

Lab 2

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Instructions

Before the lab is due, make sure that you upload a knitted HTML or pdf file to the canvas page (this should have a .html or .pdf extension). No need to upload the .Rmd file.

Part (A): Simple Linear Regression Model

- 1) Import the **diamonds_small.csv** dataset into R and store in a dataframe called **diamonds**. Use the **lm()** command to regress **price** (response) on **carat** (predictor) and save this result as **lm0**. What are the coefficients of **lm0**? (Some of this problem is solved for you below.)

coefficients of lm0 -2401 for the intercept and 7990 for diamonds\$carat

```
diamonds <- read.csv("diamonds_small.csv", as.is = TRUE, header = TRUE)
rows      <- dim(diamonds)[1]
diamonds <- diamonds[sample(1:rows, 2000), ]
lm0 <- lm(diamonds$price~diamonds$carat)
lm0
```

```
##
## Call:
## lm(formula = diamonds$price ~ diamonds$carat)
##
## Coefficients:
##      (Intercept)  diamonds$carat
##           -2204             7624
```

Recall from lecture that the estimates $\hat{\beta}_0$ and $\hat{\beta}_1$ that you just calculated with **lm()** are functions of the data values and are therefore themselves are random (they inherit variability from the data). If we were to recollect the diamonds data over and over again, the estimates would be different each time.

In this lab we'll use bootstrapping to answer the following questions:

1. "How much does $\hat{\beta}_1$ vary from one replication of the experiment to the other?"
2. "What are all the values of β_1 that would have produced this data with high probability?"

Part (B): How Does $\hat{\beta}_1$ Vary?

Strategy: we'll re-sample (**price**, **carat**) pairs in order to provide an estimate for how $\hat{\beta}_1$ varies across samples.

- 1) How many rows are in the **diamonds** dataset? Call this value **n**. $n = 53940$

```
# You'll want to type your response to question B(1) here. Your response should look like:
n <- nrow(diamonds)
n
## [1] 2000
```

- 2) We'll next use the `sample()` function to re-sample `n` rows of the `diamonds` dataset *with replacement*. The following code provides a single re-sample of the values $1, 2, \dots, n$, or a single re-sample of the rows of the dataset.

```
resample1 <- sample(1:n, n, replace = TRUE)
# Remove the comment symbol in front of the above after n is assigned in B(1)
```

Now write a loop to calculate `B <- 1000` such re-samples and store them as rows of the matrix `resampled_values` which will have `B` rows and `n` columns.

You'll want to type your response to question B(2) here. Your response should look like:

```
B <- 1000
resampled_values <- matrix(NA, nrow = B, ncol = n)
for (b in 1:B) {
  resampled_values[b,] <- sample(1:n, size = n, replace = TRUE)
}
dim(resampled_values)
```

```
## [1] 1000 2000
```

```
resampled_values[1:100, 1:100]
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12]
## [1,]  376 1010   55  993 1895  763 1397 1378  956   547  1514   496
## [2,] 1541 1381 1301  150 1806  266  422  311  110  1430  1650   831
## [3,]  257  256 1556  841 1432  307  177  411   43  1191  1446  1078
## [4,]  130 1354 1471  223   94  262 1762 1680 1737   67   216  1099
## [5,]  537  204  268 1599   30 1411  976 1939  795  1344  1407   457
## [6,]  186  894 1659 1625 1611  772 1712 1430  726   470   896  1153
## [7,] 1208 1949  407   42  144 1139 1908 1119  123  1885   849   667
## [8,]  224  154  345 1685 1073 1022 1517  506 1500   330  1795   795
## [9,]  422  230  291  620  301 1054  236  955  617   611   600  1310
## [10,] 159  358 1722 1880 1759   35 1232  319  580  1474   687  1137
## [11,]  348 1120 1837  358 1897  552 1318  310  927  1445  1164  1826
## [12,] 1180  165  414 1356  397  954   48 1342  417  1717  1857   20
## [13,] 1400  650 1680 1406 1216 1379  488  585  473  1400   919  1357
## [14,]  831  282  916 1607  643 1737  494 1643  430  1141   735  1895
## [15,] 1609 1667  105  883  815 1664  302  165  254  1444   129   98
## [16,] 1707 1837 1229 1798 1786 1532  494 1692  505   491  1654  1373
## [17,] 1659  852 1353 1296  720  770  296  176 1242  1682  1954   730
## [18,]   38  813  650 1469  869 1046 1631 1494  977   472  1937  1224
## [19,] 1187 1106 1194  786  521 1480   54 1682 1702   272   777  1714
## [20,] 1453 1467   6 1884 1145 1768 1977  415 1524  1334  1753  1482
## [21,]  842 1470  986  946 1188   18  899  610  998   594  1042  1127
## [22,] 1872 1939 1100  585  804   27  809 1613  208   188  1749  1502
## [23,] 1501 1574  517  203  149  597   66  163 1394  1016  1165   187
## [24,] 1156 1402  675  239 1756  104  685  922 1544  1639  1367    4
## [25,]  247  619 1896 1212 1013  249  179 1821 1977  1522  1098   176
## [26,] 1457  674 1366  635 1153 1236 1959  929 1490   848   645   66
## [27,] 1669 1526  984  559  767 1390 1529 1962 1962  1643   656  1518
## [28,]  591  573 1978  826 1848 1037 1437 1567 1692   36   796  1252
## [29,] 1464 1295 1629  209  669  800  765 1849  595   663  1912   318
## [30,] 1574 1745  914   67  146  614   54 1992  912  1224  1418   739
## [31,]  276  986  644 1549  958  759  343 1058  819  1597  1788   312
## [32,]  703 1375 1912 1476  738  212  326  626 1547   59  1915   69
```

##	[33,]	1480	1644	1992	1292	67	1146	550	1935	158	690	1459	1565
##	[34,]	1516	1517	244	395	1137	1022	1765	277	1319	1744	215	663
##	[35,]	1847	1383	540	1076	555	1742	1026	378	1633	1089	469	1047
##	[36,]	1669	1940	1110	573	1603	1058	1805	1282	1825	63	1013	269
##	[37,]	610	1813	346	316	1991	1009	177	1599	1786	1689	1827	593
##	[38,]	93	1030	1795	1889	1936	1328	892	252	315	1191	494	1603
##	[39,]	825	606	1276	1406	1128	1590	902	58	1491	303	615	728
##	[40,]	48	1871	1706	963	1365	364	1150	117	878	239	1016	1276
##	[41,]	1290	376	468	483	1336	527	1797	1734	1076	1384	781	1738
##	[42,]	940	940	1188	1881	1981	164	875	442	596	865	184	1930
##	[43,]	1288	1757	1809	1461	1209	264	1032	1604	1213	1369	1738	863
##	[44,]	1410	419	1792	1703	520	254	1353	1857	1560	1795	1364	508
##	[45,]	105	1345	1151	277	783	425	854	527	844	1730	679	117
##	[46,]	859	1417	1518	161	276	1309	1152	318	1806	1669	379	1092
##	[47,]	1497	1925	832	1807	1294	1049	1716	716	1769	539	1635	1693
##	[48,]	949	951	561	1130	126	954	604	1964	803	1230	336	1620
##	[49,]	1402	1404	626	1105	1745	1363	1776	1495	671	1786	147	1029
##	[50,]	1297	278	1053	1404	155	678	162	1954	1761	271	973	1631
##	[51,]	1529	1923	1896	577	1794	1331	1345	283	1069	974	295	1442
##	[52,]	525	382	1533	916	220	1527	613	604	222	1378	560	215
##	[53,]	298	1412	1846	181	1668	1171	1196	125	1203	945	977	1530
##	[54,]	896	608	155	278	712	1527	1608	980	1672	1399	944	1208
##	[55,]	1795	729	1392	1185	421	899	941	1074	1995	1256	1651	1853
##	[56,]	198	929	28	846	201	120	382	1145	1321	1166	1099	1633
##	[57,]	285	934	724	492	98	407	292	1871	946	396	1750	1167
##	[58,]	42	1345	1190	1341	1664	363	694	1473	1302	313	611	906
##	[59,]	1268	940	1321	501	1098	1901	112	481	432	948	112	1562
##	[60,]	732	719	633	1479	1037	1055	639	1947	1392	1032	1265	118
##	[61,]	1545	614	415	1625	1346	300	842	301	1413	1005	1249	780
##	[62,]	1833	1875	1908	608	661	1525	1019	1750	1566	64	857	1312
##	[63,]	1546	1504	1873	924	1336	1955	1380	1331	1359	669	1709	1874
##	[64,]	228	1193	1217	964	1149	1943	792	1602	275	1622	187	1119
##	[65,]	1373	1156	229	111	1743	206	1784	1246	1897	271	123	1118
##	[66,]	306	1670	212	820	1562	856	249	26	1598	1852	1012	90
##	[67,]	1824	35	1213	246	774	594	339	229	724	678	1287	771
##	[68,]	269	829	1864	1966	676	338	46	1825	1719	480	147	244
##	[69,]	317	1640	1021	343	655	972	1601	1794	828	1366	1367	1065
##	[70,]	1872	625	1655	519	645	1356	963	1357	1032	1377	761	610
##	[71,]	628	926	883	279	257	1356	368	411	263	237	1391	1638
##	[72,]	1338	1890	1334	1363	659	1843	162	1207	1574	1660	1748	1756
##	[73,]	588	1428	63	1849	1289	1096	262	466	649	1936	1987	1647
##	[74,]	1274	1316	1315	1943	1068	1918	1186	793	877	1248	786	1215
##	[75,]	1268	953	79	1972	1824	60	471	1247	76	403	1907	99
##	[76,]	1703	1448	1721	1720	936	857	1329	106	1000	1654	722	1563
##	[77,]	536	257	1171	1560	60	913	809	213	152	1778	104	1707
##	[78,]	348	1940	738	1276	646	1969	295	309	839	805	1871	728
##	[79,]	119	1625	1160	647	1702	108	1058	1185	988	1301	1266	707
##	[80,]	1118	274	199	1452	65	888	469	1283	773	249	142	829
##	[81,]	223	1060	1540	1072	1823	1148	1667	1351	1490	162	1832	894
##	[82,]	745	215	211	1575	1852	299	250	1475	1551	692	749	56
##	[83,]	1747	382	530	22	641	857	706	907	1097	257	261	489
##	[84,]	273	334	1985	1064	1708	1684	930	261	1992	1986	86	457
##	[85,]	1911	1528	948	969	935	1798	742	944	1369	1053	455	205
##	[86,]	1738	1652	611	1358	1270	588	131	1300	566	1214	905	605

##	[87,]	311	1025	1235	1944	1754	654	1567	350	1061	1696	660	1242
##	[88,]	20	313	943	65	1111	1475	1790	1971	228	925	1943	1841
##	[89,]	925	533	698	1673	1968	1606	1423	1165	555	1475	1872	1204
##	[90,]	1526	1224	1847	1624	1273	1135	436	1598	1426	1539	19	1469
##	[91,]	827	497	40	1528	792	1445	965	1446	841	1455	377	1933
##	[92,]	1735	1650	1279	1106	557	771	658	1856	1648	894	1664	1005
##	[93,]	1439	393	1910	485	240	1177	668	1478	1263	1317	970	1449
##	[94,]	1679	11	470	806	1498	831	569	39	1530	1692	543	401
##	[95,]	1255	1859	1359	953	1512	1361	1840	1448	1408	635	593	38
##	[96,]	1018	954	145	1643	239	1024	693	695	701	975	1408	509
##	[97,]	1400	280	952	104	545	872	1029	1896	1940	998	156	724
##	[98,]	921	695	140	667	1830	919	1983	1754	456	442	1964	873
##	[99,]	1572	1051	1306	1511	637	1526	647	1342	867	1402	1442	300
##	[100,]	1739	1232	1262	1477	1192	1951	1536	1619	509	384	1652	368
##		[,13]	[,14]	[,15]	[,16]	[,17]	[,18]	[,19]	[,20]	[,21]	[,22]	[,23]	
##	[1,]	1043	1226	191	1132	34	400	836	412	755	153	290	
##	[2,]	1930	647	955	1947	1941	1826	1886	1343	1385	210	1333	
##	[3,]	158	193	1893	773	1935	1446	1829	1656	210	202	167	
##	[4,]	219	1446	1451	1580	1235	1007	913	70	420	686	1092	
##	[5,]	576	56	1893	1827	1423	1537	1148	1833	299	1113	717	
##	[6,]	1555	1534	622	1393	1735	1210	1856	548	1475	668	1931	
##	[7,]	1691	314	1416	959	1550	460	675	371	1930	1418	912	
##	[8,]	149	768	1844	1781	113	533	1195	553	1348	1341	1657	
##	[9,]	763	1488	1364	539	804	1006	1793	177	1275	1979	1613	
##	[10,]	205	74	993	34	1268	28	1307	1526	446	171	1864	
##	[11,]	928	934	646	1544	1430	1237	145	1961	453	360	775	
##	[12,]	1461	407	1236	1035	631	1344	1986	407	460	1895	579	
##	[13,]	1169	1031	1898	759	1202	1311	39	824	173	1430	418	
##	[14,]	206	1074	164	578	1325	260	1999	1348	704	528	1908	
##	[15,]	451	1747	641	415	1048	174	1843	99	1513	263	1696	
##	[16,]	1681	715	1693	1589	1572	1415	169	1445	1147	326	1314	
##	[17,]	68	678	1822	1659	139	245	474	462	424	177	1388	
##	[18,]	227	1141	89	1530	416	1716	1796	1736	1332	762	550	
##	[19,]	159	454	1531	671	1958	290	1535	1923	1621	1950	1421	
##	[20,]	1199	211	272	658	1291	997	75	1432	1383	1376	705	
##	[21,]	1354	1912	1670	1056	158	1608	1505	140	1489	332	402	
##	[22,]	50	1419	1983	1747	1736	788	345	1673	592	1153	585	
##	[23,]	1965	1449	1986	473	1771	770	414	1584	1743	371	1637	
##	[24,]	1412	983	1459	326	1047	1093	1564	186	1936	1805	1555	
##	[25,]	1545	48	343	709	1286	26	893	923	374	1217	370	
##	[26,]	767	491	8	927	691	1229	1872	1005	93	1084	1300	
##	[27,]	1233	1618	1389	945	182	1546	1423	1187	1353	876	1361	
##	[28,]	896	170	1980	854	73	100	1592	814	1540	885	682	
##	[29,]	1606	1763	1599	1097	1495	164	276	559	932	1251	454	
##	[30,]	106	986	1143	856	1484	1709	1191	205	1997	877	1950	
##	[31,]	1759	1910	996	594	218	965	274	1239	1027	18	1568	
##	[32,]	733	1622	951	631	1742	1353	1247	1652	70	853	76	
##	[33,]	286	1953	643	1194	393	1445	1623	1772	272	1865	1278	
##	[34,]	474	1353	718	1540	31	980	446	546	474	1108	346	
##	[35,]	336	331	1535	825	1046	224	325	1890	1418	167	763	
##	[36,]	568	1814	728	650	1762	1409	1923	228	562	832	1225	
##	[37,]	119	1590	65	367	57	1052	212	81	104	93	433	
##	[38,]	217	782	767	1909	886	325	1399	337	408	604	739	
##	[39,]	1984	1360	1391	82	256	1474	168	1423	870	1194	1761	

