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C:\Users\Chayce\AppData\Local\Microsoft\WindowsApps\python3.13.exe C:\Users\Chayce\Documents\CollegeFinalSemester\Algorithms\HW_Folder\HW8\q5.py
Median-of-Three Pivot Selection in Quicksort Simulation
============================================================

This script demonstrates the probability distribution of pivot positions
when using median-of-three selection in Quicksort.

Comparing empirical results with theoretical formulas...
Comparing empirical vs theoretical probabilities:
a  EmpiricalTheoretical  Difference
-----------------------------------------------------------------
  5%|          | 1/20 [00:00<00:08,  2.16it/s]0.01 0.999300 0.999460 0.000160
0.04 0.992800 0.992903 0.000103
 15%|          | 3/20 [00:01<00:07,  2.15it/s]0.06  0.979700 0.979205 0.000495
 20%|          | 4/20 [00:01<00:07,  2.17it/s]0.09  0.958800 0.958756 0.000044
 25%|          | 5/20 [00:02<00:06,  2.15it/s]0.11 0.937100 0.931942 0.005158
0.14 0.893600 0.899154 0.005554
 35%|          | 7/20 [00:03<00:06,  2.06it/s]0.16  0.854400 0.860777 0.006377
0.19 0.815300 0.817202 0.001902
 45%|          | 9/20 [00:04<00:05,  2.00it/s]0.21 0.768500 0.768815 0.000315
0.24 0.719000 0.716005 0.002995
 55%|          | 11/20 [00:05<00:04,  2.06it/s]0.26 0.661800 0.659160 0.002640
0.29 0.591900 0.598669 0.006769
 65%|          | 13/20 [00:06<00:03,  2.07it/s]0.31   0.526200 0.534918 0.008718
 70%|          | 14/20 [00:06<00:02,  2.06it/s]0.34   0.468200 0.468297 0.000097
0.36 0.392200 0.399194 0.006994
 80%|          | 16/20 [00:07<00:01,  2.12it/s]0.39 0.323500 0.327997 0.004497
0.41 0.253800 0.255093 0.001293
 90%|          | 18/20 [00:08<00:00,  2.31it/s]0.44   0.180000 0.180871 0.
000871
0.46 0.106800 0.105719 0.001081
100%|          | 20/20 [00:09<00:00,  2.17it/s]
0.49 0.033900 0.030026 0.003874

Graph saved as 'median_of_three_splits.png'

Generating distribution of pivot positions...
100%|          | 50000/50000 [00:01<00:00, 27473.24it/s]

Pivot distribution graph saved as 'pivot_distribution.png'

Detailed probability analysis for specific values of a:
a = 0.1:
  - Empirical probability: 0.946480
  - Correct theoretical formula: 0.944431
  - Difference (empirical vs correct): 0.002049
  - Interpretation: ~94.6% chance of getting at worst a 10-90 split
a = 0.2:
  - Empirical probability: 0.791560
  - Correct theoretical formula: 0.792576
  - Difference (empirical vs correct): 0.001016
  - Interpretation: ~79.2% chance of getting at worst a 20-80 split
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a = 0.3:
  - Empirical probability: 0.571320
  - Correct theoretical formula: 0.568504
  - Difference (empirical vs correct): 0.002816
  - Interpretation: ~57.1% chance of getting at worst a 30-70 split
a = 0.4:
  - Empirical probability: 0.299080
  - Correct theoretical formula: 0.296288
  - Difference (empirical vs correct): 0.002792
  - Interpretation: ~29.9% chance of getting at worst a 40-60 split

Process finished with exit code 0

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