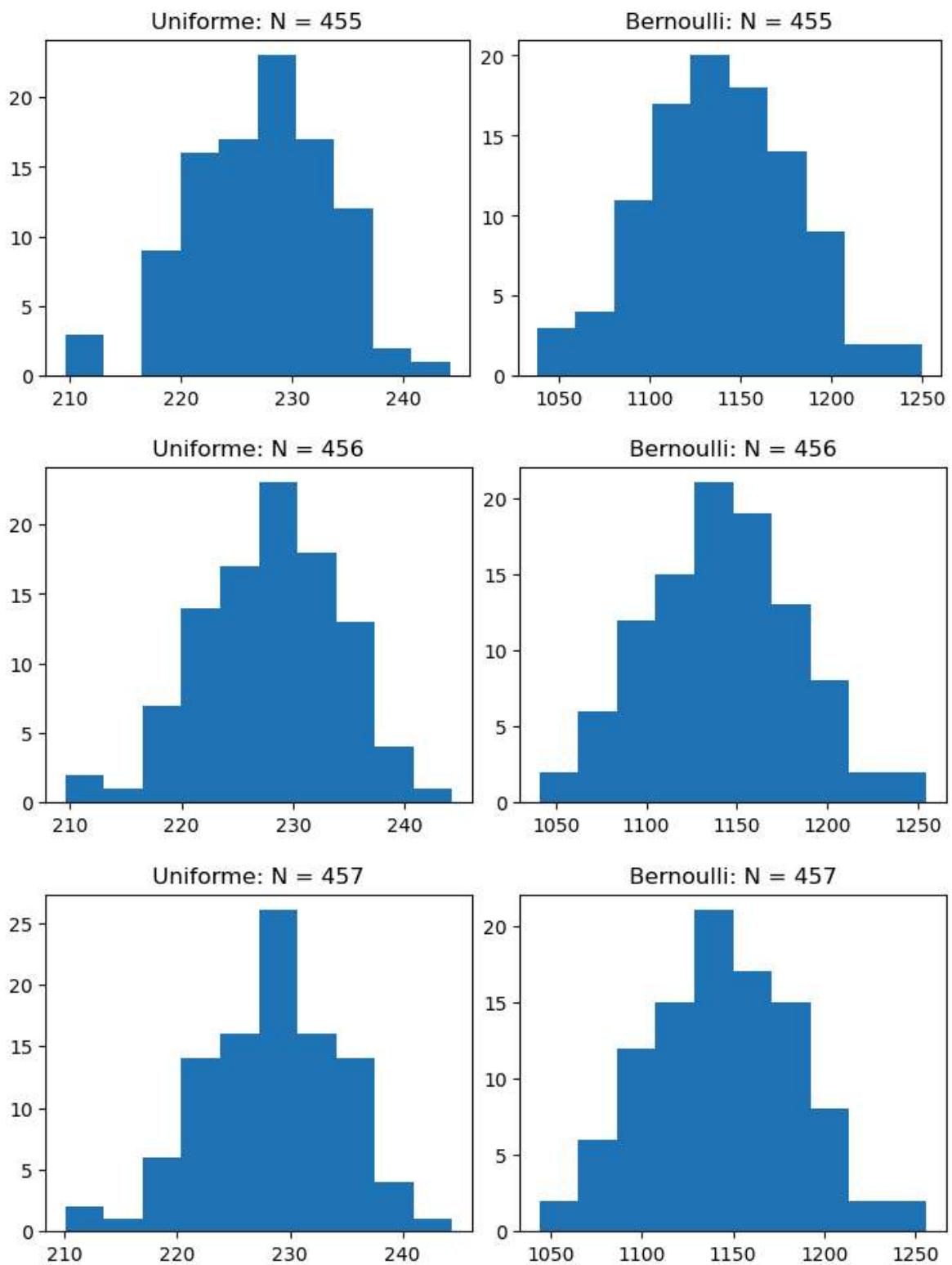
Uniforme: N = 451



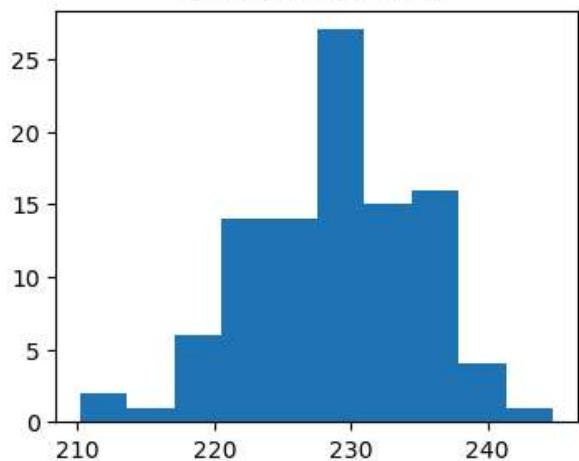
Bernoulli: N = 451



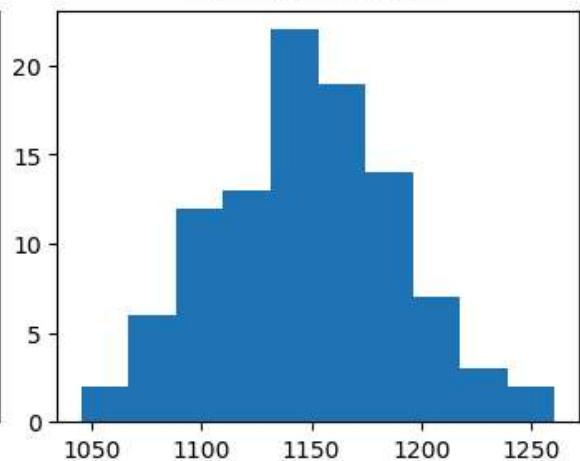




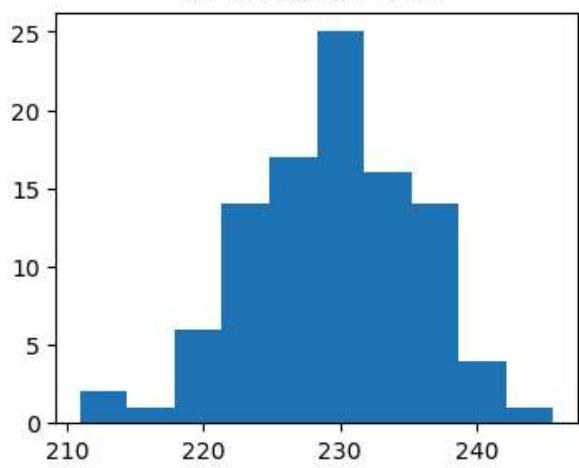
Uniforme: N = 458



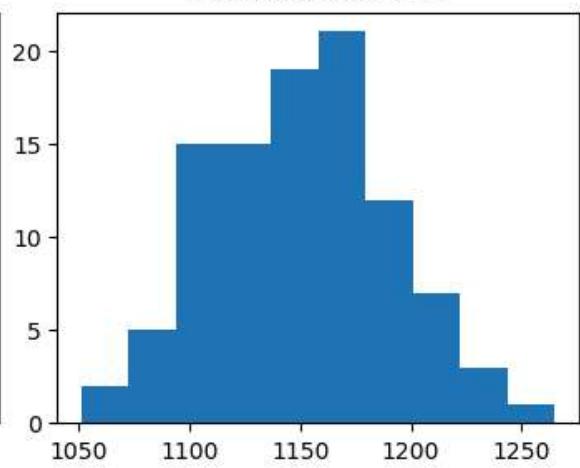
Bernoulli: N = 458



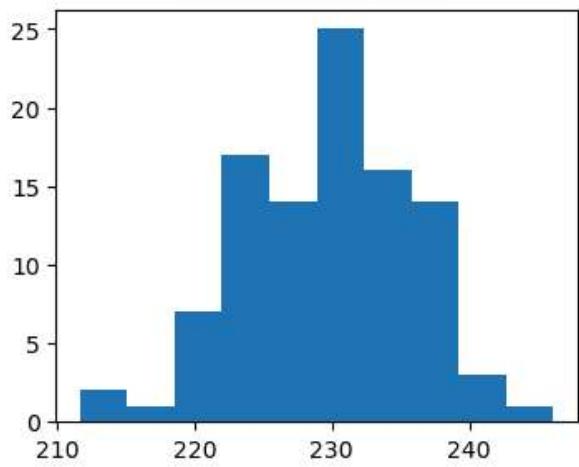
Uniforme: N = 459



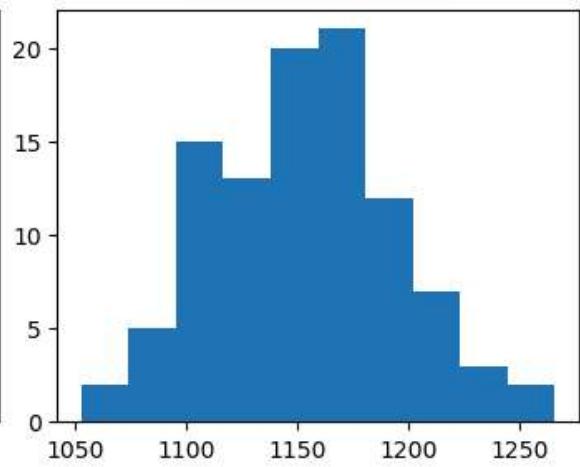
Bernoulli: N = 459



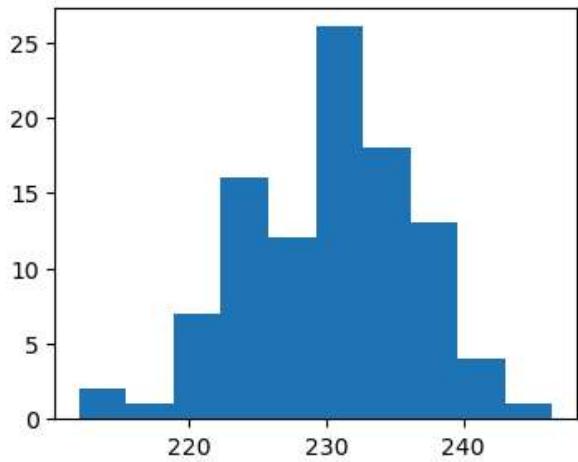
Uniforme: N = 460



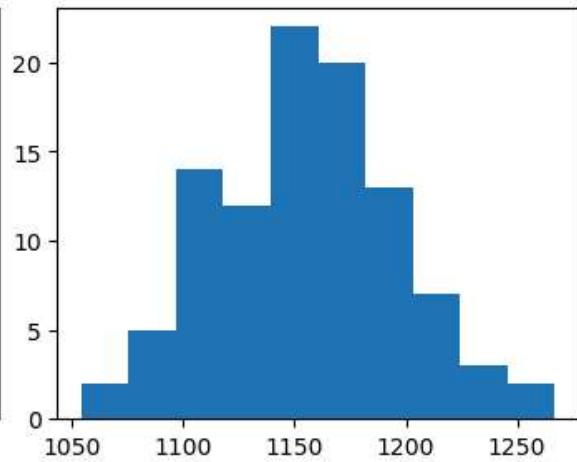
Bernoulli: N = 460



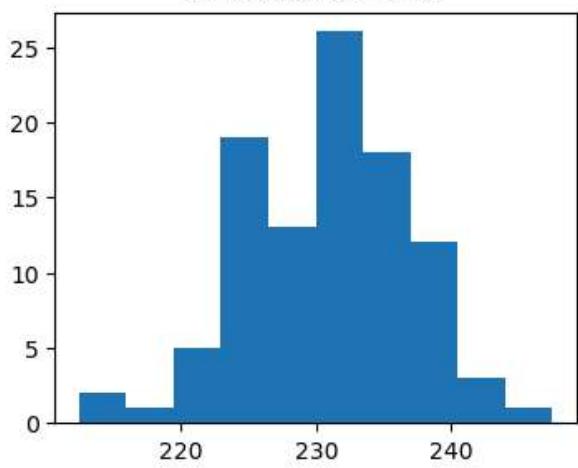
Uniforme: N = 461