##	[40,]	1059	1997	1520	967	1428	1330	354	1637	1716	680	477
##	[41,]	1473	630	1297	1007	698	6	1668	597	1796	1729	1023
##	[42,]	644	1780	387	818	51	108	1478	650	1878	1925	1848
##	[43,]	1323	588	1236	1170	159	324	200	1510	1547	676	1280
##	[44,]	1583	1032	1554	1157	1013	474	642	755	1089	573	1040
##	[45,]	1124	1112	1151	1180	175	929	1231	1823	1355	1800	1766
##	[46,]	974	1062	873	1432	1579	1521	1800	1686	1613	1266	117
##	[47,]	239	976	781	980	1131	1124	474	758	1359	1125	1769
##	[48,]	1310	1991	1432	92	783	647	307	1256	1971	1218	106
##	[49,]	446	17	631	1315	1707	110	478	776	109	1227	1744
##	[50,]	828	1532	1086	876	701	1415	911	979	758	800	1322
##	[51,]	1349	489	1002	1428	1602	22	782	711	629	1869	301
##	[52,]	628	212	14	1658	103	1564	568	387	758	149	1919
##	[53,]	808	219	1091	107	872	1018	1517	358	1354	367	363
##	[54,]	872	449	1265	755	645	1883	351	192	646	1438	1959
##	[55,]	1620	146	1271	1769	1715	1828	1377	1238	75	909	677
##	[56,]	896	1171	853	1944	1870	165	1652	1024	240	1529	603
##	[57,]	210	1059	956	1894	1695	1032	70	1338	12	1934	1680
##	[58,]	822	1553	1149	390	1780	442	170	1018	1249	1572	1554
##	[59,]	250	45	1214	816	659	1612	598	1206	241	1107	486
##	[60,]	348	1052	222	1234	1582	376	414	836	1085	1093	1815
##	[61,]	998	1174	1574	1811	91	176	762	264	562	1245	1060
##	[62,]	101	1100	369	974	660	573	1416	1280	209	1172	1368
##	[63,]	1552	1299	66	1235	809	20	1039	1750	1132	932	1128
##	[64,]	1253	313	1239	1903	1337	1457	279	392	110	112	169
##	[65,]	846	244	1878	1882	1829	765	1373	1779	1513	517	368
##	[66,]	519	843	1173	777	815	1067	701	1265	681	1939	1325
##	[67,]	51	644	1256	223	1088	571	573	1536	1326	547	1435
##	[68,]	587	1620	266	294	1451	992	787	683	716	79	661
##	[69,]	1249	830	1469	1966	1444	523	199	713	728	1868	1517
##	[70,]	362	1282	907	1835	1826	454	1969	1084	1978	1720	1725
##	[71,]	902	1091	1090	1666	1654	366	483	1928	1262	982	784
##	[72,]	12	166	1807	168	674	1947	581	16	1908	1707	1537
##	[73,]	396	860	273	632	808	1194	1447	321	1779	1378	1451
##	[74,]	1506	1352	428	1018	254	1983	955	1656	1606	847	284
##	[75,]	1575	1198	492	1348	1685	1566	591	1426	1796	568	1032
##	[76,]	450	463	941	1870	1473	345	1116	1457	754	1155	1202
##	[77,]	1790	1210	709	1361	1930	228	1343	808	966	1624	1121
##	[78,]	725	1890	1853	1634	1911	1069	1472	1483	1336	1558	469
##	[79,]	454	398	80	964	472	1421	905	308	116	749	302
##	[80,]	1568	104	1605	1210	996	1590	469	332	428	1411	1488
##	[81,]	1359	481	610	1025	467	1699	1922	1073	522	850	144
##	[82,]	1057	1817	632	1602	136	1976	26	327	1949	255	1921
##	[83,]	1229	279	732	385	1118	632	465	1343	1366	1869	1605
##	[84,]	834	768	87	341	228	694	897	1478	1590	732	88
##	[85,]	1476	1378	68	1803	31	1390	1667	488	1182	779	341
##	[86,]	1237	1285	1152	255	841	781	235	844	1249	1319	1434
##	[87,]	40	234	732	1493	243	51	587	1898	737	1366	677
##	[88,]	405	435	687	323	433	1758	493	1423	1611	525	821
##	[89,]	1412	271	874	703	613	558	438	1868	294	1862	1115
##	[90,]	1238	1914	1877	1206	54	981	547	622	85	1062	101
##	[91,]	1605	958	1169	1049	9	541	1903	1080	1797	437	584
##	[92,]	1592	482	95	649	1212	365	760	1194	1579	189	1022
##	[93,]	1503	1775	1301	200	160	1251	1984	339	151	1443	142

##	[94,]	1847	905	879	873	1285	270	696	1684	1335	664	377
##	[95,]	480	1926	230	973	573	469	937	1160	1745	503	699
##	[96,]	802	1246	645	917	1710	311	1711	857	1196	958	1996
##	[97,]	736	305	1355	1484	1607	488	959	1615	936	1386	602
##	[98,]	628	456	1691	1779	1925	1361	1737	434	420	1324	1755
##	[99,]	325	1759	991	1460	667	1156	1561	1457	1440	1942	871
##	[100,]	115	1146	1995	314	287	1026	58	320	309	395	1441
##		[,24]	[,25]	[,26]	[,27]	[,28]	[,29]	[,30]	[,31]	[,32]	[,33]	[,34]
##	[1,]	1108	1324	1472	753	1738	1591	1644	1804	1966	532	1575
##	[2,]	1015	206	17	1975	957	1261	1828	890	755	463	646
##	[3,]	846	985	1161	1130	1269	893	1767	933	101	567	1754
##	[4,]	1539	858	1373	1044	1594	1807	865	664	1835	419	1626
##	[5,]	1780	169	1804	593	1792	1217	1641	1812	1768	865	639
##	[6,]	942	749	1283	1850	1459	58	310	1198	68	956	1568
##	[7,]	869	1282	1504	916	1075	489	1957	1710	1280	1555	874
##	[8,]	1292	800	1297	1069	1254	1772	496	1136	1964	1978	1248
##	[9,]	810	633	1661	235	1497	789	1533	937	310	902	49
##	[10,]	1651	1752	369	392	408	1433	941	1102	650	1604	369
##	[11,]	20	1595	502	599	277	67	1314	1705	553	604	1303
##	[12,]	1573	1233	442	1513	349	581	187	917	847	1749	913
##	[13,]	1488	1594	553	746	1341	1119	979	542	1140	1910	25
##	[14,]	1562	1653	124	1724	1862	390	1974	452	1237	875	1726
##	[15,]	1160	362	1761	59	1613	794	1794	1421	1896	636	1646
##	[16,]	35	1629	29	596	1425	865	626	780	1281	1001	884
##	[17,]	104	1555	1509	26	531	956	458	1678	1836	1166	1411
##	[18,]	47	597	748	1216	1699	486	877	1693	1684	1328	1120
##	[19,]	9	776	481	500	653	475	826	787	168	1246	1438
##	[20,]	150	1220	1401	1021	114	1821	372	92	1409	59	214
##	[21,]	881	5	299	246	511	1858	1134	639	794	1461	1083
##	[22,]	559	1623	1995	995	241	759	2	1123	533	1692	1279
##	[23,]	1896	560	1952	918	1871	415	1795	1085	1784	970	482
##	[24,]	114	1186	1528	879	1177	22	1147	1241	1588	872	123
##	[25,]	985	32	1441	1628	661	27	1109	1758	1004	708	321
##	[26,]	512	719	326	3	810	44	97	942	182	1543	1619
##	[27,]	198	279	352	976	1469	624	992	299	1352	575	1131
##	[28,]	1082	1771	1366	1476	311	640	1421	1830	123	593	1533
##	[29,]	1779	461	910	929	542	171	1920	278	1550	495	1452
##	[30,]	1973	858	1256	1756	1418	1940	803	1435	947	1464	653
##	[31,]	1163	919	481	542	44	78	1690	1334	648	1902	1481
##	[32,]	376	899	104	557	14	477	1967	1281	1777	1442	161
##	[33,]	1996	1810	1941	796	1148	1004	1961	988	179	1683	1476
##	[34,]	1797	571	1993	694	675	239	799	1609	1465	121	1420
##	[35,]	1834	1551	189	117	452	1715	979	1628	1614	835	311
##	[36,]	1705	1220	421	1192	935	1159	1417	1429	1110	798	1638
##	[37,]	1334	378	1878	1058	1792	1971	1456	1511	184	1090	1223
##	[38,]	799	1496	1566	1234	1492	522	1569	440	717	337	1113
##	[39,]	1375	156	994	982	981	681	872	1670	1259	1830	109
##	[40,]	222	1253	326	794	743	199	907	1842	1042	361	55
##	[41,]	1264	945	243	1891	1026	404	1929	363	717	1202	665
##	[42,]	1759	1137	1444	1900	1033	1913	560	1512	13	1588	1360
##	[43,]	698	297	761	116	1714	1569	607	895	1611	654	1155
##	[44,]	925	1125	925	1440	1515	811	712	1357	1803	697	1763
##	[45,]	679	441	1552	857	814	1277	1913	490	388	1711	1629
##	[46,]	392	1094	1548	1476	906	1512	1893	462	1941	1090	117

