➤ m= 10000

n = 10

d = 0

	Running time for Merge Sort in ms(real)	Running time for Improved Insertion Sort in ms(real)	Running time for naive Insertion Sort in ms(real)
1	5	40	686
2	3	64	1157
3	15	55	1019
4	2	53	1236
5	3	97	926
6	11	94	1417
7	4	97	3533
8	15	56	971
9	3	88	1469
10	16	74	1038
Average Running Time	7.7	71.8	1345.2

➤ m= 10000

n = 10

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	2	121	1778
2	2	118	1318
3	2	148	1508
4	3	109	1319
5	2	115	1270
6	2	121	1141
7	3	121	1204
8	3	123	1657
9	2	108	1034
10	2	114	1023
Average running time	2.3	119.8	1325.2

➢ m= 10000

 n = 10

 d = 1

	Running time for Merge Sort(in ms)	Running time for Improved Insertion Sort(in ms)	Running time for naive Insertion Sort (in ms)
1	2	0	1
2	6	1	0
3	2	0	0
4	2	0	0
5	2	1	0
6	3	0	0
7	2	0	0
8	3	0	0
9	2	0	0
10	4	0	0
Average running time	2.8	0.2	0.2

➢ m = 25000

 n = 10

 d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	6	346	9116
2	7	321	5791
3	21	325	5808
4	7	361	8459
5	7	374	7464
6	6	357	5275
7	21	426	6697
8	7	363	6323
9	6	374	7341
10	7	355	6994
Average running time	9.5	360.2	6926.8

➢ m = 25000

n = 10

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	6	709	9670
2	5	586	8461
3	18	759	7400
4	9	582	8599
5	17	745	9898
6	10	554	8772
7	7	538	8765
8	7	489	10021
9	6	602	8204
10	17	661	8500
Average running time	10.2	622.5	8829

➢ m = 25000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	18	1	0
2	6	0	1
3	18	0	1
4	5	1	0
5	6	0	1
6	18	0	1
7	6	0	1
8	22	0	1
9	18	0	0
10	17	0	0
Average running time	13.4	0.2	0.6

- ➢ m = 50000

    n = 10

    d = 0

	Running time for Merge Sort in ms (real)	Running time for Improved Insertion Sort in ms(real)	Running time for naive Insertion Sort in ms(real)
1	19	868	20114
2	20	915	20675
3	14	819	21752
4	17	785	21372
5	17	804	20188
6	18	820	21821
7	20	846	21678
8	16	824	20663
9	18	787	19966
10	21	866	20568
Average Running time	18	833.4	20879.7

- ➢ m = 50000

    n = 10

    d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	15	1574	23426
2	15	1676	23555
3	14	1549	23747
4	13	1542	23261
5	19	1577	23168
6	20	1586	23434
7	13	1626	23168
8	12	1580	23144
9	17	1597	22145
10	19	1720	23596
Average Running time	15.7	1620.7	23264.4

➤ m = 50000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	15	0	2
2	17	1	1
3	17	1	1
4	19	1	1
5	17	1	2
6	14	1	1
7	18	1	1
8	20	1	2
9	16	1	1
10	23	1	1
Average Running time	17.6	0.9	1.3

➤ m = 100000

n = 10

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	29	2959	82124
2	35	3076	83835
3	35	3161	86248
4	29	3137	88316
5	28	3094	86175
6	35	3065	90426
7	35	2984	80248
8	35	2974	80930
9	35	3137	83263
10	35	3090	84659
Average Running time	33.1	3067.7	84622.4

➤ m = 100000

   n = 10

   d = -1

	Running time for Merge Sort in ms(real)	Running time for Improved Insertion Sort in ms(real)	Running time for naive Insertion Sort in ms(real)
1	29	6195	92505
2	32	5933	86893
3	30	5996	86830
4	33	5819	88377
5	29	5739	86898
6	28	5927	87125
7	29	5651	86000
8	31	5622	86805
9	32	6207	87717
10	30	5754	87787
Average Running time	30.3	5884.3	87693.7

➤ m = 100000

   n = 10

   d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	30	2	2
2	33	2	2
3	30	2	2
4	32	2	3
5	32	2	2
6	31	2	2
7	29	2	2
8	43	2	3
9	33	2	3
10	34	2	3
Average Running time	32.7	2	3.51