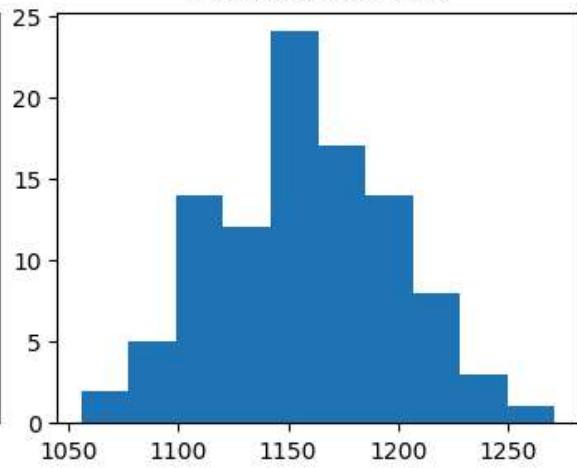
Bernoulli: N = 461



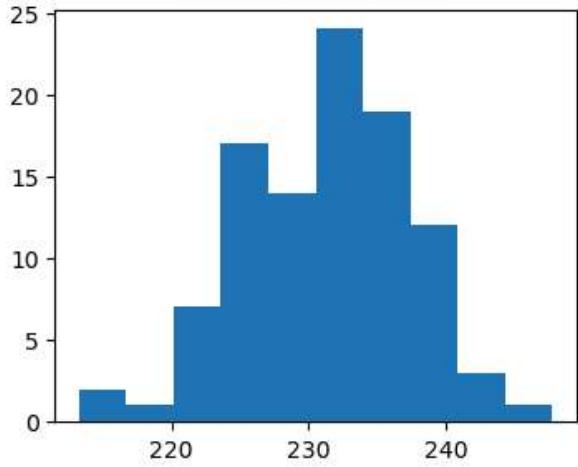
Uniforme: N = 462



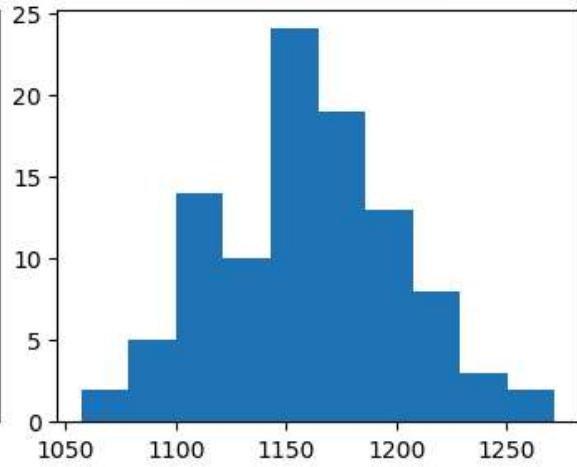
Bernoulli: N = 462



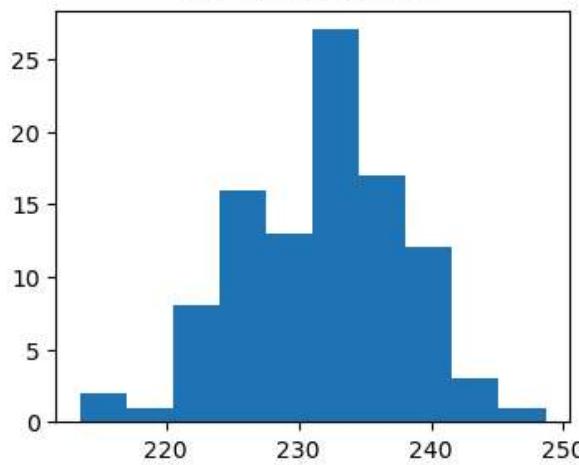
Uniforme: N = 463



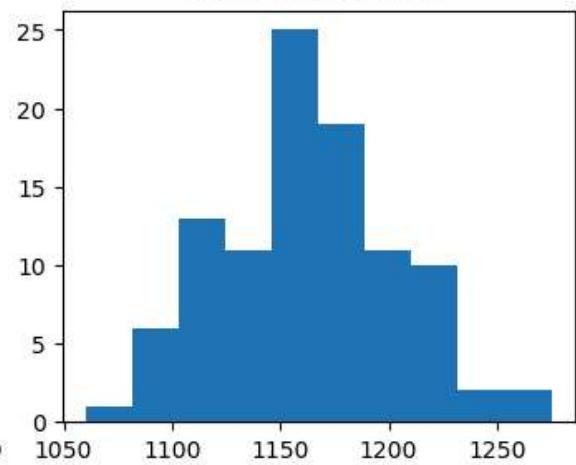
Bernoulli: N = 463



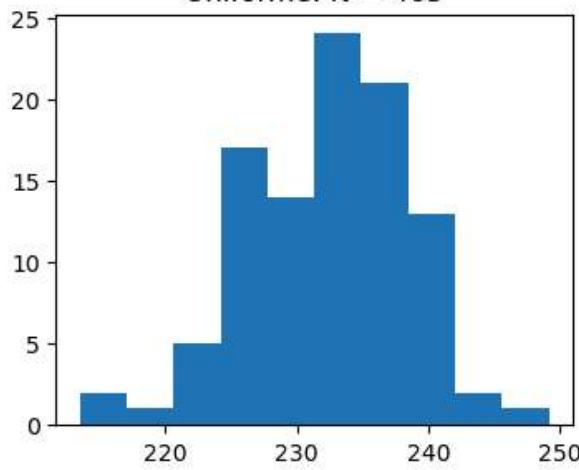
Uniforme: N = 464



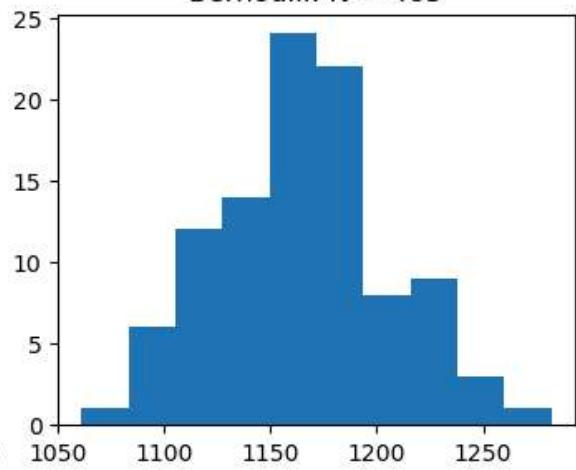
Bernoulli: N = 464



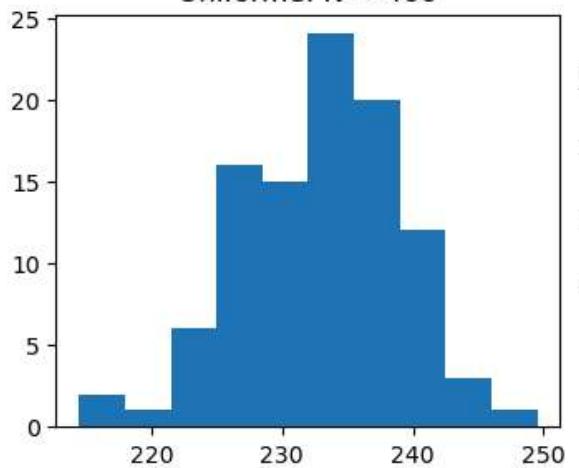
Uniforme: N = 465



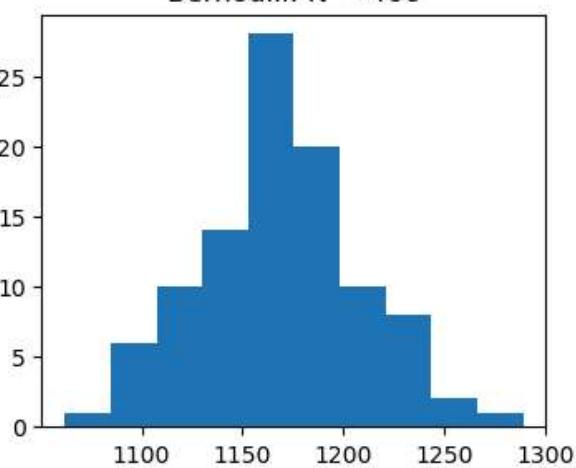
Bernoulli: N = 465

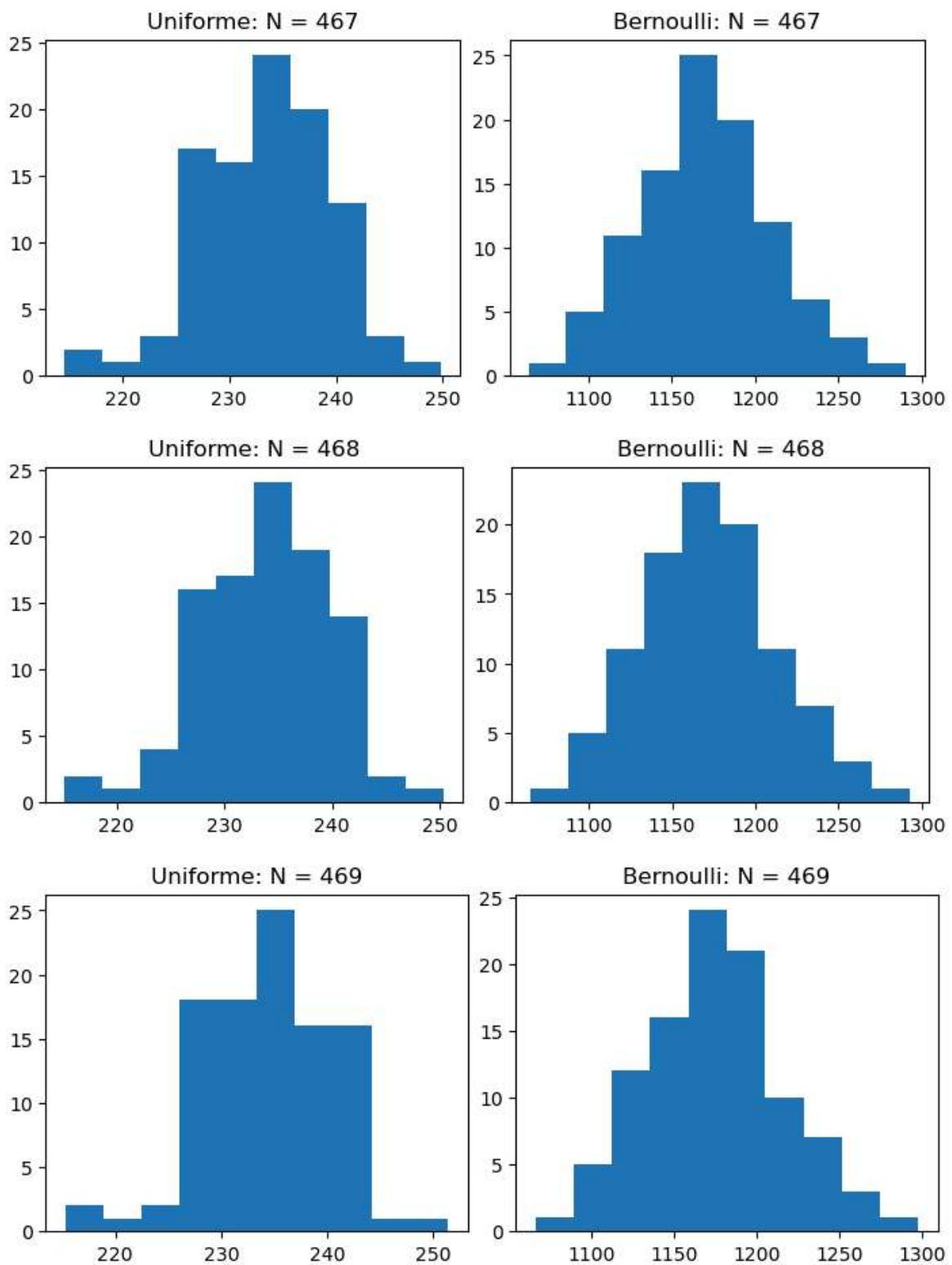