##	[47,]	1429	344	617	847	1076	35	126	148	453	889	529
##	[48,]	875	232	817	309	1910	1971	1523	422	632	549	1065
##	[49,]	1094	502	1795	1797	640	1607	390	759	1514	1271	48
##	[50,]	1761	1551	1170	732	1219	1154	298	578	252	1927	1319
##	[51,]	1446	1797	1953	1625	1258	1375	1788	1127	1364	878	104
##	[52,]	1165	638	1135	359	1636	1592	1475	299	1145	1680	237
##	[53,]	1276	880	889	1685	473	91	1025	1140	894	1782	1273
##	[54,]	159	651	1620	422	814	1904	1889	1747	1061	610	925
##	[55,]	1608	991	826	967	1859	1337	311	1371	776	841	1189
##	[56,]	682	528	1948	42	784	14	4	1239	58	876	673
##	[57,]	719	1276	171	197	1529	40	234	207	1034	1365	270
##	[58,]	509	1676	1430	560	958	1554	103	1617	362	1966	1085
##	[59,]	264	678	1594	271	1114	1581	905	181	820	1837	499
##	[60,]	1466	1145	440	1154	1707	1792	540	1590	1592	1801	1340
##	[61,]	274	357	1796	472	1244	866	952	1607	320	1806	527
##	[62,]	1772	67	1346	1035	405	1136	1488	1031	1906	156	1061
##	[63,]	1467	661	785	1695	398	1158	1434	973	232	732	927
##	[64,]	616	611	1743	1480	1871	380	695	31	638	292	1916
##	[65,]	378	313	986	1167	1568	1772	1992	1579	1176	167	434
##	[66,]	808	441	338	1893	1417	459	993	1824	1324	556	131
##	[67,]	624	1795	1754	165	1878	1445	167	1680	1351	1870	788
##	[68,]	1912	601	1308	1432	1427	1	1269	1334	190	1828	256
##	[69,]	17	1946	90	1387	1217	825	1555	268	1044	1387	1054
##	[70,]	963	1621	306	1473	929	1647	59	1529	1725	781	1876
##	[71,]	1406	443	1601	1812	1257	1005	387	472	1669	12	838
##	[72,]	407	1079	460	77	1600	325	1216	1144	1846	152	1419
##	[73,]	491	1980	518	851	797	1489	194	439	144	85	1500
##	[74,]	1007	365	894	1926	1959	838	1458	1963	363	587	547
##	[75,]	1991	1796	1582	1375	1824	1587	1207	798	1563	1556	92
##	[76,]	717	1787	461	1392	287	288	1092	1284	1040	855	760
##	[77,]	1469	52	411	1034	391	769	1750	1111	784	685	150
##	[78,]	961	170	663	959	1625	619	1142	292	1145	791	1613
##	[79,]	990	1022	210	421	1717	403	1524	1955	628	526	1844
##	[80,]	1727	686	1864	349	1451	828	1536	1099	616	1121	1938
##	[81,]	777	942	1515	1758	1986	1721	1216	339	1632	1561	1190
##	[82,]	1070	791	749	88	1680	1324	1752	755	199	94	1610
##	[83,]	553	46	1685	716	134	28	1067	1898	244	812	1621
##	[84,]	666	1978	227	1610	526	584	190	1210	1280	346	1396
##	[85,]	1727	1236	1599	1320	425	655	769	554	820	325	580
##	[86,]	226	1314	367	745	1376	873	1257	760	1986	657	856
##	[87,]	1293	996	380	1731	1059	321	121	1402	1462	531	1296
##	[88,]	420	1402	205	72	700	123	530	788	1845	1253	1198
##	[89,]	1445	1771	648	998	1117	127	1680	506	1091	982	47
##	[90,]	1525	1064	110	1706	1535	1399	1013	491	1383	2000	611
##	[91,]	1528	1246	1011	1882	204	540	1174	802	1355	848	1449
##	[92,]	687	1552	795	16	1086	135	1159	1001	756	1586	1653
##	[93,]	1180	47	1804	1605	662	1395	1033	713	698	590	1124
##	[94,]	1306	793	1944	243	1878	258	1660	1804	775	516	1722
##	[95,]	569	330	1484	1230	792	728	1515	117	1842	1177	1299
##	[96,]	729	714	1137	1499	1540	1248	1781	1940	1097	379	999
##	[97,]	180	23	1915	1841	53	534	1318	1967	1291	1619	1061
##	[98,]	822	1699	79	1969	497	116	475	1843	1208	864	663
##	[99,]	1818	1481	517	1776	1397	1380	240	139	1120	786	1451
##	[100,]	659	1438	1689	353	310	1899	61	1309	1773	787	1798

##		[,35]	[,36]	[,37]	[,38]	[,39]	[,40]	[,41]	[,42]	[,43]	[,44]	[,45]
##	[1,]	382	8	1114	820	1846	1043	83	1132	403	870	475
##	[2,]	6	1306	747	1922	301	496	1044	838	1878	1133	1666
##	[3,]	1905	197	565	1964	1238	80	697	1023	421	748	516
##	[4,]	602	1145	774	559	521	1919	1269	164	1853	1782	1825
##	[5,]	1853	421	1901	347	1690	1114	1043	153	1680	416	98
##	[6,]	122	1893	1051	1851	1503	1746	1157	1792	1186	829	165
##	[7,]	26	1088	1306	1586	446	974	873	823	1835	1108	1079
##	[8,]	1817	329	1243	1657	521	1049	461	1199	1832	914	1388
##	[9,]	921	149	404	1312	1937	1659	619	141	205	693	349
##	[10,]	437	166	1612	417	1627	1391	58	1238	634	189	1289
##	[11,]	1708	511	1827	591	1045	424	1093	1810	1858	577	1295
##	[12,]	1157	689	607	865	659	1961	343	775	1810	60	461
##	[13,]	1184	1491	342	1624	334	782	221	1066	777	1544	1543
##	[14,]	955	1787	430	550	1432	131	10	1902	1839	881	1828
##	[15,]	927	1038	325	101	202	1741	1458	1532	303	356	793
##	[16,]	646	1758	475	1182	66	822	271	1030	419	1371	637
##	[17,]	1388	781	1098	523	481	529	1366	581	1453	961	1559
##	[18,]	518	702	1283	1790	1366	1859	510	1059	979	1798	759
##	[19,]	1906	1127	1628	780	310	1850	1274	483	1571	964	1451
##	[20,]	167	960	403	971	1003	310	77	1760	1683	1820	800
##	[21,]	436	209	81	686	820	1610	1407	1090	1503	708	1902
##	[22,]	1508	1492	1360	1937	1615	107	297	175	544	557	1238
##	[23,]	1036	1982	354	1083	288	303	81	415	1845	1015	727
##	[24,]	1338	1970	1119	824	1697	1243	1759	990	1659	502	1056
##	[25,]	1309	1525	1138	1839	1854	1458	737	600	880	1607	250
##	[26,]	914	1724	135	204	1692	17	1676	1248	577	1178	1038
##	[27,]	1456	736	265	365	719	1775	1386	753	1267	907	500
##	[28,]	454	1814	681	1591	408	249	581	1630	18	1919	1316
##	[29,]	129	1418	772	1578	1198	1221	1867	568	1338	289	368
##	[30,]	833	1230	1956	1799	488	407	194	477	772	1451	1122
##	[31,]	785	1899	1597	1273	544	748	1918	446	1859	803	1375
##	[32,]	1497	252	790	1814	288	1074	1106	1685	1746	564	1335
##	[33,]	935	1945	514	565	1484	284	547	944	747	272	535
##	[34,]	549	1921	519	1002	97	1320	996	1629	813	1444	1118
##	[35,]	1846	137	1629	974	1130	642	1458	1997	1828	1812	1707
##	[36,]	1690	319	1230	1471	1436	1524	343	822	255	212	989
##	[37,]	69	92	1394	1081	445	139	181	1942	44	333	1801
##	[38,]	1816	498	259	1941	766	35	356	1908	1738	767	1596
##	[39,]	546	886	266	1207	300	1658	541	161	144	152	231
##	[40,]	153	1972	1423	1666	1347	1133	727	93	1826	1143	1835
##	[41,]	716	1397	1583	767	903	530	1936	555	1203	1680	1258
##	[42,]	1	1891	1737	1574	1359	155	471	1175	30	574	1325
##	[43,]	1210	148	531	854	1562	388	254	298	66	937	26
##	[44,]	1700	1867	342	1112	1436	280	551	1455	1719	750	1553
##	[45,]	277	1586	1655	610	1374	1488	57	1343	191	1078	546
##	[46,]	707	724	848	248	1893	941	175	772	407	93	1448
##	[47,]	1012	1997	1825	791	417	1666	902	111	1421	1485	215
##	[48,]	1310	995	1407	637	701	1429	51	1338	1920	1252	1887
##	[49,]	846	1549	327	1739	1445	1921	1585	1393	1566	1166	558
##	[50,]	607	655	1464	298	654	1608	1730	1585	46	1135	1409
##	[51,]	1913	790	1704	1598	1913	609	38	1587	950	385	713
##	[52,]	1896	187	655	1203	1307	42	1344	416	23	918	251
##	[53,]	556	1491	928	1673	1289	1340	1441	428	904	748	1393

##	[54,]	1101	844	1665	308	626	358	1904	1175	1984	1782	913
##	[55,]	1889	1507	864	293	1361	1844	937	1013	758	542	430
##	[56,]	1428	950	557	1506	407	1032	1328	187	1507	1927	482
##	[57,]	1828	1239	1628	1529	1239	688	1074	1153	288	1480	366
##	[58,]	1277	315	224	483	662	1488	1984	987	102	1338	1946
##	[59,]	1945	550	1489	783	453	734	951	406	725	1004	557
##	[60,]	1514	1104	102	1594	1414	1105	1987	1117	631	556	1670
##	[61,]	385	175	267	1565	844	676	1927	1043	1836	823	470
##	[62,]	1462	905	1795	1938	163	1044	1917	1048	405	906	1238
##	[63,]	1299	665	1621	1932	1704	170	1327	1385	91	605	330
##	[64,]	274	495	1693	1261	1622	1310	913	409	1223	1837	1623
##	[65,]	504	810	624	379	1784	135	1429	1146	54	260	961
##	[66,]	890	1170	1794	3	19	429	803	17	1474	1022	1421
##	[67,]	1699	648	1937	737	908	975	1843	1193	1925	1669	19
##	[68,]	1450	802	1650	1906	126	1780	1387	1950	859	1257	1667
##	[69,]	1183	1221	42	620	1953	448	1995	994	101	1910	1129
##	[70,]	1820	758	1650	691	406	1450	622	530	1611	1912	1073
##	[71,]	159	1144	1633	430	1608	324	713	1617	1885	1545	180
##	[72,]	357	544	1816	28	468	835	1590	919	486	1155	27
##	[73,]	1085	249	80	832	1004	1479	135	1530	775	1199	561
##	[74,]	654	1726	31	868	1144	46	936	39	782	1668	1681
##	[75,]	1633	1537	165	998	461	1467	1435	152	173	1750	1313
##	[76,]	729	1253	1019	1342	327	221	193	1162	1154	753	1164
##	[77,]	1122	1345	1824	171	1083	251	743	1688	147	809	606
##	[78,]	131	1123	679	1195	782	1964	1318	510	92	1828	336
##	[79,]	1684	996	836	1490	1167	1158	941	1909	1822	1264	1409
##	[80,]	593	348	826	1259	1976	1663	1648	645	1259	922	1161
##	[81,]	553	888	1990	1152	567	1768	349	1912	730	1129	1289
##	[82,]	786	124	584	21	105	18	890	109	241	1281	1744
##	[83,]	1576	1629	494	39	1590	659	181	1566	495	640	1327
##	[84,]	1844	1257	1728	1671	678	1610	167	929	1211	984	1250
##	[85,]	658	1369	516	16	1671	829	639	164	1080	1901	1783
##	[86,]	969	17	1089	298	797	49	1346	212	1257	964	1402
##	[87,]	132	193	605	1836	1357	1027	773	381	1367	519	943
##	[88,]	1291	1922	384	1694	28	637	367	1032	1766	1349	658
##	[89,]	1825	1085	1853	257	1848	696	1371	670	367	704	903
##	[90,]	1677	1367	270	242	485	345	1091	1288	1300	383	265
##	[91,]	1041	1810	414	118	1034	1347	35	160	1960	1496	236
##	[92,]	312	1511	570	1396	323	44	665	1877	1	358	109
##	[93,]	1875	487	668	1932	1896	728	1435	1170	100	1578	1107
##	[94,]	768	1667	1330	1835	53	1865	1367	936	1904	1852	1008
##	[95,]	1233	1559	1387	1761	1044	394	36	1932	438	623	1569
##	[96,]	1415	147	534	952	1365	1471	1859	1418	928	569	261
##	[97,]	569	822	1683	1067	1726	1386	1863	771	1913	1409	672
##	[98,]	1454	37	270	15	289	373	634	564	891	1138	1551
##	[99,]	1381	1039	1241	845	1819	321	429	362	740	270	244
##	[100,]	1713	1309	107	1202	1660	1785	34	1550	97	117	780
##	[,46]	[,47]	[,48]	[,49]	[,50]	[,51]	[,52]	[,53]	[,54]	[,55]	[,56]	
##	[1,]	1974	1293	1565	1983	1635	643	197	670	38	89	1555
##	[2,]	1422	67	1309	1106	698	302	910	84	1123	247	1827
##	[3,]	1771	68	774	921	504	1103	1294	1323	1765	1811	704
##	[4,]	1437	1366	1111	804	1728	149	567	326	1528	233	335
##	[5,]	921	1113	1065	501	937	150	491	1595	274	1203	1731
##	[6,]	848	1250	76	1608	1846	764	660	3	821	1098	1140