➤ m = 250000

n = 10

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	94	18066	More than 10 min
2	91	16764	More than 10 min
3	89	16513	More than 10 min
4	90	16605	More than 10 min
5	89	17379	More than 10 min
6	96	17383	More than 10 min
7	90	17601	More than 10 min
8	88	16699	More than 10 min
9	89	17188	More than 10 min
10	89	17212	More than 10 min
Average running time	90.5	17141	More than 10 min

➤ m = 250000

n = 10

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	75	37497	More than 10 mins
2	74	35200	More than 10 mins
3	72	34244	More than 10 mins
4	75	34427	More than 10 mins
5	74	33762	More than 10 mins
6	74	33339	More than 10 mins
7	73	35386	More than 10 mins
8	73	33882	More than 10 mins
9	76	33675	More than 10 mins
10	76	35143	More than 10 mins
Average running time	74.2	34655.5	More than 10 min

➢ m = 250000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	77	5	6
2	91	5	6
3	74	5	6
4	68	4	5
5	61	4	5
6	74	5	6
7	74	5	6
8	75	4	6
9	75	5	6
10	74	5	6
Average running time	66.9	4.2	5.2

➤ m = 500000

n = 10

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	174	54413	Taking more than 20 mins
2	196	69202	Taking more than 20 mins
3	161	69795	Taking more than 20 mins
4	185	69472	Taking more than 20 mins
5	168	69450	Taking more than 20 mins
6	182	67782	Taking more than 20 mins
7	180	68097	Taking more than 20 mins
8	157	69341	Taking more than 20 mins
9	136	68899	Taking more than 20 mins
10	142	68079	Taking more than 20 mins
Average running time	168.1	67453	

➤ m = 500000

n = 10

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	150	137714	Taking more than 20 mins
2	152	136231	Taking more than 20 mins
3	154	146128	Taking more than 20 mins
4	152	140573	Taking more than 20 mins

5	156	136417	Taking more than 20 mins
6	152	137108	Taking more than 20 mins
7	150	137559	Taking more than 20 mins
8	111	136147	Taking more than 20 mins
9	156	136422	Taking more than 20 mins
10	151	134489	Taking more than 20 mins
Average running time	148.4	137878.8	

> m = 500000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	152	9	12
2	150	9	12
3	149	9	11
4	150	10	11
5	110	8	8
6	154	10	12
7	155	9	12
8	147	8	9
9	174	9	12
10	113	8	8
	145.4	8.9	10.7

> m = 1000000

n = 10

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	295	287004	More than 10 mins
2	286	270543	More than 10 mins
3	309	273272	More than 10 mins
4	349	274458	More than 10 mins
5	315	284564	More than 10 mins
6	275	279589	More than 10 mins

7	387	279832	More than 10 mins
8	354	275487	More than 10 mins
9	320	285546	More than 10 mins
10	283	274894	More than 10 mins
Average running time	317.3	278518.9	

➢ m = 1000000

n = 10

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	350	610001	More than 10 mins
2	283	561528	More than 10 mins
3	356	554921	More than 10 mins
4	345	501564	More than 10 mins
5	348	504987	More than 10 mins
6	349	502484	More than 10 mins
7	282	550032	More than 10 mins
8	273	548464	More than 10 mins
9	356	554921	More than 10 mins
10	348	504984	More than 10 mins
Average running time	329	539388.6	

➢ m = 1000000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	242	15	18
2	259	19	18
3	302	17	20
4	281	16	18
5	284	16	20

6	265	15	20
7	289	16	20
8	275	14	18
9	286	15	19
10	262	16	20
Average running time	274.5	15.9	19.1

> m = 2000000

  n = 10

  d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	650	More than 10 mins	More than 10 mins
2	574	More than 10 mins	More than 10 mins
3	567	More than 10 mins	More than 10 mins
4	569	More than 10 mins	More than 10 mins
5	587	More than 10 mins	More than 10 mins
6	568	More than 10 mins	More than 10 mins
7	620	More than 10 mins	More than 10 mins
8	583	More than 10 mins	More than 10 mins
9	620	More than 10 mins	More than 10 mins
10	590	More than 10 mins	More than 10 mins
Average running time	650	More than 10 mins	More than 10 mins

> m = 2000000

  n = 10

  d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	471	More than 10 mins	More than 10 mins
2	492	More than 10 mins	More than 10 mins
3	466	More than 10 mins	More than 10 mins
4	467	More than 10 mins	More than 10 mins
5	489	More than 10 mins	More than 10 mins
6	468	More than 10 mins	More than 10 mins

