Average Case Analysis

*(Fill in the table cells with execution times)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | InpType1 | | | InpType2 | | | InpType3 | | | InpType4 | | |
|  | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 |
| Ver1 | 0.0002092123031616211 | 0.0025971531867980957 | 0.03441375494003296 | 0.0002442598342895508 | 0.003490626811981201 | 0.04797196388244629 | 0.0003387928009033203 | 0.004868507385253906 | 0.08332222700119019 | 0.001133739948272705 | 0.10147100687026978 | 10.37787413597107 |
| Ver2 | 0.00026422739028930664 | 0.0031175613403320312 | 0.0390472412109375 | 0.00025594234466552734 | 0.0029212236404418945 | 0.03896981477737427 | 0.00028514862060546875 | 0.003124535083770752 | 0.04035449028015137 | 0.0012550950050354004 | 0.10412824153900146 | 10.642061054706573 |
| Ver3 | 0.00020313262939453125 | 0.002553999423980713 | 0.032885730266571045 | 0.0002461671829223633 | 0.003491640090942383 | 0.04876101016998291 | 0.00034117698669433594 | 0.004954040050506592 | 0.08659875392913818 | 0.0011336207389831543 | 0.10393881797790527 | 10.515772044658661 |
| Ver4 | 0.0002066493034362793 | 0.0023996829986572266 | 0.031912147998809814 | 0.00021415948867797852 | 0.0023928284645080566 | 0.03214383125305176 | 0.00025266408920288086 | 0.0028904080390930176 | 0.037403643131256104 | 0.001199483871459961 | 0.10546886920928955 | 10.448498725891113 |

Comments:

*(Write your detailed comments about the average case running times)*

*(Worst case results and comments are on the next page)*

*In all input types except InpType4, the best performing version is Version 4, which chooses pivots according to the “median of three” rule. Since the input array is random (not sorted) in the average case, Version 3’s shuffle before Quicksort does not affect the execution time that much. Since both Version 3 and 1 choose the pivot as the first element in a random list, their execution times are very close to each other in all input types.*

*Moreover, these 2 versions are slower than Version 2 and 4 when the input types are 1, 2, and 3.*

Worst Case Analysis

*(Fill in the table cells with execution times)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | InpType1 | | | InpType2 | | | InpType3 | | | InpType4 | | |
|  | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 | *n*=100 | *n*=1000 | *n*=10000 |
| Ver1 | 0.0002932548522949219 | 0.02188897132873535 | 2.2599520683288574 | 0.00019311904907226562 | 0.012312889099121094 | 1.3410592079162598 | 0.00016379356384277344 | 0.0063550472259521484 | 0.562985897064209 | 0.0009021759033203125 | 0.07655811309814453 | 8.500389814376831 |
| Ver2 | 0.00020694732666015625 | 0.0022220611572265625 | 0.027543067932128906 | 0.00019311904907226562 | 0.0022978782653808594 | 0.03263592720031738 | 0.00022602081298828125 | 0.0027320384979248047 | 0.0303647518157959 | 0.000993967056274414 | 0.07688212394714355 | 8.567365884780884 |
| Ver3 | 0.0002880096435546875 | 0.02131032943725586 | 2.2266480922698975 | 0.00019407272338867188 | 0.011982202529907227 | 1.2757487297058105 | 0.0001647472381591797 | 0.006097078323364258 | 0.5564050674438477 | 0.0009031295776367188 | 0.07985997200012207 | 8.734565019607544 |
| Ver4 | 0.00015497207641601562 | 0.0018341541290283203 | 0.022340774536132812 | 0.00015997886657714844 | 0.0021820068359375 | 0.028973817825317383 | 0.0002028942108154297 | 0.0021398067474365234 | 0.02817511558532715 | 0.0009508132934570312 | 0.08533096313476562 | 9.161188125610352 |

Comments:

*(Write your detailed comments about the worst case running times)*