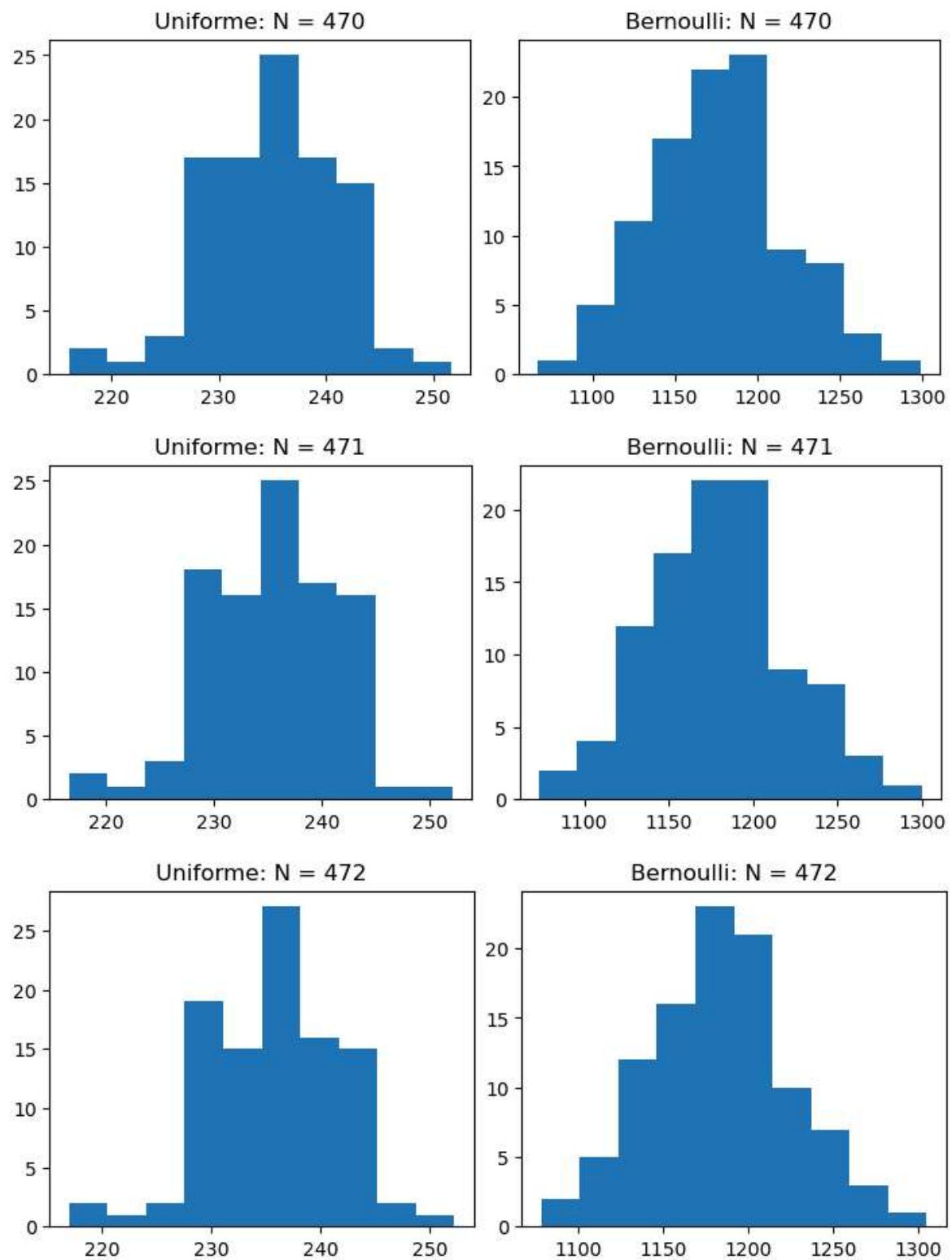
Uniforme: N = 466



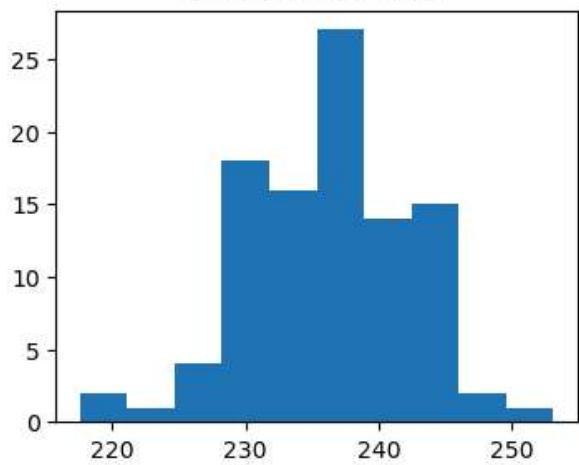
Bernoulli: N = 466



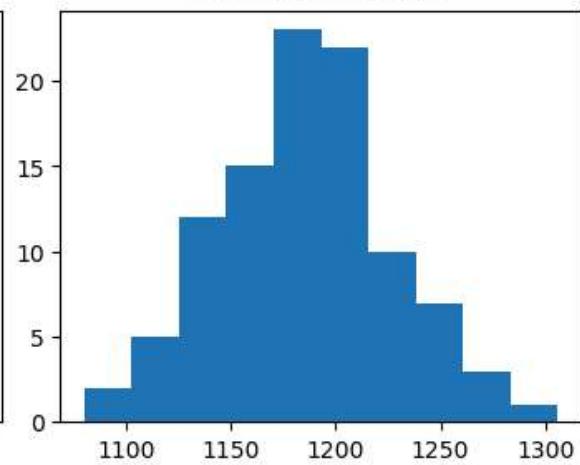




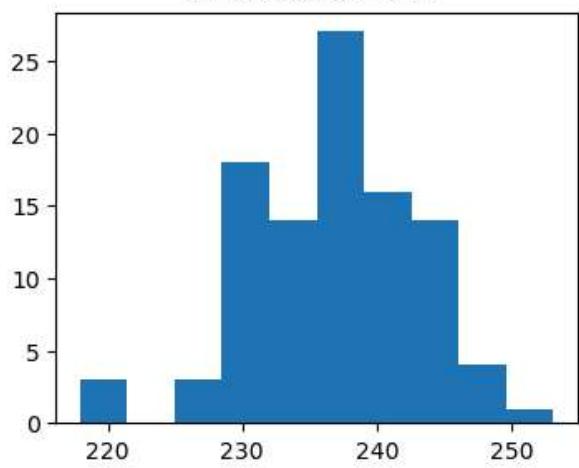
Uniforme: N = 473



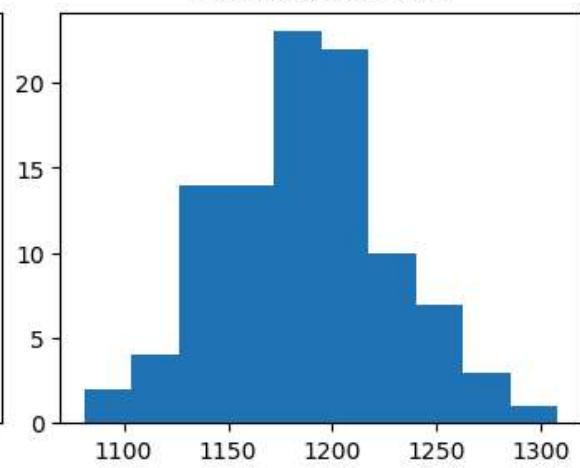
Bernoulli: N = 473



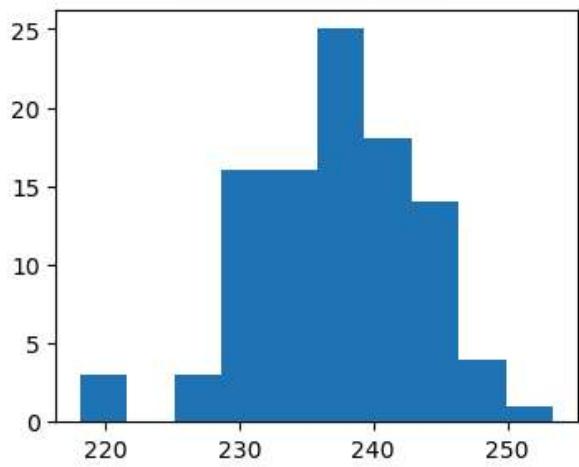
Uniforme: N = 474



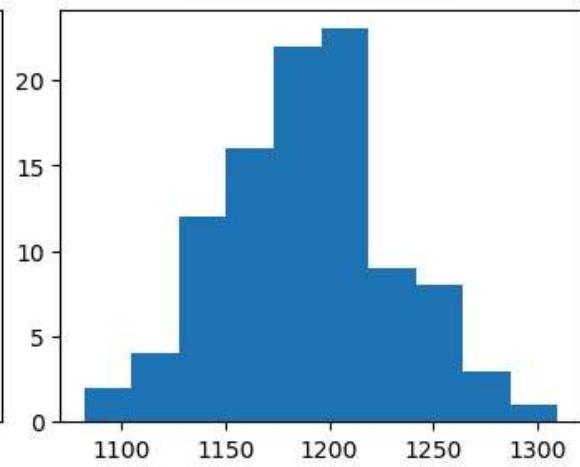
Bernoulli: N = 474

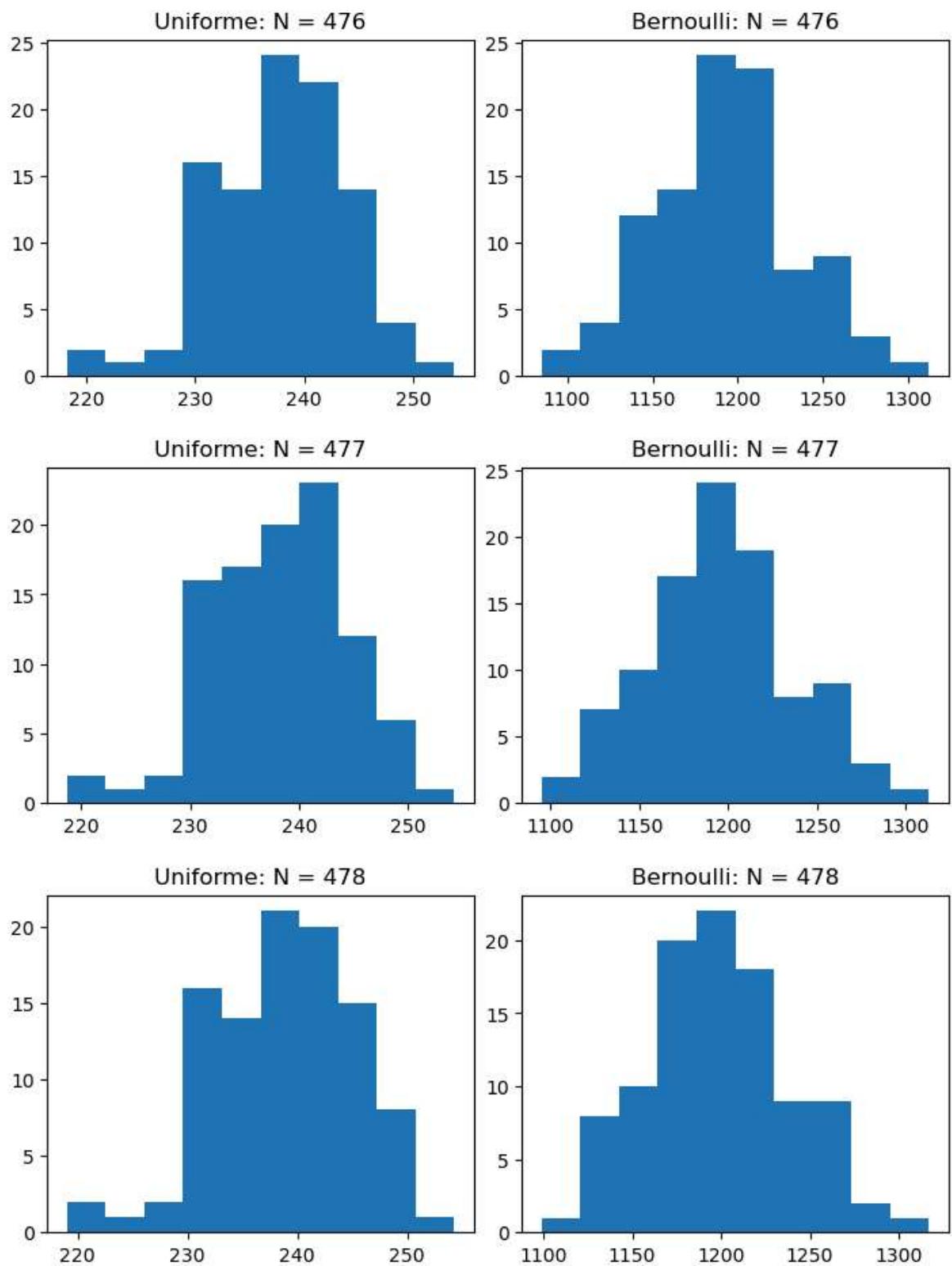


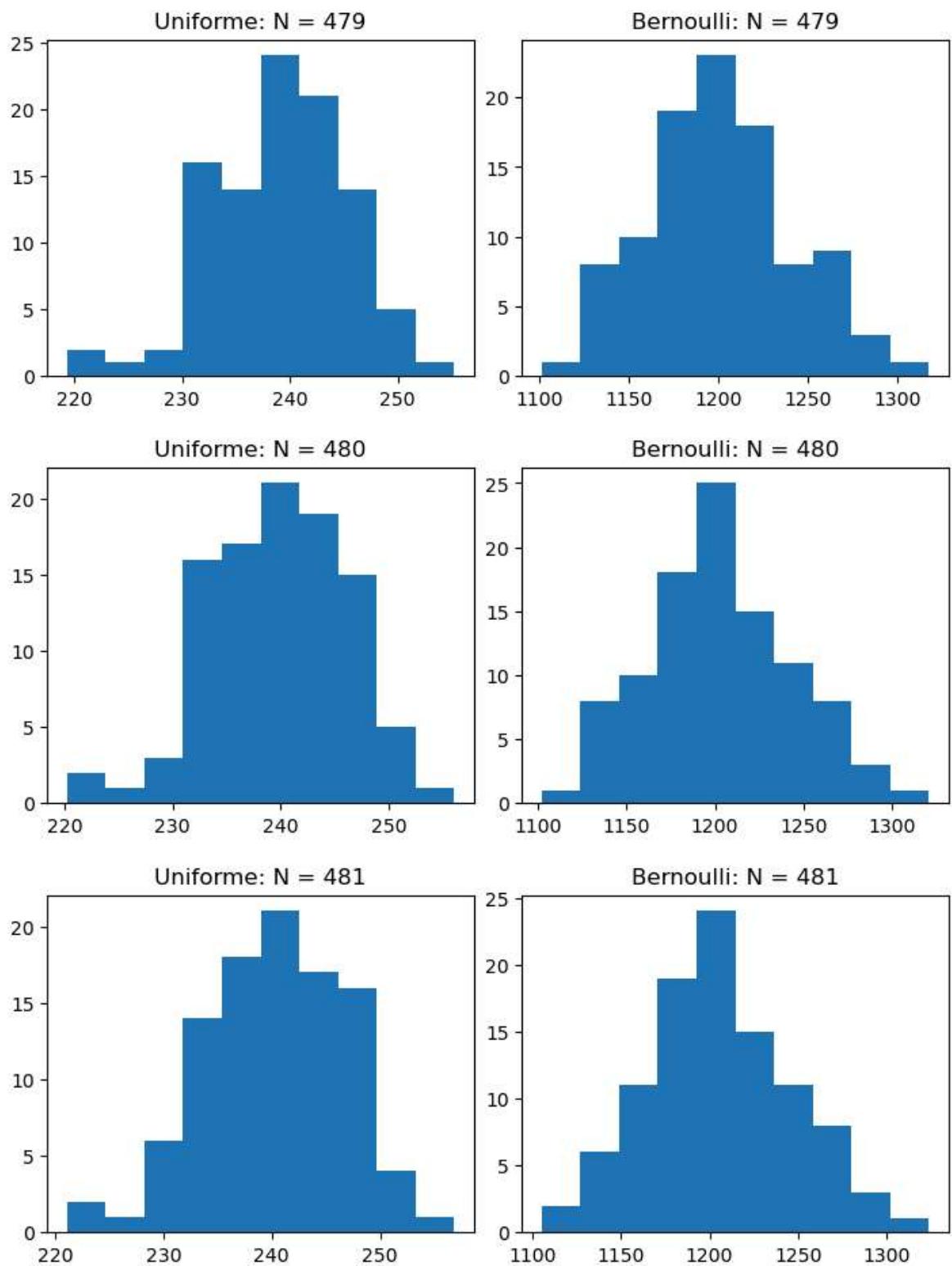
Uniforme: N = 475



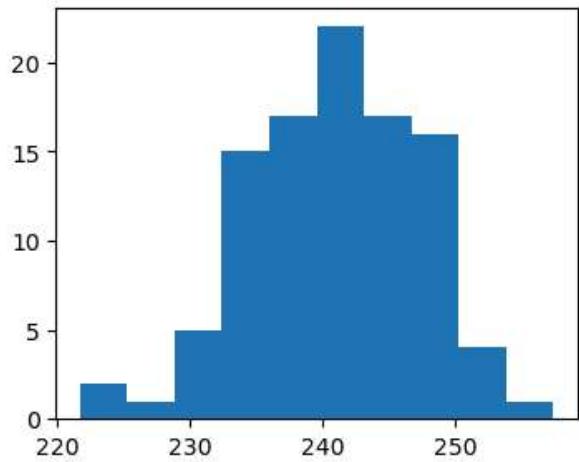
Bernoulli: N = 475



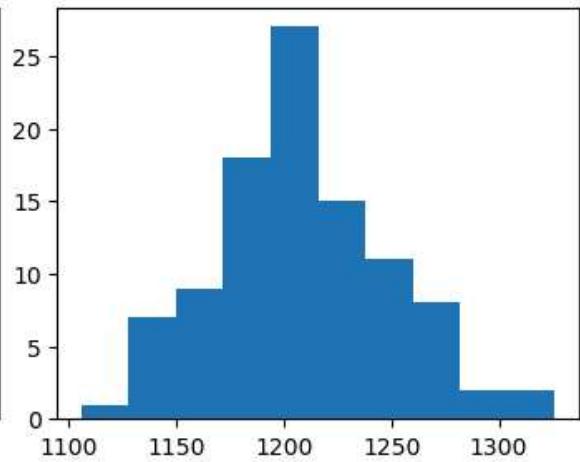