7	627	More than 10 mins	More than 10 mins
8	598	More than 10 mins	More than 10 mins
9	488	More than 10 mins	More than 10 mins
10	467	More than 10 mins	More than 10 mins
Average running time	503.3		

➢ m = 200000

n = 10

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	487	30	34
2	531	31	39
3	499	30	37
4	510	31	38
5	524	31	43
6	538	30	37
7	547	30	37
8	637	35	44
9	596	36	43
10	562	32	41
Average running time	542.5	31.6	39.3

➢ m= 10000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	3	91	3630
2	3	78	3003

3	3	51	2664
4	3	54	2606
5	3	52	2363
6	3	70	2603
7	9	70	2603
8	2	53	2396
9	3	64	1972
10	3	66	2627
Average running time	3.5	64.9	2386.4

> ➢ m= 10000
>
>   n = 25
>
>   d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	2	122	3514
2	2	106	3243
3	4	149	3478
4	2	118	3065
5	2	111	4406
6	3	119	4352
7	2	167	4668
8	2	175	4887
9	2	186	5214
10	3	176	4742
Average running time	3.2	142.9	4156.9

> ➢ m= 10000
>
>   n = 25
>
>   d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	2	0	1
2	7	0	1

3	2	1	1
4	2	0	1
5	2	0	1
6	6	1	0
7	2	0	1
8	3	0	1
9	2	0	1
10	3	0	0
Average running time	3.1	0.2	0.8

➢ m = 25000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	8	374	16008
2	20	381	15924
3	19	351	16431
4	8	337	18954
5	20	412	13458
6	8	376	18547
7	9	411	19328
8	23	424	17573
9	19	359	16681
10	17	356	16137
Average running time	15.1	378.1	16904.1

➢ m = 25000

n = 25

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	6	735	21433
2	22	481	24450

3	6	826	27864
4	6	765	24747
5	6	800	23353
6	8	573	20301
7	6	720	19407
8	6	837	22869
9	7	685	22886
10	6	720	31518
Average running time	7.9	714.2	23882.8

> m = 25000

n = 25

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	5	1	1
2	8	1	2
3	19	1	2
4	6	1	17
5	5	1	18
6	6	1	1
7	6	1	1
8	22	1	1
9	5	1	1
10	7	1	1
Average running time	8.9	1	4.5

> m = 50000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	27	1478	103210
2	32	1518	98677

3	27	1468	113280
4	39	1512	75464
5	28	1525	85257
6	40	1438	80686
7	27	1294	51376
8	28	1420	49760
9	27	1310	45539
10	19	795	44628
Average running time	29.4	1375.8	74787.7

➢ m = 50000

n = 25

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	25	1892	81506
2	25	3027	106889
3	45	3238	100265
4	27	2969	104664
5	37	3061	96366
6	24	3140	121662
7	28	2728	97458
8	33	2391	84378
9	24	2025	85349
10	23	2607	85681
Average running time	29.1	2707.8	96421.8

➢ m = 50000

n = 25

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	22	1	2
2	27	2	3

3	14	3	5
4	25	2	2
5	27	1	3
6	18	11	3
7	25	2	2
8	25	2	2
9	25	1	2
10	24	2	2
Average running time	23.2	2.7	2.6

➢ m = 100000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	39	3811	237531
2	32	3000	335306
3	43	4296	220041
4	41	3017	253239
5	38	3969	226543
6	53	3599	226859
7	45	3568	246571
8	31	3980	272702
9	38	2928	289302
10	36	3756	268456
Average running time	39.6	3592.4	257655.0

➢ m = 100000

n = 25

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	31	6040	214012
2	23	5569	213251

3	27	5633	211629
4	24	5487	235486
5	24	6283	216896
6	30	6063	235645
7	32	5965	226483
8	31	6001	221202
9	30	5956	215627
10	27	5633	211629
Average running time	27.9	5863	220186.0

> m = 100000

n = 25

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	38	3	3
2	42	3	4
3	37	3	3
4	43	4	2
5	33	3	3
6	41	3	3
7	39	2	4
8	42	3	3
9	42	3	3
10	37	3	3
Average running time	39.4	3	3.1

➢ m = 500000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	139	70930	More than 10 mins
2	196	68293	More than 10 mins
3	178	54846	More than 10 mins
4	144	67710	More than 10 mins
5	219	76184	More than 10 mins
6	143	67005	More than 10 mins
7	146	68545	More than 10 mins
8	144	67750	More than 10 mins
9	146	68548	More than 10 mins
10	181	64984	More than 10 mins
Average running time	181	67479.5	More than 10 mins