##	[7,]	240	1474	1238	583	995	1472	1832	634	391	1201	386
##	[8,]	774	1167	408	1832	1411	1046	964	455	1447	711	190
##	[9,]	1466	1407	1581	106	917	752	1221	675	1817	857	1536
##	[10,]	544	693	771	15	1484	500	1589	800	432	11	1126
##	[11,]	179	896	868	1487	1433	1801	653	1665	394	65	1017
##	[12,]	1176	867	1494	471	887	920	1509	741	66	1707	852
##	[13,]	15	759	573	579	499	425	1908	1163	1057	1916	1050
##	[14,]	34	368	1504	711	907	281	1278	149	511	415	365
##	[15,]	1992	1810	1575	676	389	1329	1687	967	292	466	1245
##	[16,]	1617	1801	554	1693	1004	596	137	1261	1980	1654	58
##	[17,]	489	1037	1187	1676	1389	1556	471	1490	359	1224	1793
##	[18,]	659	1599	597	1494	1602	340	1437	163	164	855	389
##	[19,]	1670	1991	941	433	2000	1290	1682	1064	1372	263	255
##	[20,]	1510	1559	653	919	572	134	1078	1082	1551	1857	1644
##	[21,]	131	1790	1315	834	1409	1119	1154	1753	290	1677	488
##	[22,]	1687	1718	1431	1816	617	1825	179	843	290	1077	962
##	[23,]	976	1499	1465	339	892	98	1957	1936	1578	559	1394
##	[24,]	1178	1191	1503	1610	259	1524	287	155	1612	167	1815
##	[25,]	181	927	268	1262	861	1354	184	458	360	1459	409
##	[26,]	1977	1284	1222	365	1873	1711	832	1631	1490	811	283
##	[27,]	1735	645	1083	1111	1350	590	246	1579	1248	1468	908
##	[28,]	1270	642	923	700	631	1303	1626	394	691	1748	1246
##	[29,]	1909	1014	304	1177	1763	1014	1310	1956	364	1236	1355
##	[30,]	843	689	863	1963	1715	563	1466	1177	1918	1407	141
##	[31,]	642	1486	329	679	1006	1913	283	945	382	873	1318
##	[32,]	374	688	1592	1551	1744	543	1495	346	1992	848	403
##	[33,]	1536	1906	627	900	431	1297	1087	274	1753	1326	1171
##	[34,]	795	1537	964	1353	1296	449	317	1550	423	401	93
##	[35,]	1675	120	930	1948	647	1854	1955	588	251	1609	1424
##	[36,]	1554	1922	609	1476	1222	645	113	499	1779	1415	1698
##	[37,]	341	1585	165	83	986	732	1308	467	1878	1830	516
##	[38,]	177	96	47	661	28	223	1910	1439	832	1984	481
##	[39,]	714	460	175	1018	369	111	1784	1058	1173	1975	399
##	[40,]	428	1186	21	1070	569	804	1145	644	71	1705	1908
##	[41,]	70	711	1490	289	1366	952	699	834	885	1186	1493
##	[42,]	967	1991	535	613	439	178	1760	1758	1095	433	939
##	[43,]	475	47	860	1279	1364	1812	713	287	574	351	1899
##	[44,]	1972	384	1124	970	1788	921	1437	1661	1110	576	218
##	[45,]	1021	958	1469	1076	1905	457	533	703	1228	1825	540
##	[46,]	1151	155	692	1131	1537	1101	692	729	1697	608	833
##	[47,]	879	1298	1352	616	226	390	511	540	1682	1087	1986
##	[48,]	12	1983	1659	1016	1680	1734	476	218	609	1670	1508
##	[49,]	807	1403	1763	756	33	516	1175	350	1422	870	115
##	[50,]	699	1545	524	292	905	1133	1417	1775	1638	661	1467
##	[51,]	1082	1486	892	1095	1741	1013	482	658	785	1365	24
##	[52,]	1181	1215	1166	543	406	1828	197	976	567	139	769
##	[53,]	732	1339	719	566	820	1237	615	551	992	31	1948
##	[54,]	331	585	868	1005	1717	1610	1800	1399	338	658	581
##	[55,]	1704	619	155	1969	998	969	1003	1026	1081	1417	1386
##	[56,]	338	406	984	555	617	495	1337	1083	296	176	124
##	[57,]	1152	1774	1681	663	1453	1411	489	1109	1883	1337	1112
##	[58,]	1297	1760	1843	793	817	1828	1095	793	1134	1420	464
##	[59,]	1792	1586	1432	742	1495	170	910	168	820	14	748
##	[60,]	1827	594	1575	921	1094	1037	521	1677	1640	995	1250

##	[61,]	1986	1260	1590	189	1117	693	875	533	1694	1930	1902
##	[62,]	1101	618	1920	1998	1570	376	327	1022	450	126	1298
##	[63,]	143	1289	1488	1580	410	1651	1387	1657	1046	1851	1415
##	[64,]	38	1772	867	1951	1987	1330	1828	124	867	797	179
##	[65,]	129	517	1424	1583	303	1634	1314	1214	1939	1608	866
##	[66,]	726	916	1748	1884	1814	1575	266	991	1545	741	389
##	[67,]	1765	1875	47	1462	237	351	1148	1617	520	900	119
##	[68,]	511	948	1279	33	1062	1627	50	251	355	1754	421
##	[69,]	1714	1946	389	233	1608	858	689	926	1304	844	1196
##	[70,]	996	11	746	58	1827	259	1070	1510	658	1626	1793
##	[71,]	83	1603	363	1816	1383	286	1356	1092	1275	307	1028
##	[72,]	466	1685	538	919	1567	1767	685	1237	1378	127	917
##	[73,]	1813	121	1418	936	797	1330	843	210	1346	1393	157
##	[74,]	1466	1247	1407	569	1199	1087	1335	127	818	1975	373
##	[75,]	1812	1480	1451	571	1039	1979	1162	28	1481	1334	1693
##	[76,]	1382	1545	8	1914	1865	1329	1815	692	1428	274	1453
##	[77,]	918	1642	524	1618	638	1328	1755	422	1250	1695	102
##	[78,]	1313	1494	950	213	1540	316	1050	257	864	1843	1767
##	[79,]	315	1254	1605	1147	1154	821	1906	251	1736	1314	726
##	[80,]	762	514	1085	740	396	1132	285	1302	1424	259	45
##	[81,]	1845	96	1067	985	520	1579	419	1715	1513	1648	887
##	[82,]	395	207	1668	1295	736	1892	518	666	1562	1319	1632
##	[83,]	803	1797	1170	412	837	496	279	449	214	431	1601
##	[84,]	671	1672	110	825	1576	1216	826	937	499	1326	1021
##	[85,]	827	695	462	277	15	1584	85	1999	1142	1852	1336
##	[86,]	914	1797	1035	694	213	54	494	1625	1024	1529	1202
##	[87,]	1279	994	705	1606	125	1347	1999	353	142	30	343
##	[88,]	986	1182	1074	1834	1937	380	318	899	1674	324	1922
##	[89,]	1398	1903	1707	1085	609	984	1274	704	142	1351	1649
##	[90,]	1231	1948	727	1980	1299	605	814	1206	1901	479	168
##	[91,]	385	918	185	694	1038	1820	189	966	1593	217	1345
##	[92,]	1929	147	1907	554	824	1878	29	1047	1173	1365	244
##	[93,]	527	1116	1705	397	872	1502	902	1661	1433	910	809
##	[94,]	287	316	1010	411	210	1343	1378	1816	167	1083	1757
##	[95,]	1438	74	663	1342	614	1321	286	343	472	1537	612
##	[96,]	872	1613	1666	209	209	1678	399	486	90	1085	563
##	[97,]	1392	1573	960	1050	1228	1590	970	1468	1906	1840	1022
##	[98,]	849	1917	1309	1024	55	1309	842	603	876	305	1991
##	[99,]	496	1089	43	394	1946	893	1271	76	1516	1122	795
##	[100,]	1048	1287	353	293	526	1977	1827	217	1837	729	1597
##	[,57]	[,58]	[,59]	[,60]	[,61]	[,62]	[,63]	[,64]	[,65]	[,66]	[,67]	
##	[1,]	298	77	1558	37	457	1703	627	1533	725	383	951
##	[2,]	164	1698	317	415	1823	801	76	79	1289	1161	1034
##	[3,]	98	331	579	561	102	1308	1228	1310	1979	677	1617
##	[4,]	952	12	1949	229	162	646	238	1972	809	484	710
##	[5,]	493	244	988	1351	393	1363	62	927	1542	640	730
##	[6,]	19	1870	419	160	393	1008	1743	583	1520	514	1596
##	[7,]	1438	423	550	881	637	347	790	1181	928	1516	1393
##	[8,]	1158	399	521	714	1163	1790	1802	793	122	925	515
##	[9,]	1578	1541	451	756	1142	408	1166	443	1579	730	111
##	[10,]	754	993	352	1966	559	610	1121	1915	200	890	611
##	[11,]	412	303	684	1012	119	1591	595	933	1985	1794	925
##	[12,]	581	1964	1945	1821	1727	1382	953	565	201	1681	142
##	[13,]	518	395	1784	250	1699	846	1323	1621	1015	842	1089

##	[14,]	263	1949	62	1995	104	942	1397	205	350	653	1649
##	[15,]	737	1743	1643	442	1004	1544	1131	1035	143	561	826
##	[16,]	734	146	1929	259	1975	767	765	1618	91	1601	1329
##	[17,]	1481	224	1790	610	982	138	45	448	654	1387	1118
##	[18,]	829	1317	1447	685	1196	604	1090	1245	414	1296	123
##	[19,]	803	1424	1419	184	810	1032	215	1191	1437	884	697
##	[20,]	402	844	1761	928	1039	231	1982	1948	566	1141	81
##	[21,]	36	1223	1586	519	222	826	38	728	797	1799	43
##	[22,]	390	596	586	387	108	1114	1696	1852	1390	1465	1785
##	[23,]	1280	1871	1118	216	746	1785	1658	1602	668	318	1132
##	[24,]	1186	1636	936	1084	585	1259	1117	591	946	203	1604
##	[25,]	1733	1942	1748	791	262	274	1428	1849	715	339	239
##	[26,]	1769	1601	275	1232	990	1034	208	518	961	157	1291
##	[27,]	832	443	1581	1680	597	1561	547	944	347	1901	1162
##	[28,]	1740	1448	443	1034	1503	802	484	1623	1022	717	1533
##	[29,]	129	1881	1583	1906	1751	756	1548	1982	1975	1770	1512
##	[30,]	607	1750	508	1543	72	190	1306	754	1166	1639	1522
##	[31,]	376	1741	1444	514	1759	222	1731	857	1706	1432	1215
##	[32,]	776	222	1516	908	161	758	1953	1123	1797	1520	260
##	[33,]	1519	894	1324	951	1085	236	244	584	1413	372	629
##	[34,]	1447	1506	458	43	1653	128	1362	1102	737	1453	816
##	[35,]	322	1582	915	1560	581	150	1287	878	942	9	1148
##	[36,]	883	437	1327	397	1746	42	1021	1843	484	803	676
##	[37,]	1348	1637	1298	1375	690	259	1675	284	1140	1839	1683
##	[38,]	1573	349	831	1838	1422	1574	1040	1752	1148	1199	1680
##	[39,]	1000	455	1638	377	631	281	1974	830	474	1201	594
##	[40,]	50	1746	436	866	281	1179	1697	1384	1057	527	8
##	[41,]	356	536	155	1262	1391	442	205	557	1207	604	64
##	[42,]	1963	802	495	557	582	1888	1114	1594	899	1793	1484
##	[43,]	1823	1614	668	149	1813	433	1117	949	167	1127	115
##	[44,]	1763	1849	1358	370	1231	581	670	1241	1997	756	1888
##	[45,]	1701	191	635	655	1652	1149	364	361	1133	415	1985
##	[46,]	581	1139	505	779	1051	721	345	1219	1517	372	385
##	[47,]	94	917	319	1705	630	1200	1268	315	743	233	1025
##	[48,]	276	1775	682	1730	1673	347	1133	1691	1470	1015	845
##	[49,]	49	1234	822	1185	1750	90	698	1238	926	1527	1376
##	[50,]	1764	1040	1551	771	52	42	75	1698	451	320	1690
##	[51,]	1505	523	867	529	1465	1106	1659	831	1214	212	716
##	[52,]	695	1998	13	1780	847	1197	906	1036	1964	1070	711
##	[53,]	1224	926	1487	241	467	1311	35	1284	1873	1793	1931
##	[54,]	707	1228	1979	529	1780	1112	1078	1537	86	1412	1253
##	[55,]	1383	309	620	216	263	28	1147	1768	993	1136	534
##	[56,]	67	1320	665	964	1020	878	29	1400	1760	24	371
##	[57,]	1531	1486	874	1542	1677	1044	890	1368	24	1550	222
##	[58,]	1396	82	937	668	479	255	1703	360	1216	126	666
##	[59,]	161	873	240	474	910	877	1612	1401	795	614	234
##	[60,]	1631	1237	1169	1487	773	28	1018	1370	1377	1844	1468
##	[61,]	1800	1331	103	578	102	682	459	379	1469	249	49
##	[62,]	526	1699	1046	878	580	1520	1282	992	792	1755	334
##	[63,]	1190	935	1580	727	16	1937	1115	353	1851	1041	616
##	[64,]	668	1434	1198	808	1473	460	1346	1470	1682	253	916
##	[65,]	1963	1242	169	1530	1240	282	1027	1043	836	1613	1406
##	[66,]	1839	648	750	669	807	882	316	1144	990	918	802
##	[67,]	130	1190	597	1597	589	1552	404	1253	1054	1780	691