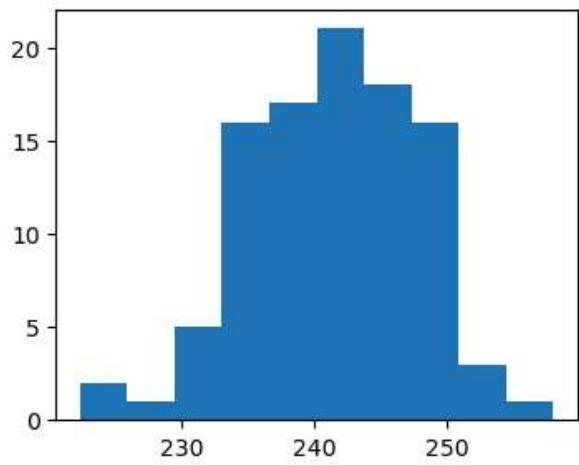
Uniforme: N = 482



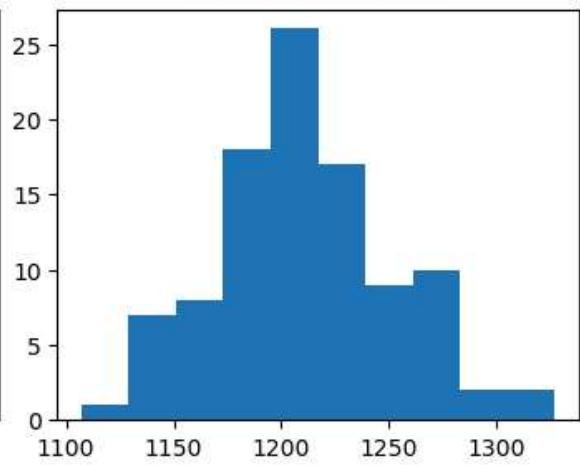
Bernoulli: N = 482



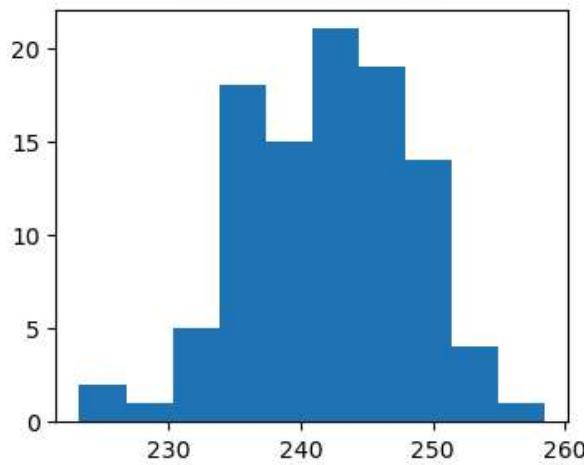
Uniforme: N = 483



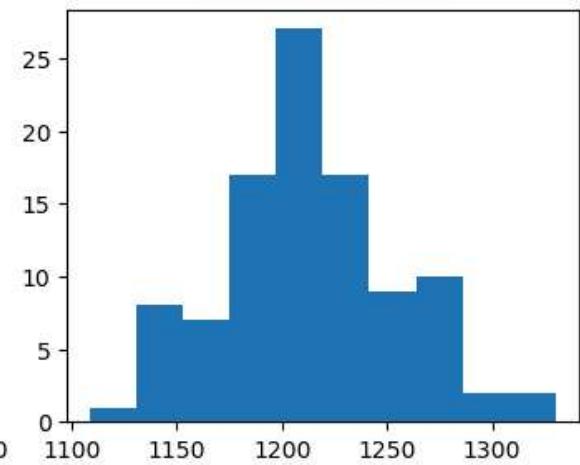
Bernoulli: N = 483



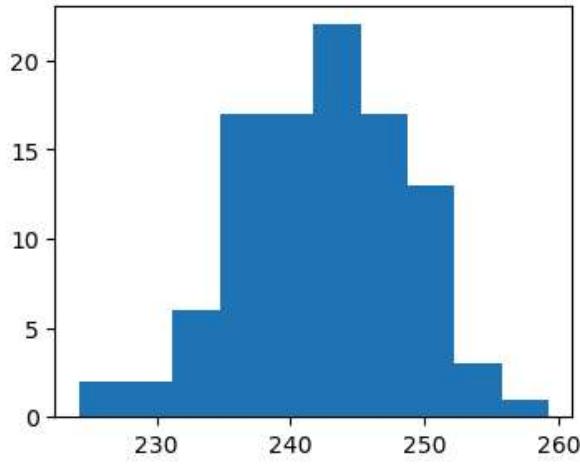
Uniforme: N = 484



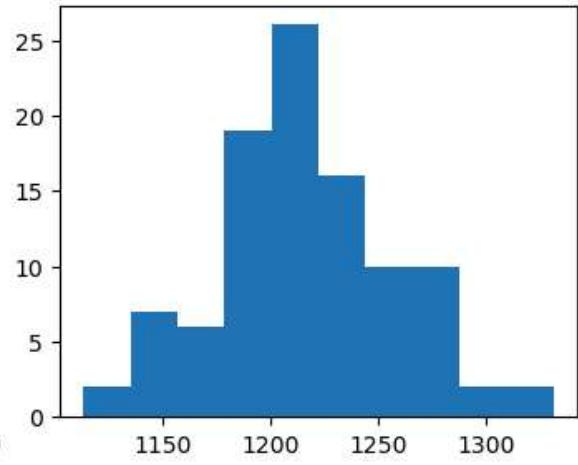
Bernoulli: N = 484



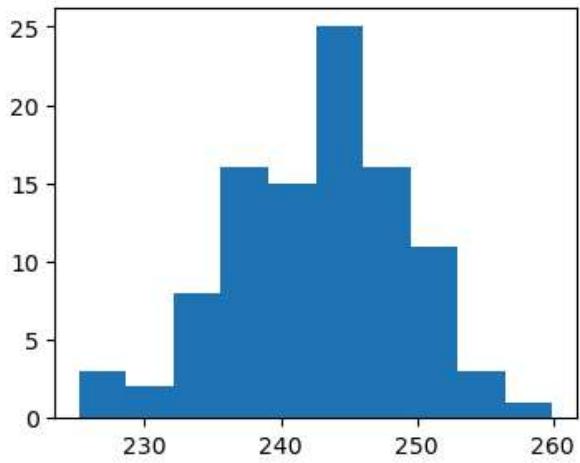
Uniforme: N = 485



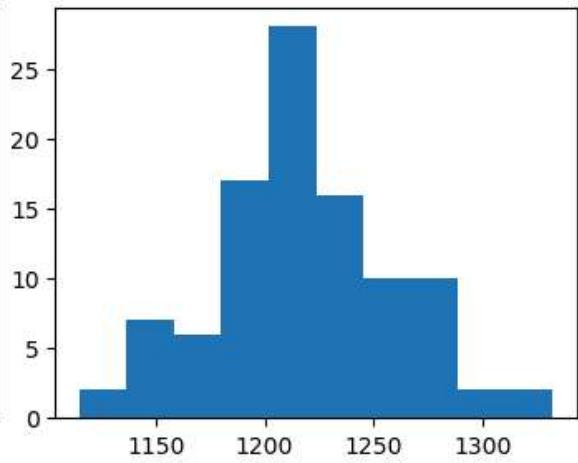
Bernoulli: N = 485



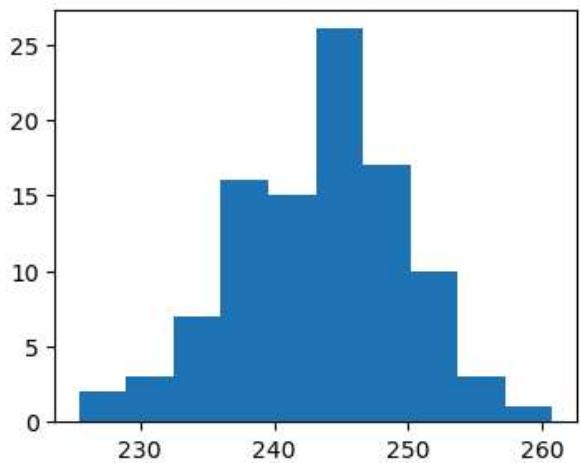
Uniforme: N = 486



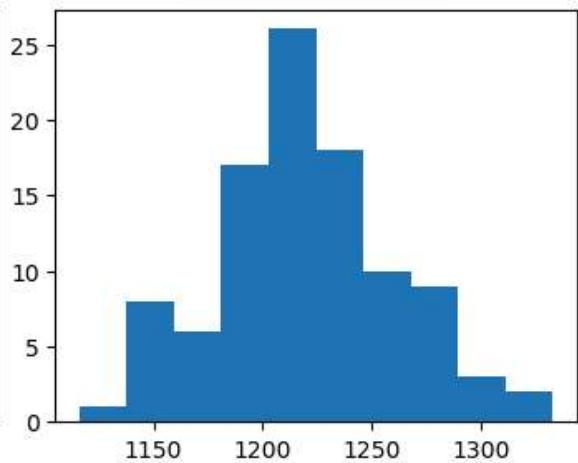
Bernoulli: N = 486