➢ m = 500000

n = 25

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	124	141734	More than 10 mins
2	170	136643	More than 10 mins
3	162	138396	More than 10 mins
4	179	139121	More than 10 mins
5	168	134687	More than 10 mins
6	160	139167	More than 10 mins
7	164	140154	More than 10 mins
8	179	139121	More than 10 mins
9	160	138165	More than 10 mins
10	187	145980	More than 10 mins
Average running time	165.3	139316.8	More than 10 mins

➤ m = 500000

n = 25

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	159	13	21
2	160	18	27
3	159	18	28
4	155	14	20
5	158	17	27
6	160	18	27
7	158	17	27
8	163	17	20
9	159	18	27
10	158	17	41
Average running time	158.9	16.7	26.7

➤ m = 1000000

n = 25

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	455	294687	More than 10 mins
2	300	276839	More than 10 mins
3	319	285577	More than 10 mins
4	301	283984	More than 10 mins
5	314	281565	More than 10 mins
6	302	274531	More than 10 mins
7	310	279545	More than 10 mins
8	330	285894	More than 10 mins
9	305	284648	More than 10 mins
10	310	279644	More than 10 mins
Average running time	324.6	282691.4	More than 10 mins

- m = 1000000

    n = 25

    d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	381	556594	More than 10 mins
2	319	561829	More than 10 mins
3	279	584524	More than 10 mins
4	392	564364	More than 10 mins
5	285	560569	More than 10 mins
6	272	574875	More than 10 mins
7	333	585465	More than 10 mins
8	241	536554	More than 10 mins
9	337	593648	More than 10 mins
10	305	520135	More than 10 mins
Average running time	314.4	563855.7	

- m = 1000000

    n = 25

    d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	271	39	49
2	252	27	41
3	256	27	45
4	279	40	55
5	244	28	43
6	250	28	46
7	268	34	45
8	343	35	55
9	291	53	64
10	250	28	41
Average running time	270.4	33.9	48.4

➤ m = 2000000

  n = 25

  d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	625	More than 10 min	More than 10 min
2	693	More than 10 min	More than 10 min
3	638	More than 10 min	More than 10 min
4	582	More than 10 min	More than 10 min
5	580	More than 10 min	More than 10 min
6	610	More than 10 min	More than 10 min
7	635	More than 10 min	More than 10 min
8	793	More than 10 min	More than 10 min
9	598	More than 10 min	More than 10 min
10	545	More than 10 min	More than 10 min
Average running time	629.9		

➤ m = 2000000

  n = 25

  d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	746	More than 10 min	More than 10 min
2	651	More than 10 min	More than 10 min
3	506	More than 10 min	More than 10 min
4	489	More than 10 min	More than 10 min
5	488	More than 10 min	More than 10 min
6	494	More than 10 min	More than 10 min
7	504	More than 10 min	More than 10 min
8	512	More than 10 min	More than 10 min
9	499	More than 10 min	More than 10 min

10	584	More than 10 min	More than 10 min
Average running time	547.3		

➤ m = 2000000

n = 25

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	511	55	82
2	501	54	80
3	612	70	110
4	504	54	81
5	489	55	79
6	509	53	81
7	523	56	82
8	509	96	131
9	493	53	79
10	508	57	86
	515.9	60.3	89.1

➤ m= 10000

n = 50

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	5	40	2433
2	5	42	2660
3	5	40	2706
4	5	38	2642
5	5	37	2480
6	5	42	2683
7	4	38	2469

8	6	40	2455
9	4	36	2379
10	3	29	2628
Average running time	4.7	38.2	2553.5

➢ m= 10000

   n = 50

   d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	5	83	4837
2	4	83	4928
3	5	84	4766
4	4	81	4834
5	3	75	4860
6	5	80	4771
7	3	69	4663
8	4	75	5047
9	3	65	4797
10	4	87	4831
Average running time	4	78.2	4833.4

➢ m= 10000

   n = 50

   d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	3	1	1
2	3	1	1
3	4	1	2
4	4	1	1
5	4	1	2
6	5	1	2
7	4	1	2