##	[68,]	1357	132	1281	791	1803	602	1717	289	819	1256	38
##	[69,]	465	619	1972	1663	14	793	601	1835	1626	631	1774
##	[70,]	363	294	1664	1476	1161	808	1094	328	1861	1935	1925
##	[71,]	1445	1303	1929	1475	1301	488	1974	656	1877	1205	599
##	[72,]	228	928	1576	470	291	1532	1800	645	1365	1154	1166
##	[73,]	494	1057	669	1225	219	1216	1552	1094	669	670	67
##	[74,]	513	479	1019	1980	26	1796	825	1253	1504	1828	1162
##	[75,]	1334	1111	330	527	896	1707	608	37	1769	259	1394
##	[76,]	1676	107	224	991	1921	1965	26	551	1344	1326	426
##	[77,]	1876	749	1206	558	1150	1060	457	1287	116	1615	1414
##	[78,]	978	706	860	1003	183	411	372	912	317	1394	350
##	[79,]	1973	201	97	1663	1901	1622	619	1395	348	1060	1447
##	[80,]	936	1229	1674	1597	1961	1127	1861	879	1605	343	49
##	[81,]	60	1440	1815	98	305	1452	22	1051	1751	102	1842
##	[82,]	958	406	899	1141	1790	364	16	282	1286	1861	291
##	[83,]	637	427	1220	1427	1426	313	627	215	462	293	1681
##	[84,]	1184	1441	1033	1888	176	1238	1838	1137	1373	77	255
##	[85,]	850	1293	717	84	759	1006	1552	304	1390	303	1601
##	[86,]	239	372	1445	273	1759	1030	713	1603	1512	815	1680
##	[87,]	536	1740	323	1151	1273	1215	715	1470	1179	287	50
##	[88,]	1415	123	1511	864	1750	1146	375	665	49	1799	446
##	[89,]	1472	508	1288	959	387	471	1657	25	1328	1556	1853
##	[90,]	1224	1277	16	1860	1001	1670	1213	675	110	742	1819
##	[91,]	1893	1764	776	952	1595	220	1420	1478	349	1554	685
##	[92,]	832	1481	1279	147	1180	1785	1757	1838	233	366	320
##	[93,]	1687	1897	23	991	1422	1558	861	1810	1567	1066	1637
##	[94,]	731	1558	1575	1065	1072	717	1634	187	1896	1762	1444
##	[95,]	1011	828	1345	1939	1313	1102	249	1828	1994	871	1856
##	[96,]	1450	1975	228	1424	1625	20	327	1330	1475	464	89
##	[97,]	1023	1593	684	757	1581	841	386	864	1406	1426	795
##	[98,]	573	1818	1193	181	1873	1893	1372	1795	61	1737	1143
##	[99,]	484	641	1075	45	1760	326	768	1201	619	1865	1449
##	[100,]	935	1188	512	1	549	1560	347	1463	628	1285	1412
##	[,68]	[,69]	[,70]	[,71]	[,72]	[,73]	[,74]	[,75]	[,76]	[,77]	[,78]	
##	[1,]	496	1895	415	1788	1921	1956	136	64	890	644	1447
##	[2,]	1521	895	1349	989	1362	715	1398	917	1675	1904	1447
##	[3,]	1118	712	1013	1806	1819	877	1917	1250	866	944	1091
##	[4,]	307	576	514	316	60	1624	1159	1154	1403	128	1005
##	[5,]	1422	164	1037	435	542	1463	942	783	537	1891	754
##	[6,]	98	727	1695	1153	1121	1287	1193	269	1452	1644	1185
##	[7,]	1336	827	1912	818	206	871	1741	70	1195	1608	171
##	[8,]	1195	742	1823	1247	1166	683	758	1650	545	1694	7
##	[9,]	1183	1891	364	1383	399	1287	472	682	644	1647	229
##	[10,]	1987	20	123	1141	785	44	1694	1043	519	1957	1725
##	[11,]	1527	1239	289	1636	387	790	1730	1818	186	847	854
##	[12,]	1618	1828	1647	3	1266	1859	378	477	1515	860	414
##	[13,]	666	777	1140	1889	708	1018	1749	515	1524	1481	931
##	[14,]	1152	255	163	1394	1496	379	1272	1297	437	523	918
##	[15,]	491	2000	1785	767	995	1632	520	1803	489	145	1082
##	[16,]	289	1540	648	1096	1532	1156	122	1063	720	1035	1674
##	[17,]	28	154	822	1467	845	1472	235	106	1477	1406	1424
##	[18,]	325	1155	745	602	980	883	1652	207	1628	713	1538
##	[19,]	1902	950	368	879	1235	1177	681	1623	1719	891	1056
##	[20,]	513	836	680	982	1300	139	1071	1994	1422	1230	139

##	[21,]	1561	83	1144	466	1646	1601	1353	233	480	429	751
##	[22,]	296	1128	171	1801	1629	91	1357	1055	1603	229	1000
##	[23,]	211	1174	197	818	1216	805	1932	421	1048	1977	1220
##	[24,]	1750	1547	1103	280	1595	1289	452	1278	1946	993	627
##	[25,]	1531	922	1372	420	603	1170	53	1180	1853	1248	373
##	[26,]	1508	278	1573	1838	615	582	1840	1869	1926	1019	376
##	[27,]	1752	1135	1676	949	156	1354	537	280	495	799	1088
##	[28,]	802	1473	1736	1695	287	1777	1154	1225	1516	399	734
##	[29,]	516	1195	1389	548	952	1724	1962	1913	1382	963	1890
##	[30,]	1011	396	743	227	1164	1537	1262	1149	1728	1240	1831
##	[31,]	1011	1082	1960	1519	1613	910	242	1246	9	325	591
##	[32,]	423	239	1427	824	1579	861	1054	1375	1726	1768	52
##	[33,]	90	633	36	1673	74	429	787	1996	203	1957	1286
##	[34,]	1281	1665	1238	1618	669	945	1454	1830	778	1213	239
##	[35,]	287	1513	49	1884	1107	1504	1284	1881	1256	347	425
##	[36,]	352	1579	141	346	380	1291	1320	266	26	1071	540
##	[37,]	890	286	1049	929	1002	831	1970	1913	348	1339	477
##	[38,]	1097	1294	166	260	1980	1833	1473	1181	496	1163	480
##	[39,]	1443	1944	1462	768	325	466	975	1087	1073	1213	1650
##	[40,]	509	1108	367	1165	196	924	1378	1229	921	550	1643
##	[41,]	1376	1961	1066	441	303	31	1657	1381	938	1484	1910
##	[42,]	1861	887	1719	1847	556	838	696	431	811	724	695
##	[43,]	1266	1435	467	100	856	1058	1823	67	1498	14	464
##	[44,]	759	1997	1624	619	1145	607	1376	694	1417	372	53
##	[45,]	1209	1736	1349	1419	356	43	1152	679	1196	1907	1247
##	[46,]	1129	237	1665	979	1132	1782	1661	547	1846	391	1000
##	[47,]	214	526	1000	990	1884	741	1050	1058	1416	1100	958
##	[48,]	483	1757	530	596	1496	927	150	1740	619	1953	1871
##	[49,]	137	1157	409	1388	1052	159	1007	386	99	1788	94
##	[50,]	92	229	657	352	329	1324	44	1099	339	1048	415
##	[51,]	1150	1303	1803	254	1116	705	1632	64	1553	868	1801
##	[52,]	750	1402	810	384	1680	617	911	974	800	520	169
##	[53,]	852	297	842	1757	1965	981	104	1715	1683	1670	525
##	[54,]	615	1379	185	1485	327	541	741	725	1275	1816	739
##	[55,]	888	1117	391	1416	1361	283	1393	1855	1714	111	134
##	[56,]	1541	380	402	757	742	1028	1561	976	1940	159	301
##	[57,]	280	1575	1734	560	25	323	1161	498	1269	794	886
##	[58,]	1998	1365	556	124	1008	54	485	183	1331	787	1386
##	[59,]	1417	359	1457	747	749	1594	951	1775	581	883	1381
##	[60,]	1570	573	1944	980	210	1107	904	627	874	942	1115
##	[61,]	1887	202	1967	224	1737	1069	899	1977	252	491	1316
##	[62,]	1730	1390	1276	36	1610	40	472	1307	835	1368	813
##	[63,]	1733	792	905	1260	1748	1697	1057	1203	1047	92	1914
##	[64,]	828	350	1302	261	423	248	586	432	403	1681	620
##	[65,]	1153	963	1184	466	817	1777	125	1303	1846	1524	1642
##	[66,]	202	1384	570	1473	1531	718	1878	301	283	1346	860
##	[67,]	887	1554	155	761	102	1473	1919	1078	555	1155	1830
##	[68,]	646	1465	1671	1836	1898	1492	593	462	167	1167	152
##	[69,]	1136	340	61	1355	427	1323	1539	264	961	912	642
##	[70,]	95	1345	1863	947	663	361	898	456	601	1096	775
##	[71,]	191	751	1296	1676	1350	385	1002	1392	1766	1224	390
##	[72,]	671	1519	1577	1940	137	931	1188	1820	1099	47	792
##	[73,]	1816	1106	1892	87	1587	1496	273	1281	1425	1275	1834
##	[74,]	969	1222	1968	1218	1073	189	1019	843	574	709	1179

##	[75,]	1769	1849	1155	1512	1810	20	1923	1172	1467	791	1074
##	[76,]	617	425	1913	477	1838	1372	719	1868	773	944	741
##	[77,]	1207	125	1012	115	1222	1429	721	144	565	430	1072
##	[78,]	823	1235	309	224	988	1879	1173	1250	1202	719	812
##	[79,]	942	209	1899	987	1257	1415	689	1306	556	1555	992
##	[80,]	1515	1522	168	1238	325	1541	1298	1478	264	59	98
##	[81,]	1986	146	493	1454	620	406	421	1755	372	1551	1959
##	[82,]	1958	569	1472	1969	129	584	1757	568	1902	392	1718
##	[83,]	1043	1355	175	829	732	1602	550	1232	1116	479	1177
##	[84,]	1237	61	1536	571	38	1495	1074	513	1895	338	413
##	[85,]	702	20	658	1738	321	403	950	1720	1468	1243	438
##	[86,]	1164	1314	1751	1934	144	1278	1207	1250	837	33	1970
##	[87,]	1595	86	1390	581	760	1892	544	1609	1626	407	956
##	[88,]	1226	511	172	468	1236	1330	592	881	276	1675	1588
##	[89,]	963	186	269	588	45	1229	667	959	875	1770	1173
##	[90,]	29	1236	1424	1006	1588	180	1139	1055	271	535	281
##	[91,]	1831	812	373	840	1658	267	1086	1913	1484	1080	1346
##	[92,]	1078	233	136	893	440	1914	145	1375	1610	1183	339
##	[93,]	1008	1555	1550	1183	151	57	56	1092	1341	1962	1170
##	[94,]	1561	592	1063	421	357	1835	1247	1966	244	1136	1328
##	[95,]	1069	247	1730	69	508	398	77	164	1448	699	1732
##	[96,]	1099	1219	552	517	1782	1603	1149	1562	1323	1682	117
##	[97,]	932	1671	1183	580	1031	73	947	1194	1648	1232	1398
##	[98,]	902	975	59	964	1963	624	590	1741	1597	695	1411
##	[99,]	1967	238	909	92	946	1164	1641	326	1813	1322	1146
##	[100,]	475	1889	1831	1268	898	1171	3	291	1754	1335	1307
##	[,79]	[,80]	[,81]	[,82]	[,83]	[,84]	[,85]	[,86]	[,87]	[,88]	[,89]	
##	[1,]	1704	974	762	836	1250	849	517	1917	62	515	228
##	[2,]	1881	173	1343	523	661	953	1774	1742	155	763	954
##	[3,]	1146	1072	1565	554	209	521	1954	419	726	1357	1312
##	[4,]	768	853	1089	1288	1583	1694	146	1721	1913	1853	108
##	[5,]	881	1762	1870	882	1322	374	461	1250	108	1524	605
##	[6,]	806	1943	1430	453	1392	809	505	407	703	538	424
##	[7,]	435	501	458	1693	903	390	1461	1708	96	1922	769
##	[8,]	615	1241	1253	1572	1313	344	421	1894	756	795	1636
##	[9,]	1613	496	1530	1576	1214	202	1247	228	1551	955	850
##	[10,]	358	348	1431	1928	66	1743	1046	193	1871	516	1269
##	[11,]	1542	992	1886	1824	366	1038	1463	1930	125	1534	1756
##	[12,]	1786	518	475	131	162	1597	608	532	154	666	1193
##	[13,]	1792	818	1358	997	586	29	903	1731	1262	889	1455
##	[14,]	760	898	122	1783	535	790	1400	252	903	500	1050
##	[15,]	473	161	955	1546	691	1802	1040	1918	951	1730	863
##	[16,]	1449	531	417	1120	372	988	234	1415	702	1855	1726
##	[17,]	1748	1096	1329	1322	774	822	320	1176	1296	39	969
##	[18,]	74	1668	1078	95	130	271	1095	1537	111	936	135
##	[19,]	35	1832	1940	613	872	855	1337	1680	1959	136	1129
##	[20,]	1853	1534	528	1034	941	1718	814	144	1984	837	255
##	[21,]	201	1960	1779	71	1033	392	936	249	114	1055	329
##	[22,]	829	471	50	851	1277	1892	1376	130	1887	1287	1259
##	[23,]	325	1389	1713	272	23	954	1825	1524	1968	1867	1739
##	[24,]	381	1532	978	1898	446	1584	1756	641	1366	705	1454
##	[25,]	1784	201	1873	1674	1179	806	1550	990	1112	1441	1454
##	[26,]	1114	1839	1927	279	756	1990	522	156	629	1694	1899
##	[27,]	1210	1909	261	783	1885	1740	519	1086	1352	905	711

##	[28,]	1840	397	226	1751	204	129	1125	759	1167	934	1199
##	[29,]	1488	468	935	302	755	762	512	542	868	1370	621
##	[30,]	1178	334	444	134	1554	630	315	679	759	499	1271
##	[31,]	622	424	726	1129	67	1597	454	724	1300	229	576
##	[32,]	601	231	1662	487	1467	529	1979	775	520	1525	751
##	[33,]	1601	1904	1264	551	1583	841	254	1785	428	1235	1486
##	[34,]	1582	1669	1273	1899	64	1664	181	1343	598	925	1557
##	[35,]	761	37	330	1452	537	186	434	1699	1701	537	16
##	[36,]	1407	1362	436	1486	294	1953	828	1408	1104	1666	1651
##	[37,]	787	703	1295	1324	340	1539	1942	616	998	527	1621
##	[38,]	1309	1598	1598	1757	1042	252	15	1942	1004	201	594
##	[39,]	354	64	282	711	1522	7	1627	811	690	1875	566
##	[40,]	639	734	1277	1360	199	817	1075	1439	810	1018	724
##	[41,]	1300	1094	468	377	996	1167	1831	1074	1665	1560	1906
##	[42,]	1874	284	885	80	139	1421	1298	671	215	1678	57
##	[43,]	654	1746	1822	1638	3	1564	108	1641	1695	577	376
##	[44,]	1521	1698	437	1643	867	1457	914	749	1855	453	323
##	[45,]	1618	482	573	535	848	1230	1820	1533	785	441	1207
##	[46,]	894	450	759	1707	527	185	978	643	418	1113	415
##	[47,]	1227	1751	174	1780	238	814	1030	37	211	1826	774
##	[48,]	1522	1199	48	697	743	389	284	1683	29	498	425
##	[49,]	291	1126	1119	377	388	464	1754	407	982	978	984
##	[50,]	734	574	60	1459	850	275	901	1943	286	65	1118
##	[51,]	579	641	623	910	202	1162	1936	1757	1467	1320	1072
##	[52,]	1489	729	1793	167	1529	1726	1331	1687	1104	1847	644
##	[53,]	1656	785	89	658	477	143	582	1925	1292	903	1420
##	[54,]	1373	1238	556	422	1801	1655	1850	1776	290	1545	48
##	[55,]	1210	1730	949	1950	1664	1259	673	678	531	1497	1835
##	[56,]	1786	1334	1936	1507	1296	128	461	1230	1121	747	1356
##	[57,]	78	521	987	1462	1021	272	294	679	1102	773	783
##	[58,]	856	422	688	1962	1539	1642	142	1565	969	1283	1474
##	[59,]	1105	538	1472	492	960	1567	513	1719	381	656	1374
##	[60,]	559	1919	68	463	74	580	438	1269	907	1039	1625
##	[61,]	1105	1376	425	1387	106	385	995	548	1900	669	1901
##	[62,]	400	331	1562	139	53	745	75	1179	573	1857	1912
##	[63,]	161	1470	1750	345	1285	1023	314	1806	634	1538	160
##	[64,]	1426	1931	1407	861	1323	46	249	989	1256	435	1053
##	[65,]	1661	861	626	917	190	1999	1398	1785	894	1717	214
##	[66,]	1213	1090	1183	607	1673	974	1956	1158	498	45	492
##	[67,]	1643	910	1977	173	1320	1004	764	1876	974	1315	740
##	[68,]	1770	1935	624	1248	513	977	1448	793	828	38	518
##	[69,]	966	288	1963	633	1817	1439	1861	1843	216	1730	1447
##	[70,]	864	924	1963	1376	103	361	735	211	670	674	1624
##	[71,]	1281	1667	1945	619	582	1441	1843	1782	176	1426	633
##	[72,]	436	831	552	1528	1585	1895	802	1295	1730	1256	786
##	[73,]	486	231	523	1760	926	614	1637	1908	833	1252	1308
##	[74,]	1735	14	1311	1213	1843	384	396	1256	1322	1837	556
##	[75,]	1032	1714	194	637	1929	1802	1528	1227	74	311	151
##	[76,]	773	947	700	303	1661	1652	1725	130	1284	1072	309
##	[77,]	1470	988	75	1384	612	904	1506	731	1937	1437	1790
##	[78,]	774	103	1557	64	1913	1196	1447	1378	1024	110	864
##	[79,]	1189	211	1355	835	105	936	1377	1041	1513	385	1456
##	[80,]	1150	1350	222	360	800	1895	672	871	1292	551	1140
##	[81,]	1485	1369	1242	1836	1378	1548	117	1962	323	1166	560

##	[82,]	998	333	1246	1241	565	271	1568	1825	1037	515	1766
##	[83,]	1236	56	119	188	1336	1322	1809	521	1069	143	464
##	[84,]	1960	1878	1485	1795	925	938	458	992	1232	849	49
##	[85,]	136	1719	648	1178	1651	1577	140	1265	813	1097	511
##	[86,]	299	1967	539	1640	216	1718	1959	1362	651	53	728
##	[87,]	1799	1896	873	1448	1853	788	1632	1499	1801	35	1289
##	[88,]	621	1879	1	1049	1640	353	692	648	936	1776	363
##	[89,]	1899	1247	1198	1088	1622	201	1793	1942	1322	1702	739
##	[90,]	154	890	1095	1773	114	1603	1384	135	217	899	593
##	[91,]	411	1059	1409	501	541	37	953	508	466	1838	1960
##	[92,]	1626	514	1256	112	146	241	1330	311	317	1459	376
##	[93,]	539	978	1318	1469	1753	494	1618	1550	734	1561	1884
##	[94,]	1268	50	1749	341	1917	61	1827	1376	1468	1009	367
##	[95,]	1323	1868	1775	589	1925	913	745	564	1457	997	472
##	[96,]	394	1893	312	1771	597	280	835	342	1755	873	578
##	[97,]	1668	1397	1147	1403	1268	357	352	1828	188	1591	1553
##	[98,]	1792	666	10	120	445	1956	954	759	1735	1228	524
##	[99,]	956	52	1081	1843	60	534	887	61	747	11	1830
##	[100,]	1749	1870	1835	1349	1898	88	1494	726	1464	1417	262
##	[,90]	[,91]	[,92]	[,93]	[,94]	[,95]	[,96]	[,97]	[,98]	[,99]	[,100]	
##	[1,]	486	1943	1705	794	961	1927	1920	1615	1311	1518	1422
##	[2,]	1058	1162	1129	1543	480	706	1596	1983	1414	375	1338
##	[3,]	20	1968	1691	943	980	547	1387	1960	864	322	1852
##	[4,]	493	975	201	391	428	416	58	470	215	555	1393
##	[5,]	1337	1764	645	1167	665	836	687	266	940	1934	652
##	[6,]	1592	538	536	91	1097	1572	939	836	593	111	970
##	[7,]	726	902	482	161	1397	28	769	983	1087	526	20
##	[8,]	979	1792	1351	1706	1481	408	170	75	668	1386	1257
##	[9,]	1385	1295	521	684	1451	791	212	1069	379	843	691
##	[10,]	325	1681	1905	662	1070	626	1590	1527	1523	1892	1391
##	[11,]	472	1626	1634	717	4	992	1103	1163	968	1277	1380
##	[12,]	1799	330	809	122	255	1682	989	1046	253	1493	1221
##	[13,]	1244	1092	267	1526	914	1398	1348	365	680	275	624
##	[14,]	1345	1188	1220	298	827	1444	248	743	1032	484	1700
##	[15,]	141	309	1525	1203	1537	1371	1976	1637	535	1353	1638
##	[16,]	1533	714	1875	109	1299	1203	1394	1326	312	1652	452
##	[17,]	1243	1906	1746	1447	1636	61	1526	1440	1444	769	928
##	[18,]	197	691	1824	1291	1193	330	244	1112	1029	230	1202
##	[19,]	719	511	1983	1773	1113	1569	1607	1439	636	234	905
##	[20,]	1983	204	1200	450	569	1134	1466	55	906	1645	1807
##	[21,]	1981	1302	1689	1125	1344	586	1442	1257	453	333	696
##	[22,]	570	1348	1518	1387	1612	684	1736	831	488	166	1042
##	[23,]	1043	834	1383	1327	847	1541	349	314	1476	861	399
##	[24,]	972	1907	1510	98	1281	1544	811	1373	209	235	387
##	[25,]	1888	1515	367	260	211	815	1988	998	562	895	237
##	[26,]	1632	1504	1684	1626	103	563	542	570	1558	612	1034
##	[27,]	1952	255	71	1091	1497	1035	1058	251	1797	1771	403
##	[28,]	599	1207	1600	620	1660	1297	150	1674	95	767	391
##	[29,]	1954	1122	1428	1399	1500	376	1918	1501	175	1449	830
##	[30,]	172	1869	1101	1546	222	1536	153	1067	388	187	545
##	[31,]	1603	182	33	999	489	1562	1313	992	529	901	1146
##	[32,]	402	1166	48	1752	355	598	897	411	383	606	210
##	[33,]	190	1458	1624	833	982	819	844	1282	1554	967	471
##	[34,]	47	747	1732	1382	1483	94	6	1127	1619	1009	1317

##	[35,]	49	788	1806	1250	192	125	1712	386	1901	482	134
##	[36,]	1578	1751	928	1271	1372	1864	172	900	1656	1282	1220
##	[37,]	50	974	176	596	468	1951	1497	1727	647	893	43
##	[38,]	730	1217	1626	524	1643	1753	1822	36	1402	969	769
##	[39,]	41	429	617	560	842	1469	1270	808	349	1015	601
##	[40,]	1695	72	1007	565	720	832	807	1652	724	567	1374
##	[41,]	1386	1978	513	1603	1805	911	729	107	1297	449	1229
##	[42,]	666	1431	1177	1953	515	839	324	1827	247	1382	272
##	[43,]	417	1382	505	1234	330	375	1584	429	3	116	1952
##	[44,]	535	451	367	180	387	1193	1334	775	426	1510	1891
##	[45,]	820	916	1722	1789	1878	926	1707	1575	127	1930	1968
##	[46,]	1434	1139	190	1887	670	841	963	502	93	1550	608
##	[47,]	1336	837	988	1524	799	295	158	1635	1355	1505	1299
##	[48,]	1880	1400	1349	532	1075	1486	1680	1107	1094	389	223
##	[49,]	1124	1103	930	245	32	22	824	969	1152	165	1684
##	[50,]	1560	247	734	770	1186	1533	1511	1890	111	275	1012
##	[51,]	1086	1341	1636	841	47	1457	1937	218	1032	411	519
##	[52,]	1171	58	789	1777	1752	1426	1566	1925	740	1878	984
##	[53,]	1062	758	719	863	1079	1767	1308	222	756	1972	1980
##	[54,]	1815	1025	620	1056	852	109	414	1831	763	1673	110
##	[55,]	1225	1354	215	347	1916	1827	395	401	904	641	130
##	[56,]	1467	162	746	122	222	31	644	474	1988	160	1317
##	[57,]	1761	1617	378	1525	264	1238	250	1687	348	517	763
##	[58,]	690	557	1542	513	1486	1249	1791	307	1475	1814	1481
##	[59,]	1942	1952	1821	101	49	1863	934	1441	1540	700	805
##	[60,]	72	1943	271	1067	1746	497	871	1881	684	656	1556
##	[61,]	930	187	1612	605	76	658	1411	609	1032	1452	503
##	[62,]	1902	502	1630	471	632	484	1200	1024	511	1226	1136
##	[63,]	838	564	862	1076	1698	246	1304	1344	149	1607	1450
##	[64,]	1481	1615	1810	1857	637	1056	685	674	879	112	1299
##	[65,]	991	1931	1823	673	155	321	112	1335	863	1037	28
##	[66,]	244	869	177	1618	162	498	1899	1109	830	234	1849
##	[67,]	448	222	1847	1173	968	343	1745	10	880	1067	1665
##	[68,]	308	1017	69	1988	926	79	1177	851	807	1152	880
##	[69,]	1493	992	1819	533	478	383	1368	1943	504	1031	674
##	[70,]	1736	1981	1902	1619	843	818	27	1493	141	1183	684
##	[71,]	1637	637	1154	1141	1285	762	78	1801	992	596	1835
##	[72,]	1178	1224	1029	48	298	1752	1633	456	1997	1524	524
##	[73,]	1653	528	516	818	1559	57	108	26	150	100	1610
##	[74,]	1562	928	1466	96	1382	889	524	115	156	297	554
##	[75,]	559	1520	534	211	1965	300	1931	445	1818	1706	104
##	[76,]	1246	1625	1620	843	1252	196	401	993	1022	1235	1235
##	[77,]	1754	1857	537	1114	1471	270	1057	1071	1187	25	930
##	[78,]	1229	794	270	1992	568	54	1460	720	278	1179	48
##	[79,]	935	693	336	934	1556	148	147	1557	1364	873	817
##	[80,]	609	808	142	951	1649	815	1336	1164	850	1209	1652
##	[81,]	1776	8	1290	1611	1177	579	1813	1811	593	818	977
##	[82,]	585	1916	149	1446	601	198	361	239	841	1024	25
##	[83,]	188	1503	164	1098	914	749	1254	1190	702	962	1586
##	[84,]	1904	274	661	1480	990	560	1879	965	266	1114	1979
##	[85,]	1930	1946	295	614	1016	1592	484	1291	1160	461	1404
##	[86,]	1193	739	1592	882	688	1146	1679	275	1872	1652	1776
##	[87,]	800	851	1154	1841	242	35	61	1103	952	1861	648
##	[88,]	116	1911	1547	1086	186	699	548	290	1463	1751	1536

```
## [89,] 1008 969 602 277 910 1505 1128 167 1293 1595 170
## [90,] 753 838 1148 1664 1562 985 1306 968 1436 29 998
## [91,] 454 1559 1027 891 157 755 1862 440 990 1414 575
## [92,] 1280 387 1939 479 1126 271 585 1668 1106 1781 1525
## [93,] 381 8 640 968 1731 1679 1417 966 355 1749 1219
## [94,] 1399 473 1099 91 1149 1859 1139 1740 68 206 265
## [95,] 907 1801 1701 295 1873 651 64 1962 562 1892 844
## [96,] 1828 1296 589 650 1987 1497 157 1375 1198 1731 697
## [97,] 1128 851 304 729 4 8 1781 1192 625 1371 718
## [98,] 1611 1075 188 712 1503 83 379 1771 1840 479 746
## [99,] 746 1166 1073 974 427 1738 476 1994 1499 1096 1119
## [100,] 466 1678 126 351 1071 957 1129 958 953 228 1571
```

- 3) Now we'll use each re-sampled dataset to provide a new estimate of $\hat{\beta}_1$. Write a line of code that uses **resample1** above to produce a resamples dataset of (**price**, **carat**) pairs. Using the re-sampled dataset, use **lm()** to produce new estimates of $\hat{\beta}_0$ and $\hat{\beta}_1$. These values should be stored in a vector called **resample1_ests**.

You'll want to type your response to question B(3) here. Your response should look like:

```
resample1_ests <- lm(diamonds$price~diamonds$carat,diamonds[resample1,])
coefficients(resample1_ests)
```

```
## (Intercept) diamonds$carat
## -2204.243 7624.315
```

Hint: (a) Note that the following code produces the re-sampled dataset from the re-sampled values:

```
# resampled_data <- diamonds[resample1, ]
# Remove the comment symbol in front of the above after resample1 is assigned in B(2)
```

Hint: (b) You'll probably want to use the **coefficients()** function.

- 4) Repeat the above call for each re-sampled dataset produced from the **resampled_values** matrix. We'll store the new coefficient estimates in a matrix **resampled_ests** with **B** rows and **2** columns. Again you'll want to write a loop, this time that iterates over the rows of **resampled_values**. (Note that if you are very clever this could be done using **apply()**.) Make sure to print **head(resampled_ests)** at the end.

You'll want to type your response to question B(4) here. Your response should look like:

```
resampled_ests <- matrix(NA, nrow = B, ncol = 2)
names(resampled_ests) <- c("Intercept_Est", "Slope_Est")
for (b in 1:B) {
  resampled_ests[b,] <- coefficients(lm(price~carat,diamonds[resampled_values[b,],]))
}
head(resampled_ests)
```

```
##      [,1]      [,2]
## [1,] -2071.804 7429.441
## [2,] -2350.208 7892.800
## [3,] -2050.613 7372.194
## [4,] -2210.127 7622.836
## [5,] -2258.332 7673.258
## [6,] -2301.808 7806.000
```

Hint: You may want to use multiple lines of code within the for loop. One idea is to first use the rows

corresponding to re-sample **b** provided in **resampled_values** to create a resampled dataset. Then use the new dataset to provide new estimates of the coefficients.

- 5) Recall from lecture that $(\hat{\beta}_1^{(b)})_{b=1}^B - \hat{\beta}_1$ approximates the sampling distribution of $\hat{\beta}_1 - \beta_1$ where β_1 is the population parameter, $\hat{\beta}_1$ is the estimate from our original dataset, and $(\hat{\beta}_1^{(b)})_{b=1}^B$ are the B bootstrap estimates.

Make a vector **diff_estimates** that holds the differences between the original estimate of $\hat{\beta}_1$ from **lm0** and the bootstrap estimates. It should have length **B**.

```
diff_estimates <- c(lm0$coefficients[["diamonds$carat"]]- resampled_estimates[,2])
diff_estimates
```

```
##      [1] 194.8730610 -268.4857837 252.1205764 1.4786994 -48.9437828
##      [6] -181.6859711 -70.4441727 115.7711419 -176.4200195 2.2884928
##     [11] 36.4840088 106.7193575 -47.8264675 51.4087012 73.2444122
##     [16] 180.3110503 -100.2320341 -225.5247929 234.2867468 -34.6217704
##     [21] 233.0195187 -139.5153664 -7.5138849 -90.5352054 45.4652301
##     [26] -120.1675516 -16.7434769 -197.4399927 -239.1176386 -223.0990173
##     [31] 179.4635773 -234.5371822 -175.7875530 -54.5005069 -71.7821125
##     [36] 21.5686187 -94.3450522 99.5557742 145.8093480 36.4851290
##     [41] 184.9161994 102.5890125 -185.0191698 264.4998806 -35.4818590
##     [46] 63.0447444 66.6209196 141.6216517 -100.2592044 154.0870642
##     [51] 19.4127137 -170.3880980 6.7386507 -69.2549030 -101.7987254
##     [56] 113.5148096 83.3264082 220.4186362 120.0821667 -167.6082628
##     [61] 167.2404563 12.9108133 -166.8217280 125.7366415 -330.9328929
##     [66] 7.4905134 39.7011610 33.1251131 -2.9745607 72.9882885
##     [71] -77.6972565 -100.6694726 108.9089733 -16.7405410 36.5883763
##     [76] 214.2534967 -4.0875930 90.0550144 -4.8348342 -45.9963797
##     [81] -346.3837493 -99.7946848 15.9788049 -143.9145774 22.1496536
##     [86] 21.5809732 121.9898842 -38.5673588 -52.0821102 -57.6616361
##     [91] -82.8899107 -2.7906356 296.2186162 48.0152248 22.9895385
##     [96] 147.1183511 -19.3114508 -12.5105227 -57.5562166 121.6517381
##    [101] 3.7427990 53.3863430 -23.5750292 126.6055703 -92.3101881
##    [106] 71.7976487 48.8962189 125.8296889 -132.7264624 -163.7944958
##    [111] -234.1147170 143.7057411 46.6220592 -119.6610389 254.9840611
##    [116] -272.2124729 -131.9976389 -66.2855787 112.5669137 -49.7495871
##    [121] 4.5558230 -18.1391602 -12.6064840 64.8602236 191.4323845
##    [126] 2.6926350 54.4291107 66.4999650 -117.5594090 -97.3426690
##    [131] 17.6520326 -83.0243623 -22.0344400 133.9906052 -62.0427488
##    [136] -109.0666548 -205.5823710 -53.0738272 69.5940191 156.9047283
##    [141] 205.7914299 4.5038937 -254.7881679 149.8081186 -95.2153455
##    [146] 69.2654778 -34.1153017 47.8722931 64.2460456 -186.8559504
##    [151] -139.2090116 -183.5951540 -170.9398913 60.6471308 -65.1593442
##    [156] -182.0924192 -211.8411780 109.4982780 67.4849140 11.5120123
##    [161] -5.7780143 -163.9403898 230.9575083 -26.0445757 -275.4134477
##    [166] -291.2668669 122.0173886 -141.0059750 284.6615517 22.6319701
##    [171] -78.0798917 27.1773428 -25.0559565 96.6011202 -204.3264970
##    [176] 92.0640790 -221.0798186 45.8030668 -175.2643618 144.3417112
##    [181] 166.0500634 137.7203774 -83.1448756 167.6172915 -133.3043405
##    [186] 44.8783530 136.3259222 57.7797376 -79.0189225 218.0198224
##    [191] -216.7163000 28.0502600 -44.8564416 -284.3869629 -269.6143908
##    [196] -96.8726119 -76.2077616 -19.3381861 -203.8603741 188.8126855
##    [201] 38.5955475 198.5147646 -106.5505201 -7.7252726 30.6240266
##    [206] -200.8171915 -84.5454888 19.2854218 61.3250032 78.8398048
```

##	[211]	-171.0106639	313.4914378	184.0277216	-144.2073173	7.1045626
##	[216]	-113.6789650	58.0903963	273.7207856	10.7183985	-118.3318689
##	[221]	-130.9400651	33.2928879	-173.8108163	3.5733492	-50.7648257
##	[226]	-304.5895470	201.2089420	169.6268290	-77.5231168	-112.8848641
##	[231]	-105.7535957	-109.2740498	-27.3255357	7.0672965	78.3490132
##	[236]	-2.3976207	-121.4409219	-246.2571483	-11.6212259	168.5005565
##	[241]	-233.3876889	-18.3945951	-290.1541652	-188.5161248	-18.4041034
##	[246]	-15.5073713	48.1232200	266.1088832	163.3934656	-35.2579137
##	[251]	134.9485489	31.2956622	-91.9496137	-199.9220190	78.0347650
##	[256]	-209.7113942	340.5531686	-14.9364958	-53.2085143	50.0201454
##	[261]	36.3886806	177.6013231	-231.8116506	-13.5012463	-108.9288760
##	[266]	-104.7089956	55.0358026	63.0633615	-174.0011222	-35.3824896
##	[271]	-106.8060917	-62.3177141	-255.1873212	-126.7352728	-10.7177025
##	[276]	95.2734354	-51.3373405	65.9517164	116.4703891	-6.9719981
##	[281]	59.5500674	-6.7601247	95.7529539	-26.3153777	-127.5685758
##	[286]	92.9719800	267.9028259	130.9932483	-124.5287187	-18.0052897
##	[291]	147.0372045	-135.1849891	-49.8316378	-182.1913459	66.6757908
##	[296]	232.7119312	-106.0841196	-9.7543097	154.7147015	-59.4023182
##	[301]	-1.7504995	-31.5684567	-126.7133126	143.1819694	339.1140346
##	[306]	-136.2426550	-24.6599350	-48.2902966	-144.5462922	107.4721964
##	[311]	130.2163775	9.4941797	330.9833440	-120.1241953	12.3366925
##	[316]	276.8760316	-2.4145271	-279.5122136	-234.5159282	231.7528833
##	[321]	-230.1471964	221.1464045	217.0551444	144.4706380	107.3049346
##	[326]	-85.6950648	-9.4458946	142.2564718	195.2399869	-175.4346668
##	[331]	67.3821712	59.6604093	-47.1522353	31.9439749	-169.8740505
##	[336]	97.6248950	18.4842745	-244.5093303	-42.8307324	-283.7301579
##	[341]	-269.4724154	-248.9849309	65.5502660	-184.0337518	122.2655627
##	[346]	-34.7474867	13.6074073	-197.6004071	21.4532518	-56.0052469
##	[351]	144.7779282	-173.1525986	248.9771859	-78.9502558	-35.1687729
##	[356]	53.5683644	-154.8767783	-182.7645100	-180.3625806	108.4190827
##	[361]	77.4144780	39.7441980	-52.6194656	-115.2014584	-97.7076297
##	[366]	139.6832542	-129.9925845	43.1105437	80.9044831	-78.6469929
##	[371]	313.9080995	25.6685877	-210.4037628	-218.4595590	183.0337980
##	[376]	-41.8248375	-31.1440943	406.3539547	133.0974866	-181.4961949
##	[381]	-23.7404444	-81.2388542	-38.3092823	-73.4184919	-52.4956608
##	[386]	-192.8216999	-148.4876349	7.5127088	-75.3374023	-201.5874735
##	[391]	45.5802272	-260.9421830	-75.9342229	199.1487421	-16.8587080
##	[396]	-228.2627023	230.2944012	-131.9628013	-274.9715508	-145.6454586
##	[401]	90.3837598	113.7949615	118.1645926	-214.5819321	-302.3901710
##	[406]	149.7293654	216.2263332	-26.7731797	-253.5490989	-45.4252432
##	[411]	-157.1799217	-40.1314312	172.7376720	-64.0888055	-342.4500751
##	[416]	83.6074657	-161.2693057	-202.5551224	11.7968783	195.6566615
##	[421]	121.3569650	242.2694500	-3.6224363	-97.2313941	24.5290391
##	[426]	134.6426539	-69.7243701	188.5996179	32.7557264	-263.1883495
##	[431]	-22.4313684	-176.3828158	-119.2748455	-63.6624297	-16.1494832
##	[436]	30.9941431	284.9544665	-70.9180319	-157.4334310	259.4613618
##	[441]	-33.9799710	-41.4212661	-53.7689917	-193.4915694	29.7614765
##	[446]	353.6604578	25.3485543	-59.1425672	-321.1155672	245.3900819
##	[451]	-173.3672519	-295.4027897	-190.1865825	146.3051869	-53.6844996
##	[456]	-67.1195084	-16.2555290	-39.1952618	31.6542834	-83.7477898
##	[461]	59.1334961	62.4524090	-43.5250619	-150.1859206	58.3711927
##	[466]	165.4302574	225.8655285	-246.2783679	167.6845688	91.7478282
##	[471]	97.4449639	14.5849221	-54.6265254	281.2056526	20.8189720
##	[476]	30.1206072	-50.4325237	86.6463645	7.3609167	-317.8302800

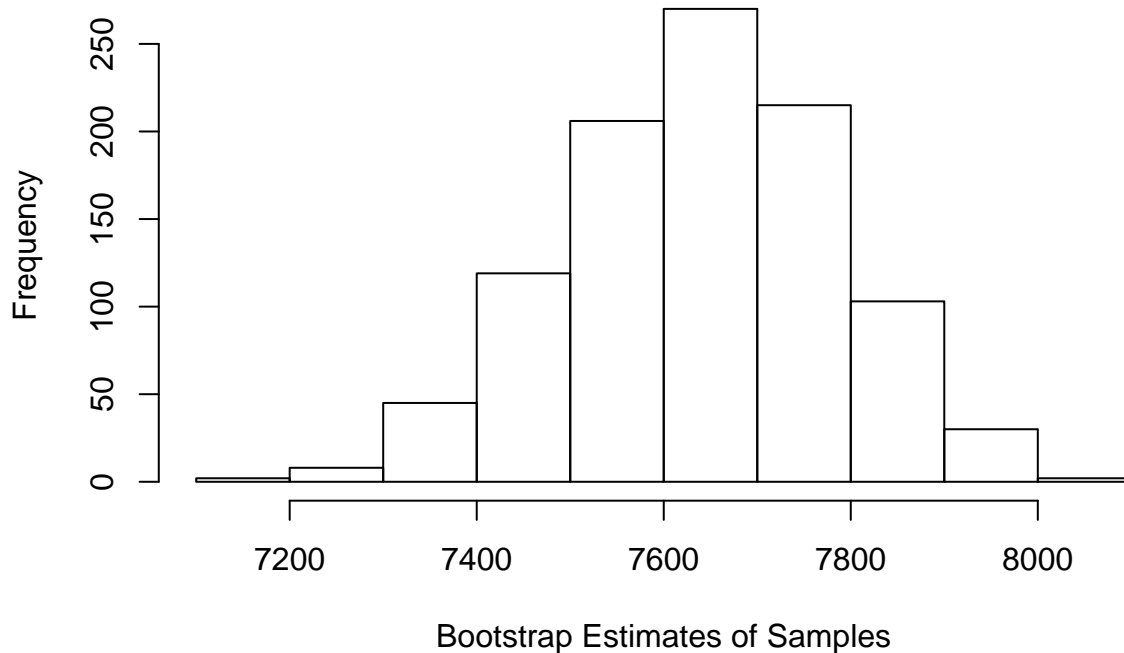
##	[481]	-56.5849013	94.3110050	-202.7144587	-88.4035212	319.1883715
##	[486]	-162.4682224	-109.0077355	-169.0965615	-174.0277792	-95.9387670
##	[491]	-82.2412661	217.2161601	163.3092058	214.3933087	-57.0359999
##	[496]	-105.2401940	-58.1813517	-266.7177157	-122.5114611	45.4512290
##	[501]	-239.0133525	330.7027216	-49.5490843	-112.2756991	53.5667390
##	[506]	-158.8152259	3.1175676	-21.9936902	-77.6668314	24.6524593
##	[511]	-170.4519127	-175.2594193	113.5997427	-31.6270357	293.1573440
##	[516]	-71.8973278	-36.5124145	-159.5017497	-280.3494677	-117.8953110
##	[521]	112.6859424	-38.0738259	75.8553383	-282.7043621	471.5924077
##	[526]	-45.5045048	-220.9579892	-152.6729786	-47.5947686	-184.4304627
##	[531]	124.9882343	51.5248467	-18.5837138	-54.1204993	25.4060663
##	[536]	-62.0562010	-64.2036916	171.8008778	-19.2897265	91.8069341
##	[541]	-137.1731311	-149.6915937	-92.1211035	-74.3579580	-154.1673299
##	[546]	-106.6797281	147.0227261	82.2455732	10.4805173	-99.9717589
##	[551]	75.1738685	323.7734449	-63.8177521	-131.6846531	-286.3386373
##	[556]	72.8666575	-4.3651859	-109.9544671	-226.1311750	62.0998087
##	[561]	208.7307493	72.3473163	-86.7753598	172.5219483	42.1135573
##	[566]	-141.4486992	-100.2976442	-55.2281974	-149.8267887	-65.1351048
##	[571]	134.4154158	-32.4272805	82.4189196	134.3418696	-75.9477757
##	[576]	155.8725868	-99.3797106	196.0417213	64.1957105	-113.3898537
##	[581]	232.1408102	183.8101327	-117.5428086	-222.8884542	-17.2182203
##	[586]	165.2271805	-1.3927600	-224.5176601	-108.1408348	-177.5350097
##	[591]	-301.6402638	-120.1159738	99.2914771	38.6162083	161.3995511
##	[596]	-82.8525279	7.3810311	-158.2670754	-303.4000661	38.6965479
##	[601]	170.2430092	-43.0977083	26.9886264	9.4956852	-137.4155396
##	[606]	65.1415727	-68.1225059	-186.5075375	-95.4712031	293.2514678
##	[611]	166.3486225	-135.2640114	-161.3040372	-46.6154005	-205.5575156
##	[616]	-64.5912824	-180.0702717	0.2835776	-156.7609726	34.1713817
##	[621]	-203.8114620	184.6288018	-26.4992091	-32.7692788	60.1833022
##	[626]	-5.7559435	84.3793922	103.2914734	340.6322682	-108.1331157
##	[631]	214.4341924	-10.2667191	-22.9347444	193.6961494	-206.5564688
##	[636]	292.1919820	31.8408884	-248.2666804	-24.3484942	223.5727049
##	[641]	-0.7917024	-26.5188558	99.6778279	-126.0628739	-62.9079496
##	[646]	189.6164003	-114.8753439	-180.3421356	191.3442280	58.0282248
##	[651]	113.0697604	-283.5417540	31.2946800	-176.3641250	-39.5016343
##	[656]	-85.2774556	-34.3327322	1.4992910	-24.4363485	-188.6477519
##	[661]	41.0948869	-253.2526951	-114.3359186	126.3307788	-62.5583798
##	[666]	-21.6698372	-89.7129426	-137.7637071	-36.4152927	17.9384960
##	[671]	23.6890245	13.9327526	-33.2438959	31.4015171	-90.6808494
##	[676]	-39.7795623	101.6669479	94.7642450	33.2464999	-75.7181319
##	[681]	26.4862106	-147.3190391	275.6985920	-126.9479041	-79.1738039
##	[686]	132.8623843	270.8213447	-70.3110077	-184.3251785	-150.4508145
##	[691]	-146.1366544	-35.1250916	-130.8486406	-117.9235960	-20.5122009
##	[696]	127.6290054	164.2484928	-120.4796256	21.7657165	159.3165491
##	[701]	97.2564933	87.0942557	16.0196956	-90.7681264	-77.9387664
##	[706]	112.2024406	-92.5445658	-56.4167546	-22.9827073	-54.1560237
##	[711]	23.0321966	20.2569437	302.7086749	81.1131363	-30.8785197
##	[716]	-51.5339576	-228.3334010	267.2180205	292.1846563	-38.9435376
##	[721]	-22.9463038	-151.9415818	-17.1460722	119.2236153	27.4264256
##	[726]	201.0924255	-227.3139747	-204.6860123	-50.3219899	241.7572852
##	[731]	-67.4826395	34.8188028	85.0348737	287.4462596	-284.1326712
##	[736]	212.7901469	-32.6104237	-113.7404642	-146.6151809	-63.6196977
##	[741]	-318.9322399	-101.2680410	168.3407237	-192.7075548	-159.3228194
##	[746]	-134.6796755	-3.3283835	20.3984832	-94.3155184	-112.2877556

```
## [751] -104.0010808 166.8452268 -190.1267099 -334.8071570 -124.6409965
## [756] 33.0455294 -75.0884616 137.9730931 -314.9640021 -94.2694792
## [761] 76.0392424 -169.4031715 -60.7190937 52.9704970 78.7159542
## [766] -275.7193746 290.0796658 73.3520280 -103.7608282 -182.2237219
## [771] -30.1176569 -151.8235244 -139.8515700 -37.4646250 -35.9811735
## [776] -269.0629425 41.2206684 -141.3506223 20.0756032 64.3786347
## [781] -151.9731302 18.8903084 89.4263648 -6.7611402 46.4750862
## [786] 149.7001901 66.6500103 170.3314848 -279.1569165 -45.9949601
## [791] -98.6888826 -111.5270083 -65.5204585 -112.5243604 -180.4752800
## [796] -169.0538626 99.4870278 103.5916743 75.1478914 281.8590807
## [801] 268.6917974 119.0184676 -282.0282316 163.8721979 -132.1684918
## [806] -116.6454005 -109.3993912 79.7329619 -86.4270199 -72.1620910
## [811] -16.1465236 169.9595805 -239.8725375 206.3231759 12.6827623
## [816] 248.0909789 -33.9163624 -173.4004815 -48.1763743 -68.5654757
## [821] 43.3600144 -223.8675783 147.4463287 135.6628320 -14.8219605
## [826] -156.1968301 -77.2570706 139.5440190 20.1265635 40.2874481
## [831] -338.0649396 -133.6425058 2.1161825 -6.1768750 115.0698404
## [836] -263.4198175 1.9297944 120.9116011 -18.4797331 -17.6626886
## [841] 196.0219581 -303.5755258 -33.8573237 -42.7166062 -219.0285064
## [846] 31.8663933 125.3807761 -395.3234684 -216.9279126 195.7041765
## [851] 57.5155852 -190.2062171 -114.4899982 -187.1056801 -37.9838223
## [856] -27.6198031 -202.5990663 162.2057560 -18.8929377 -141.5351160
## [861] 57.3928186 -389.0342259 -222.5583979 -301.3696828 -150.0928373
## [866] -107.9333721 149.5917527 -59.0758041 -82.9934717 142.5101973
## [871] 18.2984806 257.6620685 113.2630455 -174.3125529 -247.9048750
## [876] -159.6786805 -165.3274432 -77.9012571 79.0019792 163.5484973
## [881] 119.6426803 -219.9511101 118.6519828 50.0377489 460.6648133
## [886] 32.1528075 -67.5562462 29.0799934 85.1001490 -56.9042455
## [891] -76.0378837 166.6273237 -139.6377619 21.2826667 104.1640797
## [896] -119.6593669 -33.1351653 36.0667110 59.3385476 94.4119501
## [901] 96.9587537 90.1639058 145.2990945 43.6686345 -121.5183662
## [906] 151.2941003 1.1826234 -109.1617172 24.1802121 150.2492491
## [911] 9.4810770 9.0926690 50.6082563 -39.4738628 -43.6441208
## [916] 108.1966080 -67.5683022 -81.9530931 -62.3825745 -173.0288953
## [921] 59.3651980 2.5715397 85.2420825 87.5286065 -116.2447637
## [926] 163.5116050 -139.8620682 -220.9773545 -179.5656810 -65.4647713
## [931] 133.1279911 36.3492528 164.1578367 -145.8396886 91.6666655
## [936] -145.4649249 48.5043987 155.7646219 -87.7790615 -19.3715200
## [941] -57.0947923 -130.4499152 -63.9562045 86.2465959 -6.3861511
## [946] -33.8434287 80.4072325 -193.0493825 73.2668493 82.6508652
## [951] -123.0810273 90.3765439 -191.6201263 -118.6385762 -27.3355647
## [956] 79.4322843 -88.7821368 67.6336303 -121.4336820 37.6284514
## [961] 245.6947093 -47.1539233 -211.9230207 245.6945909 -33.3145819
## [966] -9.3312304 -120.4391041 -111.3748673 69.8840592 -172.1629258
## [971] 27.1941340 22.4388494 240.5862246 118.3969786 36.3405649
## [976] 209.9678397 -41.3743241 166.7267182 -163.6682064 -39.1291530
## [981] -218.6736735 -316.3918738 -94.3106076 -32.2938294 -5.0538800
## [986] 79.9062999 -89.7654518 -115.0946851 184.7399558 -166.7249657
## [991] 342.0404385 -83.8680214 124.4323110 -44.3078557 -37.6072905
## [996] -74.3598535 -86.3500648 -168.8338585 41.4026605 -144.9075995
```

- 6) Plot a histogram of the bootstrap estimates of $\hat{\beta}_1$ (they're in the 'Slope_Est' column). Label the x-axis appropriately.

```
hist(resampled_estimates[,2], xlab = "Bootstrap Estimates of Samples")
```

Histogram of resampled_estimates[, 2]



7) Calculate the standard deviation of the bootstrap estimates.

```
sd(resampled_estimates[,2])
```

```
## [1] 143.9599
```

Part (C): Bootstrap Confidence Intervals

Note: This section is optional. If you get the chance to do it during lab, great, but it's not necessary that this part is completed when you turn in the lab.

Finally we'd like to approximate confidence intervals for the regression coefficients. Recall that a confidence interval is a random interval which contains the truth with high probability (the confidence level). If the confidence interval for β_1 is C , and the confidence level is $1 - \alpha$, then we want

$$Pr(\beta_1 \in C) = 1 - \alpha$$

no matter what the true value of β_1 .

We estimate the confidence interval from the bootstrap estimates by finding a range of $(\hat{\beta}_1^{(b)})_{b=1}^B - \hat{\beta}_1$ which holds $1 - \alpha$ percent of the values. In our case, let $\alpha = 0.05$, so we estimate a confidence interval with level 0.95.

- (1) Let **Cu** and **Cl** be the upper and lower limits of the confidence interval. Use the **quantile()** function to find the 0.025 and 0.975 quantiles of the vector **diff_estimates** calculated in B(5). Then **Cu** is the sum of the original estimate of $\hat{\beta}_1$ from **lm0** with the upper quantile and **Cl** is the sum of the original estimate of $\hat{\beta}_1$ from **lm0** with the lower quantile.


```
# You'll want to type your response to question C(1) here. Your response should look like:  
# Cl <-  
# Cu <-  
# int <- c(Cl, Cu)  
# int
```

- (2) Instead of traditional bootstrap intervals, construct **percentile** based bootstrap intervals. Use the **quantile()** function to find the 0.025 and 0.975 quantiles of the vector **resampled_ests[, "Slope_Est"]** calculated in B(4).