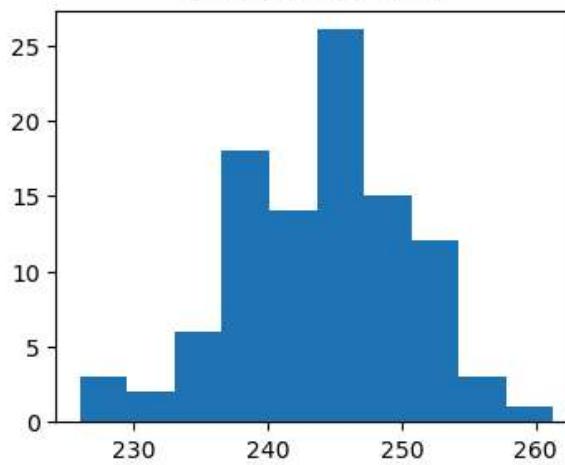
Uniforme: N = 487



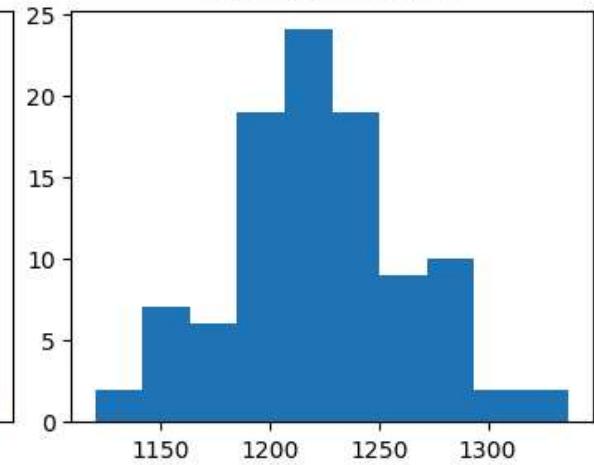
Bernoulli: N = 487



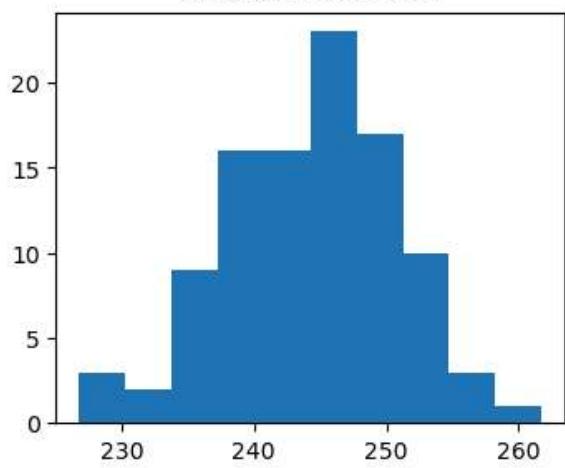
Uniforme: N = 488



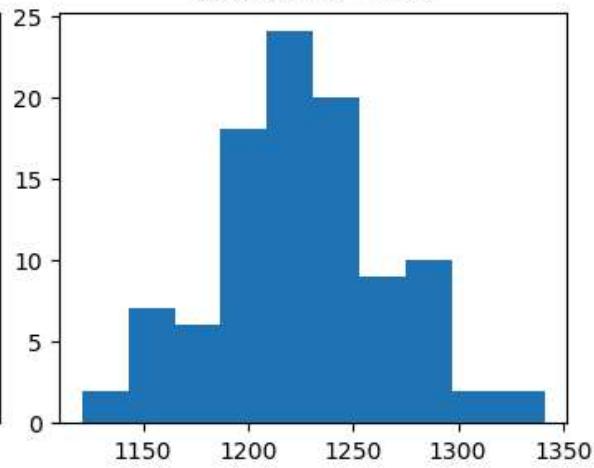
Bernoulli: N = 488



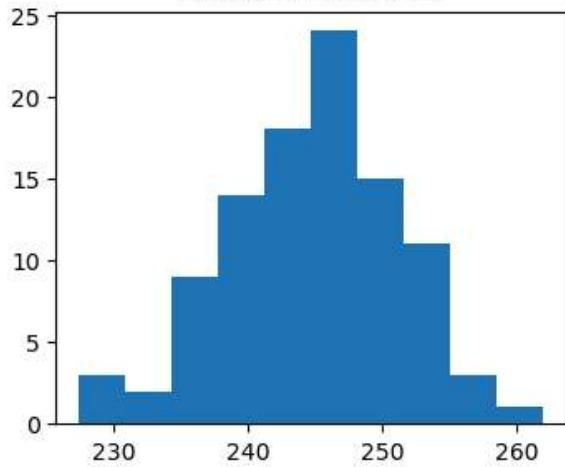
Uniforme: N = 489



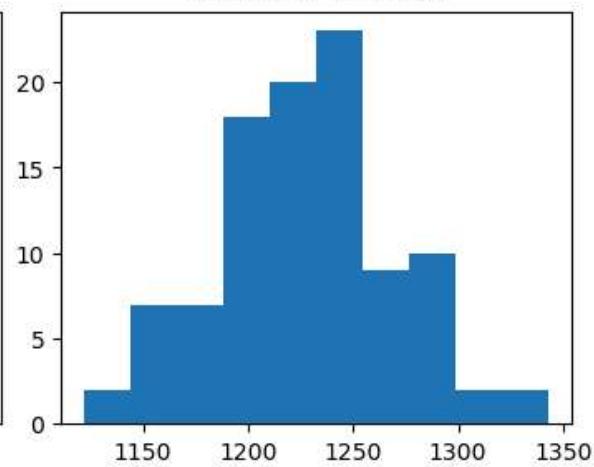
Bernoulli: N = 489



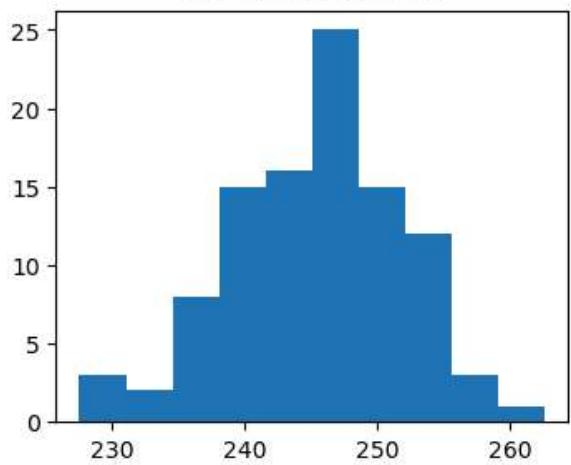
Uniforme: N = 490



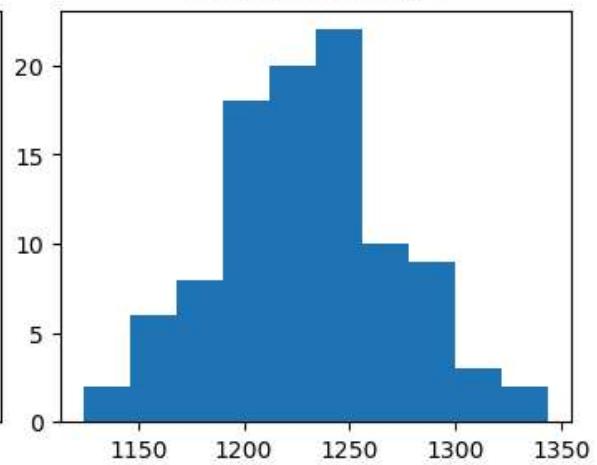
Bernoulli: N = 490



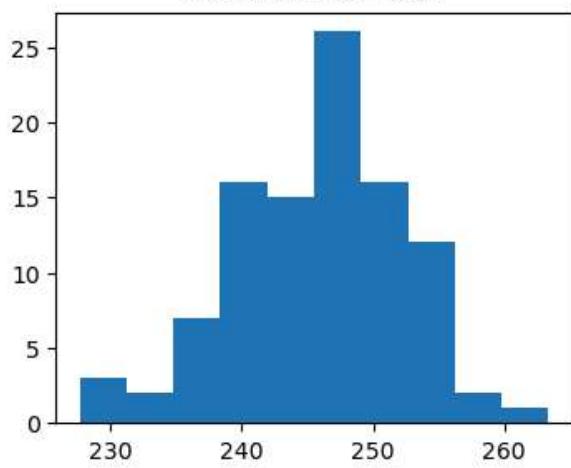
Uniforme: N = 491



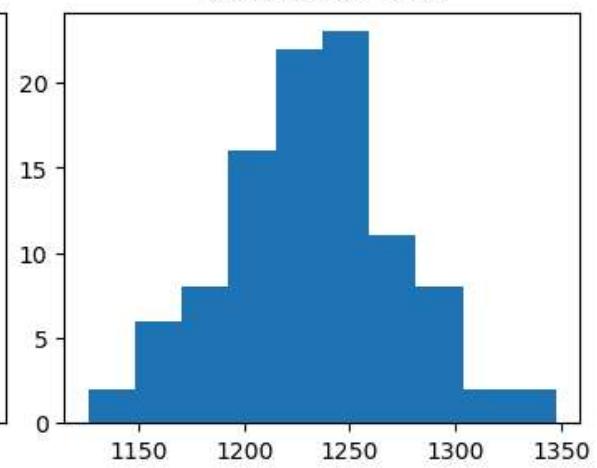