8	3	1	1
9	5	1	2
10	4	1	1
Average running time	3.9	1	1.5

> m = 25000

n = 50

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	10	228	19441
2	9	228	17612
3	10	228	18332
4	8	182	19511
5	10	230	15245
6	10	243	16233
7	10	228	16995
8	10	231	18943
9	10	230	16585
10	10	209	15296
Average running time	9.7	223.7	17419.3

> m = 25000

n = 50

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	8	419	29713
2	11	379	30081
3	9	402	29280
4	8	446	29213
5	9	452	29812
6	10	460	30347
7	10	457	28433

8	9	443	29456
9	10	459	28612
10	9	458	29412
Average running time	9.3	437.5	29435.9

➢ m = 25000

n = 50

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	10	2	4
2	8	2	4
3	10	2	4
4	9	2	2
5	8	2	4
6	10	2	4
7	10	2	4
8	11	2	4
9	13	3	4
10	10	2	4
Average running time	9.9	2.1	3.8

➢ m = 50000

n = 50

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	20	784	70363
2	20	799	70410
3	21	804	71201
4	23	850	71784
5	19	774	70252

6	24	864	71223
7	18	765	70360
8	20	785	70508
9	22	813	71235
10	19	780	70605
Average running time	20.6	801.8	70794.1

➢ m = 50000

n = 50

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	17	1494	107035
2	16	1460	109775
3	18	1504	111988
4	16	1483	108731
5	17	1550	108960
6	17	1592	107298
7	17	1572	105862
8	16	1592	103562
9	17	1485	106586
10	18	1589	116552
Average running time	16.9	1532.1	108634.9

➢ m = 50000

n = 50

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	16	4	7
2	17	4	6
3	17	4	6
4	17	4	7
5	16	3	7

6	17	4	6
7	17	4	6
8	16	4	7
9	13	3	5
10	16	4	7
Average running time	16.2	3.8	6.4

> m = 100000
>
> n = 50
>
> d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	41	3036	305295
2	41	2831	301523
3	42	2892	296140
4	40	2924	302528
5	41	2726	299723
6	41	2758	303216
7	40	2741	305531
8	41	2765	302952
9	40	2924	302528
10	42	2871	295123
Average running time	409	2846.8	301455.9

➢ m = 100000

n = 50

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	33	5513	446200
2	36	5652	456202
3	37	5717	465224
4	34	5782	490015
5	32	5623	445265
6	35	6542	489523
7	31	5855	452623
8	40	6985	465225
9	36	5852	445256
10	33	5513	446200
Average running time	34.7	5903.4	460173.3

➢ m = 100000

n = 50

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	30	9	12
2	34	7	14
3	34	8	13
4	34	8	13
5	34	7	13
6	34	7	13
7	34	7	13
8	33	7	13
9	34	8	13
10	34	7	20
Average running time	33.5	7.5	13.7

> m = 250000

  n = 50

  d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	78	17219	More than 10 mins
2	82	17599	More than 10 mins
3	83	17309	More than 10 mins
4	80	17707	More than 10 mins
5	87	17303	More than 10 mins
6	115	17587	More than 10 mins
7	86	17661	More than 10 mins
8	87	16938	More than 10 mins
9	82	17149	More than 10 mins
10	89	18213	More than 10 mins
Average running time	86.9	17468.5	More than 10 mins

> m = 250000

  n = 50

  d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	85	34795	More than 10 mins
2	93	34536	More than 10 mins
3	87	36264	More than 10 mins
4	85	35388	More than 10 mins
5	65	35006	More than 10 mins
6	85	35741	More than 10 mins
7	75	36201	More than 10 mins
8	81	35892	More than 10 mins
9	85	34956	More than 10 mins
10	91	34562	More than 10 mins
Average running time	83.2	35334.1	More than 10 mins

- m = 250000

  n = 50

  d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	92	18	33
2	85	19	32
3	99	18	32
4	85	19	32
5	87	19	33
6	69	14	24
7	84	18	33
8	85	18	32
9	91	19	33
10	90	18	32
Average running time	86.7	18	31.6

- m = 500000

  n = 50

  d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	178	71935	More than 10 mins
2	162	71270	More than 10 mins
3	166	69660	More than 10 mins
4	165	69852	More than 10 mins
5	225	72600	More than 10 mins
6	160	72562	More than 10 mins
7	155	71266	More than 10 mins
8	160	69852	More than 10 mins
9	156	68562	More than 10 mins
10	155	71265	More than 10 mins
Average running time	168.2	70882.4	

➢ m = 500000

n = 50

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	135	138741	More than 10 mins
2	134	142129	More than 10 mins
3	142	136568	More than 10 mins
4	139	135485	More than 10 mins
5	133	136521	More than 10 mins
6	131	139520	More than 10 mins
7	178	145200	More than 10 mins
8	131	139520	More than 10 mins
9	135	138741	More than 10 mins
10	140	136522	More than 10 mins
Average running time	139.8	138894.7	More than 10 mins

➢ m = 500000

n = 50

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	138	29	50
2	131	27	49
3	132	28	48
4	161	31	52
5	188	48	69
6	201	38	67
7	130	28	48
8	146	28	48
9	136	31	51
10	135	28	50
Average running time	149.8	28.8	53.2

➢ m = 1000000

n = 50

d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	313	286716	More than 10 mins
2	448	287471	More than 10 mins
3	326	289378	More than 10 mins
4	353	290082	More than 10 mins
5	401	286254	More than 10 mins
6	326	286545	More than 10 mins
7	365	295232	More than 10 mins
8	330	290350	More than 10 mins
9	315	286552	More than 10 mins
10	365	295562	More than 10 mins
Average running time	390.7	289414.2	More than 10 mins

➢ m = 1000000

n = 50

d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	281	More than 10 mins	
2	358	More than 10 mins	
3	370	More than 10 mins	
4	276	More than 10 mins	
5	283	More than 10 mins	
6	285	More than 10 mins	
7	273	More than 10 mins	
8	279	More than 10 mins	
9	276	More than 10 mins	
10	277	More than 10 mins	

Average running time	295.8	More than 10 mins	

- m = 1000000

  n = 50

  d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	279	70	103
2	270	55	102
3	273	60	96
4	351	82	171
5	349	60	97
6	281	61	98
7	276	61	96
8	265	54	96
9	273	55	95
10	272	61	97
Average running time	272.6	61.9	105.1

➤ m = 2000000

   n = 50

   d = 0

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	679	More than 10 mins	
2	924	More than 10 mins	
3	682	More than 10 mins	
4	827	More than 10 mins	
5	680	More than 10 mins	
6	685	More than 10 mins	
7	648	More than 10 mins	
8	677	More than 10 mins	
9	771	More than 10 mins	
10	664	More than 10 mins	
Average running time	723.7	More than 10 mins	

➤ m = 2000000

   n = 50

   d = -1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	612	More than 10 mins	
2	551	More than 10 mins	
3	576	More than 10 mins	
4	564	More than 10 mins	
5	550	More than 10 mins	
6	563	More than 10 mins	
7	639	More than 10 mins	
8	575	More than 10 mins	
9	562	More than 10 mins	
10	565	More than 10 mins	
Average running time	575.7	More than 10 mins	

➤ m = 2000000

n = 50

d = 1

	Running time for Merge Sort	Running time for Improved Insertion Sort	Running time for naive Insertion Sort
1	553	118	192
2	669	121	193
3	559	157	316
4	557	111	193
5	726	173	225
6	639	142	224
7	574	136	199
8	559	117	203
9	652	177	223
10	558	112	192
Average running time	604.6	1364	216.0

NOTE: All the readings above are real timings in milliseconds.

- A factor that affects the running time is the input size:
  It was observed that as the size of input increased, the running time also increased.
  i.e.**, size of input is directly proportional to the running time**.

- We noted that for large input sizes merge sort runs faster than insertion sort.

- For large enough input size, the running time for merge sort will beat insertion sort as

  Θ(nlogn) beats Θ(n^2)

From our readings we concluded the following findings:

- Behavior for random inputs (d=0):
  The average running time taken by merge sort, improved insertion sort and naïve insertion sort for the average case

  Time (merge sort) **<** Time (improved insertion sort) **<** Time (naïve insertion sort)
  For the average case, naïve insertion sort takes the longest time.

- Behavior for reverse inputs (d=-1):

The average running time taken by merge sort, improved insertion sort and naïve insertion sort for the worst case:

Time (merge sort) < Time (improved insertion sort) < Time (naïve insertion sort)

For the worst case, naïve insertion sort takes the longest time.

- Behavior for sorted inputs(d=1):
  The findings in case of sorted input were opposite to the above findings.

  The average running time taken by merge sort, improved insertion sort and naïve insertion sort for the best case

  Time (merge sort) > Time (naïve insertion sort) **>** Time (improved insertion sort)

  For the best case, merge sort takes longest time.