Bernoulli: N = 491



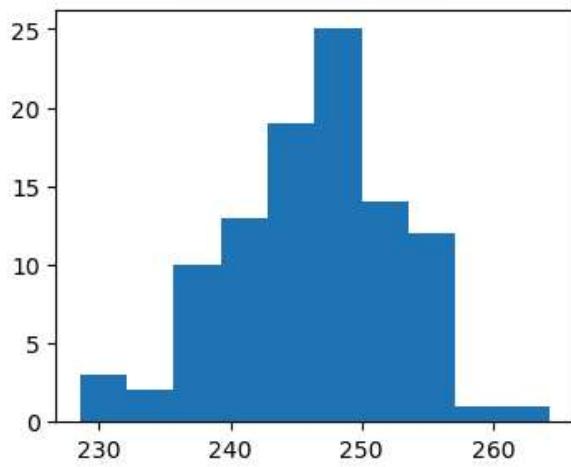
Uniforme: N = 492



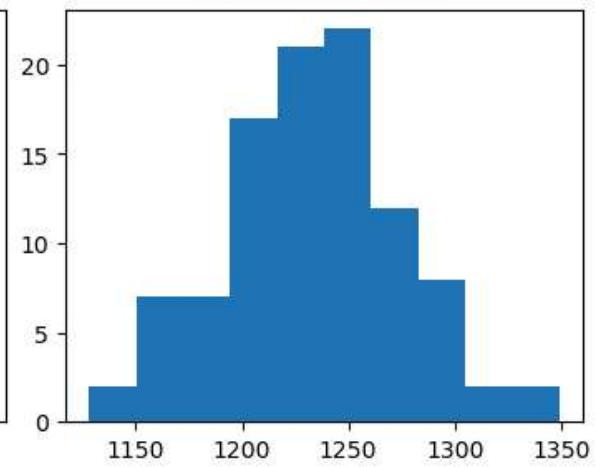
Bernoulli: N = 492



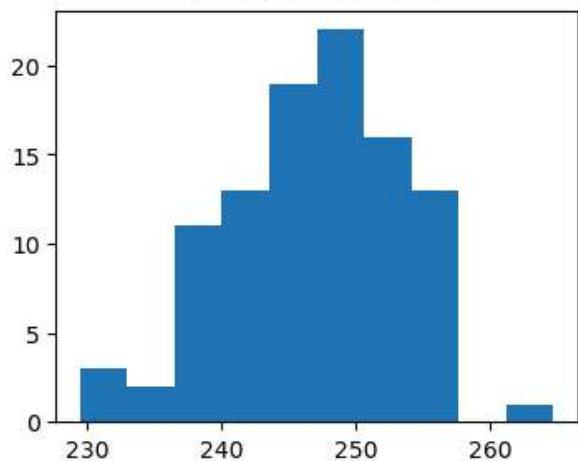
Uniforme: N = 493



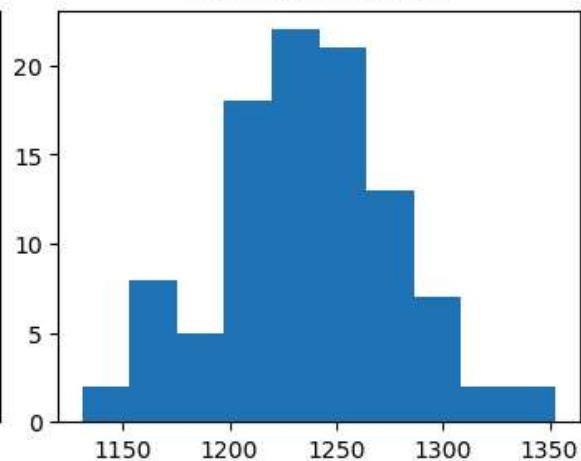
Bernoulli: N = 493



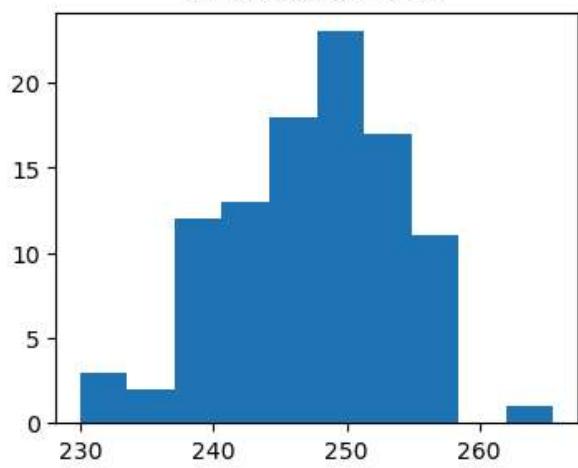
Uniforme: N = 494



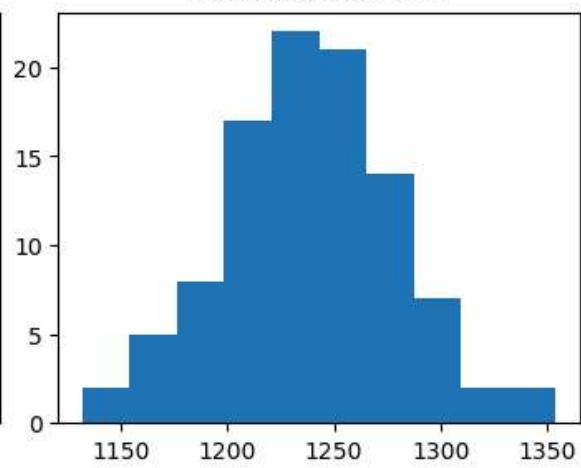
Bernoulli: N = 494



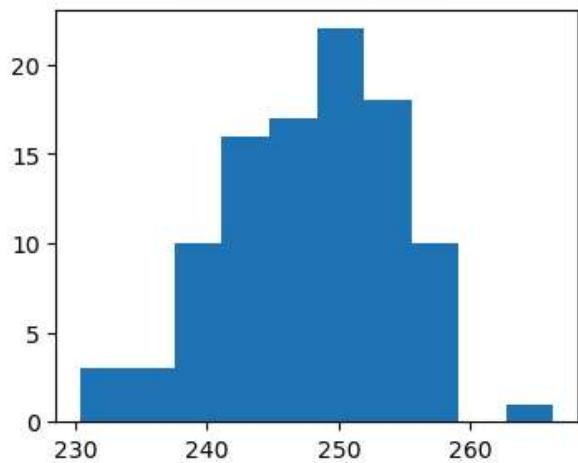
Uniforme: N = 495



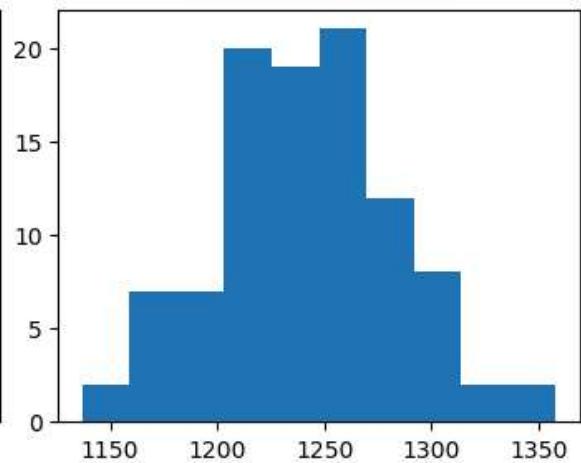
Bernoulli: N = 495

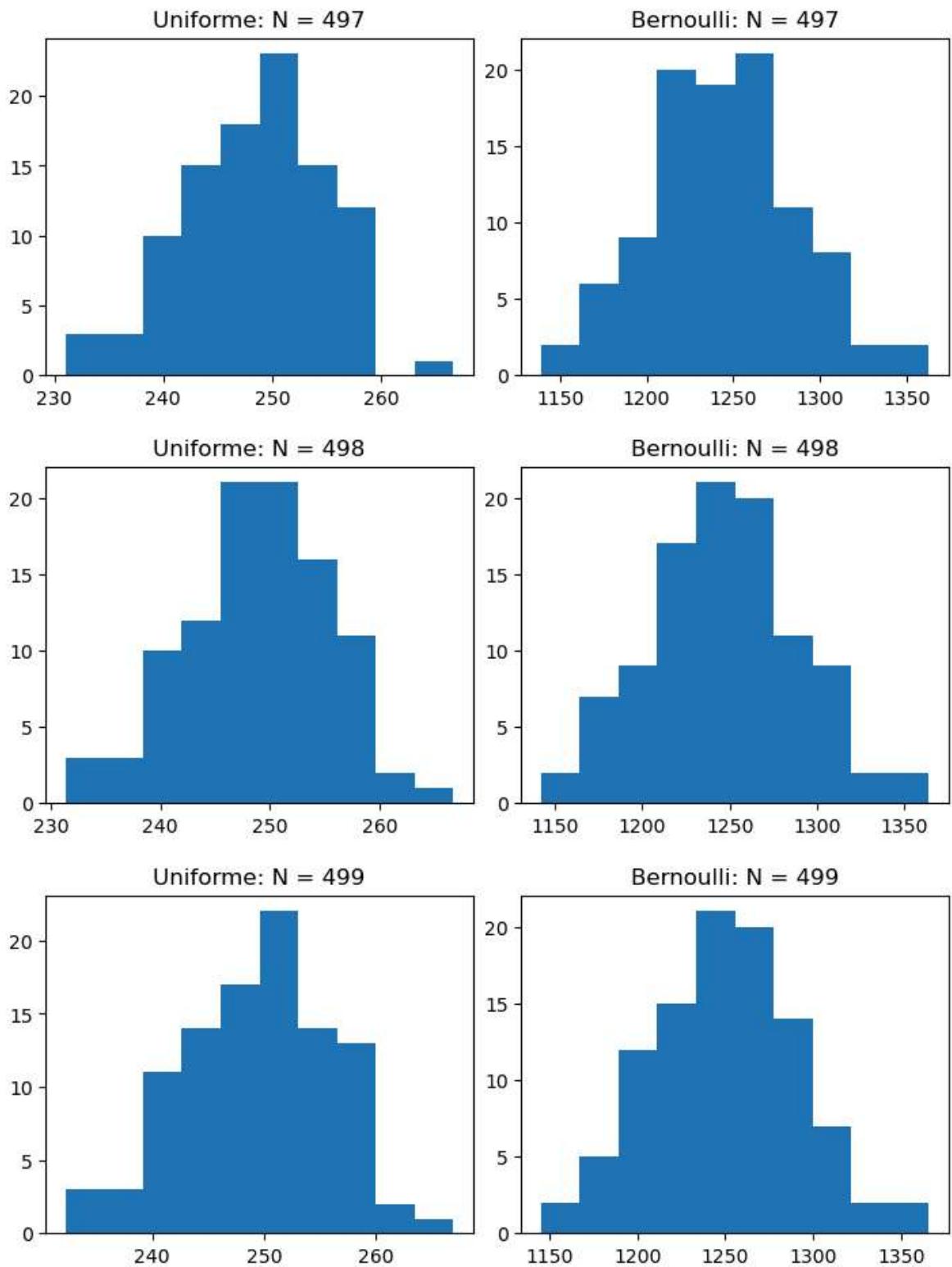


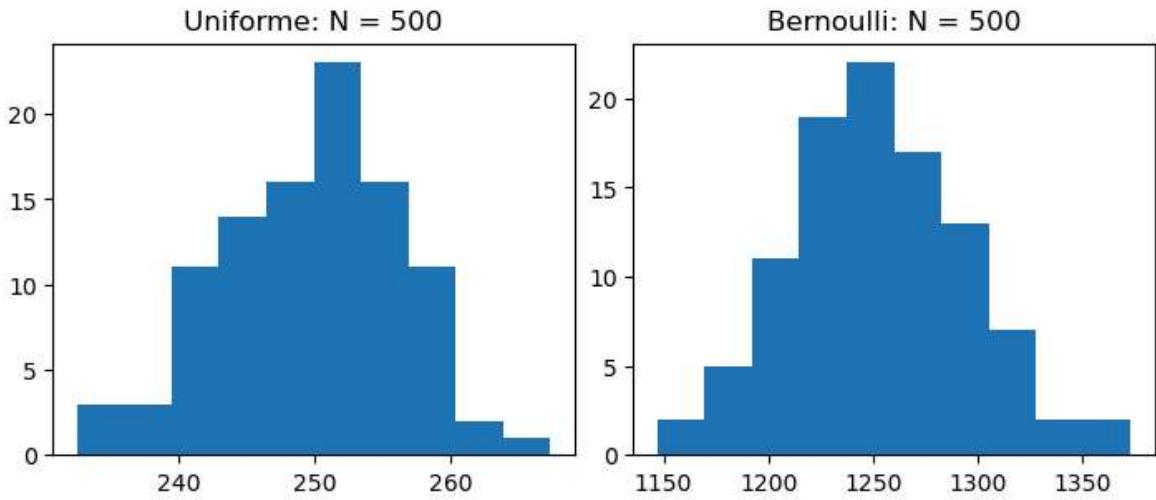
Uniforme: N = 496



Bernoulli: N = 496







```
In [11]: #Parâmetros da Curva Gaussiana para efeito de comparação com o histograma final
xU = np.linspace(0.45, 0.55, num=50)
xB = np.linspace(2., 3.0, num=50)

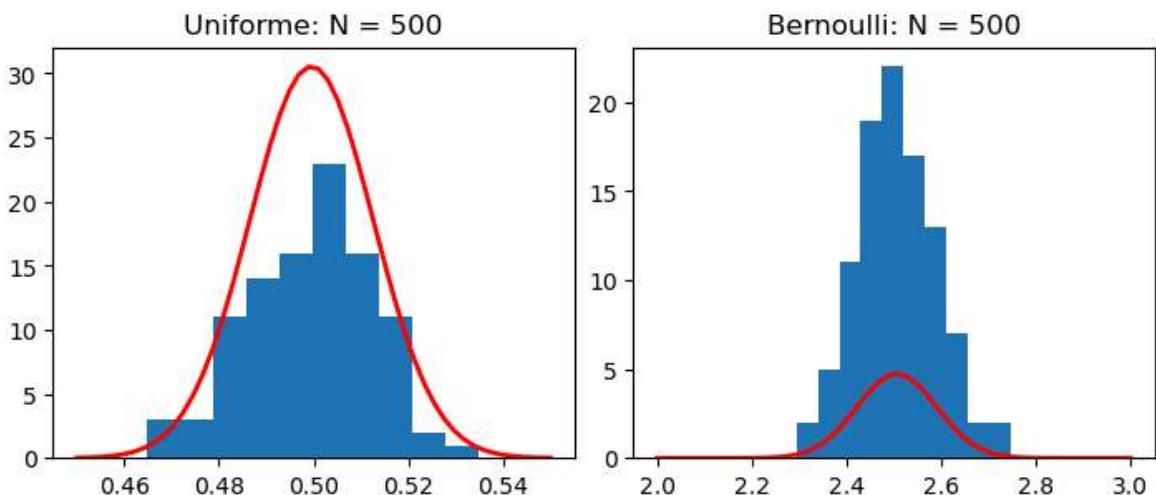
muU = np.mean(Ut/N)                                #média de todas a distribuições unifo
sigmaU = np.std(Ut/N, ddof=1)                      #desvio padrão

muB = np.mean(Bt/N)                                #média de todas a distribuições berno
sigmaB = np.std(Bt/N, ddof=1)                        #desvio padrão

#imprime os histograma final (média da N variáveis)
fig, axs = plt.subplots(1, 2, figsize=(7, 3), layout='constrained')

axs[0].hist(Ut/N, bins = 10)
axs[0].plot(xU, (1/np.sqrt(2 * np.pi * sigmaU**2)) * np.exp( -(xU - muU)**2 ) / (sigmaU * np.sqrt(2 * np.pi)))
axs[0].set_title("Uniforme: N = " + str(i+1))

axs[1].hist(Bt/N, bins = 10)
axs[1].plot(xB, (1/np.sqrt(2 * np.pi * sigmaB**2)) * np.exp( -(xB - muB)**2 ) / (sigmaB * np.sqrt(2 * np.pi)))
axs[1].set_title("Bernoulli: N = " + str(i+1))
plt.show()
```



Conclusão: A média das distribuições uniforme e Bernoulli tendem para uma curva Gaussiana para N suficientemente grande, confirmando o Teorema Central do Limite

In []: