

hw6

Tinglei Wu

3/29/2022

```
library('ElemStatLearn')
library('randomForest')
```

```
## Warning: package 'randomForest' was built under R version 4.1.2
```

```
## randomForest 4.7-1
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
library('caret')
```

```
## Loading required package: ggplot2
```

```
##
```

```
## Attaching package: 'ggplot2'
```

```
## The following object is masked from 'package:randomForest':
```

```
##
```

```
##     margin
```

```
## Loading required package: lattice
```

Q1 and Q2:

```
vowel.train
```

```
##      y    x.1    x.2    x.3    x.4    x.5    x.6    x.7    x.8    x.9    x.10
## 1  1 -3.639  0.418 -0.670  1.779 -0.168  1.627 -0.388  0.529 -0.874 -0.814
## 2  2 -3.327  0.496 -0.694  1.365 -0.265  1.933 -0.363  0.510 -0.621 -0.488
## 3  3 -2.120  0.894 -1.576  0.147 -0.707  1.559 -0.579  0.676 -0.809 -0.049
## 4  4 -2.287  1.809 -1.498  1.012 -1.053  1.060 -0.567  0.235 -0.091 -0.795
## 5  5 -2.598  1.938 -0.846  1.062 -1.633  0.764  0.394 -0.150  0.277 -0.396
## 6  6 -2.852  1.914 -0.755  0.825 -1.588  0.855  0.217 -0.246  0.238 -0.365
## 7  7 -3.482  2.524 -0.433  1.048 -1.995  0.902  0.322  0.450  0.377 -0.366
## 8  8 -3.941  2.305  0.124  1.771 -1.815  0.593 -0.435  0.992  0.575 -0.301
## 9  9 -3.860  2.116 -0.939  0.688 -0.675  1.679 -0.512  0.928 -0.167 -0.434
```

## 10	10	-3.648	1.812	-1.378	1.578	0.065	1.577	-0.466	0.702	0.060	-0.836
## 11	11	-3.032	1.739	-1.141	0.737	-0.834	1.386	-0.575	0.679	-0.018	-0.823
## 12	1	-3.653	0.373	-0.600	1.705	-0.222	1.765	-0.353	0.537	-0.797	-0.813
## 13	2	-3.237	0.436	-0.860	1.363	-0.251	1.915	-0.395	0.751	-0.774	-0.327
## 14	3	-2.135	0.954	-1.632	0.121	-0.704	1.600	-0.628	0.713	-0.903	-0.027
## 15	4	-2.304	1.784	-1.506	0.981	-0.961	0.806	-0.294	-0.002	0.119	-0.760
## 16	5	-2.540	2.144	-1.024	0.933	-1.567	1.024	0.188	-0.047	0.309	-0.633
## 17	6	-2.826	2.003	-0.738	0.801	-1.669	0.939	0.245	-0.257	0.256	-0.458
## 18	7	-3.582	2.374	-0.358	1.162	-1.953	0.621	0.339	0.355	0.415	-0.259
## 19	8	-3.951	2.250	0.127	1.772	-1.906	0.567	-0.432	1.045	0.598	-0.293
## 20	9	-3.783	1.974	-1.200	0.606	-0.650	1.504	-0.134	0.528	0.392	-0.580
## 21	10	-3.673	1.811	-1.405	1.621	0.044	1.572	-0.453	0.745	-0.066	-0.733
## 22	11	-2.946	1.649	-1.167	0.788	-0.909	1.300	-0.562	0.902	-0.070	-0.842
## 23	1	-3.665	0.337	-0.641	1.791	-0.194	1.686	-0.359	0.570	-0.676	-0.841
## 24	2	-3.165	0.408	-0.971	1.207	-0.298	1.921	-0.215	0.723	-0.492	-0.425
## 25	3	-2.105	1.035	-1.705	0.231	-0.558	1.554	-0.649	0.710	-0.855	-0.151
## 26	4	-2.312	1.746	-1.510	1.019	-0.990	0.941	-0.488	0.208	0.033	-0.847
## 27	5	-2.635	2.147	-1.129	0.911	-1.407	1.095	-0.071	0.118	0.139	-0.685
## 28	6	-2.887	2.131	-0.830	0.682	-1.557	0.818	0.448	-0.382	0.207	-0.402
## 29	7	-3.635	2.250	-0.394	1.012	-1.693	0.117	0.665	0.281	0.343	-0.003
## 30	8	-3.986	2.325	0.102	1.633	-2.014	0.576	-0.344	1.003	0.566	-0.245
## 31	9	-3.712	1.816	-1.171	0.647	-0.767	1.698	-0.347	0.920	0.159	-0.359
## 32	10	-3.740	1.832	-1.384	1.587	0.049	1.642	-0.516	0.707	-0.169	-0.522
## 33	11	-2.859	1.627	-1.140	0.769	-0.948	1.390	-0.608	0.956	-0.204	-0.727
## 34	1	-3.624	0.305	-0.708	1.758	-0.194	1.675	-0.273	0.561	-0.577	-0.843
## 35	2	-3.062	0.351	-1.071	1.061	-0.355	1.990	-0.210	0.796	-0.358	-0.299
## 36	3	-2.081	1.050	-1.778	0.411	-0.518	1.460	-0.576	0.735	-0.866	-0.172
## 37	4	-2.289	1.845	-1.616	0.987	-0.876	1.044	-0.549	0.196	-0.070	-0.814
## 38	5	-2.724	2.067	-1.142	0.923	-1.157	1.170	-0.276	0.172	-0.008	-0.649
## 39	6	-3.015	2.232	-0.899	0.574	-1.331	0.546	0.610	-0.452	0.035	-0.156
## 40	7	-3.559	2.126	-0.445	1.053	-1.765	0.349	0.546	0.321	0.443	-0.118
## 41	8	-4.074	2.281	0.152	1.556	-1.613	-0.047	0.222	0.252	0.775	0.125
## 42	9	-3.618	1.576	-1.140	0.699	-0.741	1.633	-0.387	1.086	0.235	-0.388
## 43	10	-3.687	1.784	-1.593	1.603	0.123	1.424	-0.225	0.441	0.206	-0.714
## 44	11	-2.690	1.652	-1.261	0.674	-0.964	1.449	-0.593	1.005	-0.303	-0.541
## 45	1	-3.593	0.290	-0.782	1.707	-0.175	1.662	-0.137	0.493	-0.492	-0.926
## 46	2	-3.046	0.387	-1.165	0.940	-0.386	1.978	-0.186	0.811	-0.394	-0.198
## 47	3	-2.255	0.902	-1.723	0.454	-0.524	1.453	-0.614	0.761	-0.885	-0.118
## 48	4	-2.299	1.848	-1.695	1.065	-0.861	1.047	-0.607	0.313	-0.253	-0.759
## 49	5	-2.911	1.928	-1.131	0.899	-0.911	1.111	-0.208	-0.047	-0.029	-0.539
## 50	6	-3.089	2.339	-0.973	0.463	-1.169	0.543	0.598	-0.450	-0.080	-0.039
## 51	7	-3.459	2.086	-0.595	0.937	-1.841	0.600	0.457	0.400	0.473	-0.211
## 52	8	-4.208	2.447	0.049	1.331	-2.088	0.585	-0.050	0.820	0.606	-0.302
## 53	9	-3.543	1.391	-1.220	0.699	-0.769	1.579	-0.379	1.158	0.181	-0.178
## 54	10	-3.684	1.774	-1.728	1.611	0.100	1.393	-0.193	0.554	0.245	-0.919
## 55	11	-2.596	1.560	-1.249	0.656	-1.095	1.292	-0.550	1.006	-0.150	-0.553
## 56	1	-3.604	0.235	-0.836	1.786	-0.153	1.642	-0.096	0.488	-0.524	-1.003
## 57	2	-3.171	0.490	-1.128	0.911	-0.388	2.014	-0.212	0.707	-0.551	-0.187
## 58	3	-2.302	0.850	-1.646	0.455	-0.488	1.491	-0.617	0.819	-0.887	-0.080
## 59	4	-2.368	1.727	-1.556	1.162	-0.819	0.941	-0.572	0.345	-0.279	-0.736
## 60	5	-3.141	1.873	-1.131	0.941	-0.759	1.224	-0.354	0.016	-0.218	-0.568
## 61	6	-3.065	2.372	-1.002	0.496	-1.295	0.860	0.327	-0.404	0.067	-0.155
## 62	7	-3.473	2.178	-0.820	0.706	-1.710	0.779	0.422	0.351	0.426	-0.267
## 63	8	-4.238	2.437	0.036	1.158	-2.127	0.554	0.120	0.823	0.565	-0.293

## 64	9	-3.546	1.258	-1.227	0.823	-0.702	1.734	-0.397	1.333	-0.277	0.013
## 65	10	-3.869	1.860	-1.646	1.612	0.044	1.531	-0.493	0.862	-0.106	-1.001
## 66	11	-2.666	1.516	-1.198	0.741	-1.066	1.240	-0.574	0.965	-0.130	-0.711
## 67	1	-4.102	0.209	0.414	0.423	0.985	1.434	0.663	0.036	-0.784	-0.668
## 68	2	-1.372	-0.030	-1.003	-0.388	-0.471	1.141	0.654	0.823	0.558	0.043
## 69	3	-1.816	0.458	-0.947	-0.341	0.085	0.750	0.144	0.462	-0.240	-0.266
## 70	4	-1.954	1.595	-1.593	0.370	-0.136	0.022	0.034	0.321	-0.190	-0.491
## 71	5	-2.654	2.390	-0.008	0.070	-1.063	0.304	-0.105	0.281	0.488	-0.382
## 72	6	-2.321	1.303	0.320	-0.085	-0.278	0.001	-0.094	-0.283	0.852	0.022
## 73	7	-3.141	3.314	-0.996	-0.394	-0.190	-0.312	0.137	0.631	0.547	-0.247
## 74	8	-3.941	3.353	0.486	-0.506	-1.120	0.101	0.297	0.711	-0.078	0.648
## 75	9	-4.161	2.937	0.157	0.336	-0.968	0.641	0.088	0.237	0.565	0.823
## 76	10	-4.520	2.231	-0.088	0.513	-0.528	1.246	0.198	0.242	0.161	0.769
## 77	11	-3.088	1.389	0.048	-0.216	-0.329	0.910	0.045	-0.075	0.101	-0.134
## 78	1	-4.275	0.162	0.728	0.662	0.940	1.269	0.711	0.073	-0.827	-0.655
## 79	2	-1.657	0.056	-1.044	-0.320	-0.316	1.321	0.638	0.800	0.298	-0.159
## 80	3	-1.709	0.486	-0.953	-0.346	0.020	0.786	0.145	0.564	-0.229	-0.322
## 81	4	-1.952	1.469	-1.375	0.105	-0.154	0.170	-0.047	0.336	-0.098	-0.410
## 82	5	-2.670	2.696	-0.231	-0.028	-1.014	0.486	-0.137	0.448	0.285	-0.482
## 83	6	-2.441	1.415	0.386	-0.335	-0.187	-0.079	0.000	-0.175	0.792	-0.026
## 84	7	-3.146	3.076	-0.683	-0.032	-0.693	-0.060	-0.267	0.476	0.982	-0.352
## 85	8	-3.902	3.586	0.334	-0.669	-1.087	0.255	0.461	0.812	-0.185	0.535
## 86	9	-4.267	3.010	0.172	0.028	-0.827	0.532	0.099	0.326	0.340	0.696
## 87	10	-4.650	2.455	0.013	0.681	-0.800	1.434	0.126	0.036	0.382	0.278
## 88	11	-3.030	1.185	0.314	-0.121	-0.591	0.965	0.353	-0.137	-0.221	0.075
## 89	1	-4.473	0.373	0.858	0.919	0.778	1.272	0.653	-0.216	-0.891	-0.627
## 90	2	-1.856	0.063	-1.011	-0.238	-0.152	1.461	0.572	0.775	0.154	-0.310
## 91	3	-1.976	0.389	-0.947	-0.250	-0.065	0.949	0.127	0.478	-0.323	-0.345
## 92	4	-1.914	1.473	-1.342	-0.013	-0.213	0.253	0.005	0.229	-0.009	-0.445
## 93	5	-2.700	2.830	-0.389	0.032	-0.958	0.440	-0.168	0.519	0.169	-0.525
## 94	6	-2.554	1.117	0.420	-0.022	-0.645	0.020	0.145	-0.327	0.660	0.073
## 95	7	-3.054	3.104	-0.513	-0.085	-0.952	0.299	-0.269	0.459	0.892	-0.308
## 96	8	-3.840	3.745	0.121	-0.656	-1.066	0.329	0.734	0.875	-0.295	0.418
## 97	9	-4.323	2.853	0.385	0.209	-1.096	0.431	0.119	0.268	0.131	0.654
## 98	10	-4.676	2.537	0.075	0.730	-0.933	1.493	0.049	0.076	0.254	0.276
## 99	11	-2.922	1.516	-0.002	-0.353	-0.464	1.184	0.383	-0.175	-0.346	-0.033
## 100	1	-4.477	0.246	1.087	1.108	0.682	1.057	0.424	-0.264	-1.195	-0.520
## 101	2	-1.895	-0.012	-0.970	-0.152	-0.161	1.509	0.487	0.809	0.044	-0.264
## 102	3	-1.945	0.352	-1.053	-0.228	-0.120	0.927	0.088	0.509	-0.279	-0.246
## 103	4	-1.912	1.554	-1.455	-0.017	-0.118	0.270	-0.037	0.163	-0.027	-0.474
## 104	5	-2.724	2.998	-0.560	-0.077	-0.944	0.548	-0.080	0.400	0.144	-0.630
## 105	6	-2.385	1.241	0.272	-0.040	-0.692	0.160	-0.061	-0.189	0.744	0.088
## 106	7	-3.092	3.014	-0.307	-0.016	-0.956	0.195	-0.227	0.367	0.958	-0.092
## 107	8	-3.917	3.496	0.409	-0.531	-1.150	0.017	0.605	0.977	-0.328	0.447
## 108	9	-4.232	3.035	0.428	0.497	-1.374	0.549	0.133	0.232	0.129	0.487
## 109	10	-4.759	2.696	0.104	0.697	-0.787	1.114	0.205	-0.066	0.369	0.306
## 110	11	-2.945	1.724	-0.312	-0.239	-0.447	1.360	0.014	-0.102	0.021	-0.564
## 111	1	-4.314	-0.106	1.044	1.192	0.687	0.763	0.158	-0.193	-1.342	-0.447
## 112	2	-2.050	0.065	-0.938	-0.037	0.082	1.561	0.393	0.835	-0.029	-0.394
## 113	3	-1.804	0.431	-1.000	-0.427	-0.094	0.848	0.084	0.636	-0.275	-0.214
## 114	4	-1.978	1.542	-1.487	-0.096	-0.025	0.320	-0.063	0.097	-0.073	-0.381
## 115	5	-2.748	3.217	-0.976	-0.213	-0.792	0.771	-0.032	0.223	0.043	-0.825
## 116	6	-2.351	1.530	0.086	-0.075	-0.426	0.125	-0.197	0.033	0.848	-0.038
## 117	7	-3.105	2.916	-0.207	0.031	-0.897	0.021	-0.229	0.256	1.073	-0.065

##	118	8	-3.985	3.614	0.584	-0.420	-1.105	-0.174	0.348	0.885	-0.165	0.650
##	119	9	-4.160	3.329	0.275	0.394	-1.287	0.693	0.483	0.121	0.286	0.153
##	120	10	-4.880	3.064	0.060	0.434	-0.575	0.897	0.250	0.085	0.093	0.445
##	121	11	-3.082	1.633	-0.118	-0.147	-0.484	1.176	-0.086	-0.072	0.086	-0.564
##	122	1	-4.158	-0.342	0.900	1.090	0.560	0.955	0.395	-0.328	-1.520	-0.498
##	123	2	-2.441	0.191	-0.814	0.255	0.411	1.636	0.395	0.761	-0.005	-0.564
##	124	3	-1.672	0.328	-0.833	-0.577	-0.363	0.840	0.180	0.682	-0.124	-0.109
##	125	4	-2.051	1.508	-1.641	-0.058	-0.102	0.346	-0.021	0.109	-0.147	-0.298
##	126	5	-2.788	3.194	-1.142	-0.313	-0.580	0.357	0.281	0.082	0.109	-0.858
##	127	6	-2.489	1.773	-0.180	-0.152	-0.353	0.133	-0.186	0.207	0.788	-0.285
##	128	7	-3.065	3.139	-0.461	-0.221	-0.759	-0.045	0.068	0.274	0.999	-0.331
##	129	8	-3.963	3.938	0.466	-0.564	-1.042	-0.064	0.241	0.888	-0.032	0.798
##	130	9	-4.136	3.582	-0.407	-0.038	-0.687	1.031	0.491	0.157	0.305	0.028
##	131	10	-4.944	3.325	0.015	0.079	-0.593	1.047	0.337	0.296	-0.453	0.371
##	132	11	-3.058	1.678	-0.351	-0.255	0.038	0.692	-0.173	0.226	0.202	-0.593
##	133	1	-1.202	-0.253	-2.487	0.809	-0.367	2.169	0.320	1.034	-1.385	-0.706
##	134	2	-1.077	0.511	-2.006	0.305	-0.584	1.962	0.089	1.406	-0.669	-0.027
##	135	3	-1.768	0.786	-1.468	1.077	-0.347	1.704	-0.171	1.076	-0.691	-0.060
##	136	4	-1.737	1.789	-1.046	1.071	-0.775	1.041	-0.025	0.925	-0.452	0.007
##	137	5	-2.432	2.126	-0.218	1.422	-1.169	0.410	-0.393	1.326	-0.067	0.225
##	138	6	-2.125	1.952	-0.415	1.458	-0.985	0.520	-0.344	1.249	-0.370	0.145
##	139	7	-2.607	2.406	-0.088	1.586	-1.477	0.164	-0.527	1.551	0.033	0.522
##	140	8	-3.813	3.705	-0.157	1.561	-1.503	-0.366	-0.581	1.412	0.290	-0.099
##	141	9	-3.050	1.600	-0.686	1.543	-1.149	-0.043	0.297	0.727	0.598	0.458
##	142	10	-3.972	2.279	-0.620	0.954	-1.090	0.719	0.717	0.300	1.309	0.171
##	143	11	-2.979	1.795	-0.870	1.427	-0.930	1.323	-0.212	1.286	-0.135	-0.496
##	144	1	-1.298	-0.295	-2.433	0.955	-0.278	2.252	0.285	0.915	-1.569	-0.562
##	145	2	-1.012	0.516	-2.041	0.320	-0.634	1.969	0.041	1.414	-0.687	0.047
##	146	3	-1.501	0.847	-1.619	0.920	-0.488	1.616	-0.161	1.127	-0.613	-0.051
##	147	4	-1.674	1.711	-1.040	1.136	-0.869	1.036	-0.157	0.946	-0.361	0.020
##	148	5	-2.308	2.023	-0.203	1.493	-1.223	0.379	-0.481	1.403	-0.045	0.402
##	149	6	-2.155	2.027	-0.393	1.354	-1.045	0.646	-0.246	1.279	-0.396	0.177
##	150	7	-2.652	2.156	-0.053	1.694	-1.258	0.062	-0.610	1.397	0.133	0.602
##	151	8	-3.834	3.749	-0.183	1.518	-1.585	-0.281	-0.334	1.191	0.425	-0.104
##	152	9	-3.330	1.529	-0.552	2.023	-0.845	0.016	0.049	0.512	0.396	0.386
##	153	10	-4.170	2.232	-0.389	1.211	-1.011	0.570	0.543	0.218	1.206	0.044
##	154	11	-2.867	1.391	-0.817	1.595	-0.883	1.143	-0.427	1.159	0.170	-0.456
##	155	1	-1.393	-0.305	-2.290	1.100	-0.254	2.327	0.363	0.795	-1.521	-0.756
##	156	2	-0.941	0.539	-2.020	0.314	-0.679	1.897	0.028	1.504	-0.632	0.111
##	157	3	-1.332	0.848	-1.665	0.970	-0.463	1.522	-0.159	1.101	-0.541	-0.050
##	158	4	-1.570	1.655	-1.040	1.160	-0.923	0.961	-0.231	0.955	-0.273	0.065
##	159	5	-2.227	1.993	-0.156	1.554	-1.190	0.332	-0.548	1.362	-0.013	0.369
##	160	6	-2.043	1.950	-0.435	1.341	-1.049	0.558	-0.237	1.237	-0.283	0.306
##	161	7	-2.679	1.731	-0.090	2.003	-1.009	0.038	-0.822	1.232	0.128	0.720
##	162	8	-3.836	3.699	-0.225	1.520	-1.729	-0.184	0.064	0.970	0.500	-0.130
##	163	9	-3.478	1.703	-0.557	2.191	-1.043	0.339	-0.004	0.587	0.450	0.006
##	164	10	-4.333	2.438	-0.219	1.372	-0.761	0.306	0.594	-0.022	1.103	0.190
##	165	11	-2.704	1.285	-0.908	1.570	-0.840	1.044	-0.399	0.951	0.345	-0.695
##	166	1	-1.417	-0.319	-2.254	1.072	-0.221	2.268	0.430	0.923	-1.486	-0.698
##	167	2	-0.961	0.514	-1.951	0.364	-0.680	1.895	0.047	1.539	-0.630	0.094
##	168	3	-1.220	0.831	-1.674	0.940	-0.425	1.463	-0.063	1.135	-0.422	0.060
##	169	4	-1.501	1.611	-1.003	1.156	-0.883	0.901	-0.169	0.862	-0.151	0.164
##	170	5	-2.176	1.952	-0.144	1.659	-1.128	0.280	-0.658	1.346	0.008	0.505
##	171	6	-1.891	1.776	-0.518	1.461	-1.050	0.567	-0.307	1.152	-0.239	0.325

##	172	7	-2.624	1.653	-0.156	2.023	-1.052	0.086	-0.752	1.341	0.196	0.710
##	173	8	-3.763	3.252	-0.262	1.520	-1.684	-0.225	0.235	0.989	0.616	0.046
##	174	9	-3.549	1.905	-0.509	1.963	-1.200	0.847	-0.157	0.842	0.625	-0.586
##	175	10	-4.373	2.463	-0.171	1.501	-0.639	0.292	0.518	-0.114	1.127	0.332
##	176	11	-2.562	1.361	-0.940	1.333	-1.047	1.208	-0.316	1.055	0.354	-0.770
##	177	1	-1.384	-0.321	-2.266	0.937	-0.289	2.290	0.463	1.096	-1.436	-0.701
##	178	2	-1.123	0.415	-1.954	0.563	-0.465	1.983	0.027	1.614	-0.568	0.007
##	179	3	-1.280	0.798	-1.647	0.968	-0.418	1.609	-0.031	1.224	-0.374	0.044
##	180	4	-1.475	1.557	-1.009	1.202	-0.846	0.883	-0.138	0.822	-0.165	0.198
##	181	5	-2.205	1.804	-0.199	1.773	-1.089	0.312	-0.621	1.247	0.137	0.406
##	182	6	-1.824	1.682	-0.669	1.483	-1.036	0.711	-0.249	1.193	-0.274	0.224
##	183	7	-2.574	1.814	-0.167	1.826	-1.156	0.120	-0.609	1.543	0.110	0.750
##	184	8	-3.693	3.067	-0.273	1.619	-1.905	0.045	0.006	1.347	0.346	0.360
##	185	9	-3.545	1.926	-0.512	1.732	-1.109	1.006	0.021	0.820	0.731	-0.639
##	186	10	-4.386	2.271	-0.157	1.536	-0.614	0.230	0.570	-0.117	1.074	0.397
##	187	11	-2.530	1.492	-0.936	1.210	-1.154	1.316	-0.267	1.149	0.226	-0.770
##	188	1	-1.215	-0.288	-2.423	0.834	-0.379	2.266	0.503	1.337	-1.360	-0.682
##	189	2	-1.400	0.316	-1.894	0.830	-0.242	2.038	0.003	1.667	-0.515	-0.087
##	190	3	-1.494	0.663	-1.580	1.191	-0.252	1.777	-0.072	1.189	-0.409	0.090
##	191	4	-1.512	1.492	-1.053	1.262	-0.809	0.941	-0.122	0.807	-0.206	0.145
##	192	5	-2.274	1.653	-0.226	1.857	-0.971	0.327	-0.605	1.121	0.121	0.291
##	193	6	-1.804	1.556	-0.803	1.388	-0.989	0.751	-0.029	0.963	-0.228	0.297
##	194	7	-2.447	1.914	-0.208	1.641	-1.159	0.104	-0.539	1.580	0.058	0.786
##	195	8	-3.675	3.132	-0.241	1.587	-1.750	-0.222	0.039	1.052	0.545	0.233
##	196	9	-3.425	1.724	-0.638	1.573	-1.041	1.204	-0.124	1.258	0.548	-0.507
##	197	10	-4.376	2.216	-0.269	1.320	-0.660	0.159	0.719	0.008	1.058	0.472
##	198	11	-2.520	1.520	-0.959	1.296	-1.103	1.149	-0.268	1.249	0.092	-0.682
##	199	1	-1.548	-0.400	-1.659	0.244	-0.101	1.562	0.551	1.248	0.129	-0.456
##	200	2	-1.614	0.287	-1.195	-0.252	-0.257	1.251	0.281	0.898	0.188	-0.423
##	201	3	-1.891	0.988	-1.060	0.119	0.590	0.263	0.372	0.390	-0.376	-0.655
##	202	4	-2.030	1.764	-0.386	-0.249	0.180	0.117	0.096	-0.121	0.067	-0.552
##	203	5	-2.550	2.629	0.084	-0.159	-0.882	0.093	-0.190	0.961	0.032	-0.589
##	204	6	-2.464	1.968	0.026	0.078	-0.542	0.074	0.051	0.596	0.260	-0.437
##	205	7	-3.193	2.026	0.830	0.813	-1.205	0.036	-0.950	0.786	1.045	0.210
##	206	8	-3.566	1.504	0.940	1.829	-1.224	0.178	-1.454	0.920	0.767	1.059
##	207	9	-3.299	1.730	0.187	0.121	-1.251	0.796	-0.366	1.091	0.493	0.436
##	208	10	-3.601	0.742	-0.238	0.332	-0.561	1.275	-0.014	0.844	0.558	0.659
##	209	11	-2.439	0.789	0.082	0.242	-0.693	0.595	-0.353	0.702	0.413	0.098
##	210	1	-1.507	-0.457	-1.728	0.256	-0.081	1.571	0.556	1.291	0.121	-0.456
##	211	2	-1.425	0.256	-1.130	-0.284	-0.394	1.253	0.306	0.893	0.272	-0.378
##	212	3	-1.814	0.923	-0.931	0.120	0.425	0.554	0.237	0.426	-0.184	-0.727
##	213	4	-2.007	1.814	-0.581	-0.027	0.127	0.081	0.089	-0.016	0.115	-0.719
##	214	5	-2.559	2.300	0.408	-0.001	-1.077	0.125	-0.254	0.975	0.070	-0.470
##	215	6	-2.431	1.873	0.208	0.123	-0.634	0.178	0.040	0.612	0.446	-0.562
##	216	7	-3.240	1.749	0.959	1.071	-1.188	0.018	-1.024	0.664	1.007	0.443
##	217	8	-3.565	1.363	0.958	1.976	-1.268	0.091	-1.363	0.720	0.738	1.145
##	218	9	-3.198	1.373	0.392	0.423	-1.203	0.656	-0.428	0.994	0.576	0.865
##	219	10	-3.772	0.904	-0.195	0.317	-0.473	1.310	-0.043	0.898	0.536	0.503
##	220	11	-2.434	0.870	0.127	0.224	-0.811	0.666	-0.233	0.705	0.408	0.136
##	221	1	-1.656	-0.496	-1.719	0.363	-0.002	1.637	0.535	1.319	-0.012	-0.490
##	222	2	-1.388	0.215	-1.105	-0.295	-0.390	1.282	0.356	0.816	0.292	-0.376
##	223	3	-1.764	0.888	-1.001	0.197	0.300	0.660	0.159	0.557	-0.301	-0.650
##	224	4	-2.026	1.750	-0.526	-0.131	0.266	-0.055	0.084	0.063	0.047	-0.691
##	225	5	-2.531	1.802	0.739	0.236	-1.169	-0.069	-0.349	0.903	0.123	-0.119

##	226	6	-2.375	1.642	0.308	0.255	-0.820	0.225	-0.092	0.874	0.367	-0.525
##	227	7	-3.179	1.346	0.988	1.320	-0.852	-0.008	-1.234	0.347	1.020	0.771
##	228	8	-3.570	1.366	0.970	1.957	-1.262	0.002	-1.275	0.585	0.754	0.993
##	229	9	-3.169	1.041	0.509	0.693	-1.185	0.673	-0.352	0.877	0.434	1.009
##	230	10	-4.066	1.050	-0.049	0.458	-0.357	1.331	-0.129	0.848	0.509	0.317
##	231	11	-2.483	0.810	0.185	0.284	-0.917	0.730	-0.111	0.613	0.373	0.184
##	232	1	-1.823	-0.578	-1.624	0.520	0.052	1.711	0.535	1.318	-0.115	-0.505
##	233	2	-1.450	0.199	-1.127	-0.281	-0.372	1.287	0.369	0.855	0.303	-0.385
##	234	3	-1.790	0.793	-1.041	0.214	0.215	0.694	0.121	0.583	-0.403	-0.487
##	235	4	-2.089	1.695	-0.528	-0.232	0.385	-0.137	0.033	0.071	0.033	-0.744
##	236	5	-2.475	1.498	0.864	0.397	-1.170	-0.234	-0.388	0.825	0.160	0.057
##	237	6	-2.314	1.494	0.294	0.245	-0.769	0.050	-0.068	0.819	0.618	-0.572
##	238	7	-3.062	1.008	0.935	1.443	-0.579	0.068	-1.333	0.106	0.958	0.979
##	239	8	-3.576	1.357	0.912	1.878	-1.166	0.039	-1.537	0.658	0.843	1.087
##	240	9	-3.155	1.021	0.455	0.624	-1.306	0.842	-0.123	0.909	0.328	0.876
##	241	10	-4.316	1.147	0.088	0.593	-0.314	1.316	-0.255	0.761	0.492	0.133
##	242	11	-2.608	0.839	0.203	0.305	-0.851	0.780	-0.143	0.607	0.344	0.106
##	243	1	-1.953	-0.596	-1.543	0.619	0.056	1.742	0.592	1.289	-0.163	-0.523
##	244	2	-1.495	0.117	-1.134	-0.249	-0.370	1.286	0.348	0.854	0.313	-0.376
##	245	3	-1.921	0.719	-0.950	0.299	0.222	0.786	0.128	0.588	-0.462	-0.491
##	246	4	-2.052	1.483	-0.488	0.041	-0.131	0.273	-0.112	-0.064	0.307	-0.800
##	247	5	-2.507	1.528	0.852	0.331	-1.231	-0.259	-0.265	0.856	0.070	0.069
##	248	6	-2.291	1.146	0.352	0.354	-0.714	0.080	-0.181	0.787	0.709	-0.409
##	249	7	-2.933	0.717	0.829	1.508	-0.517	0.069	-1.163	0.021	0.866	1.066
##	250	8	-3.530	1.268	0.903	1.887	-1.279	0.008	-1.441	0.657	0.873	1.042
##	251	9	-3.145	0.863	0.416	0.699	-1.378	0.892	0.020	0.890	0.221	0.834
##	252	10	-4.394	1.162	0.157	0.608	-0.409	1.352	-0.243	0.758	0.447	0.096
##	253	11	-2.704	0.917	0.267	0.314	-0.756	0.818	-0.114	0.673	0.261	0.056
##	254	1	-2.058	-0.610	-1.497	0.696	0.072	1.802	0.626	1.303	-0.192	-0.538
##	255	2	-1.537	0.043	-1.125	-0.213	-0.378	1.265	0.330	0.870	0.293	-0.393
##	256	3	-1.933	0.728	-1.015	0.270	0.199	0.780	0.192	0.706	-0.446	-0.595
##	257	4	-2.076	1.413	-0.584	0.190	-0.350	0.518	-0.406	0.313	0.027	-0.724
##	258	5	-2.554	1.532	0.812	0.367	-1.208	-0.352	-0.252	0.894	0.050	0.084
##	259	6	-2.343	0.788	0.373	0.492	-0.667	0.279	-0.240	0.827	0.589	-0.267
##	260	7	-2.834	0.654	0.733	1.434	-0.716	-0.028	-0.841	0.239	0.920	0.885
##	261	8	-3.482	1.127	0.899	1.993	-1.385	-0.050	-1.273	0.647	0.844	1.044
##	262	9	-3.246	0.712	0.390	0.820	-1.352	1.074	0.197	0.857	-0.056	0.485
##	263	10	-4.521	1.430	0.162	0.580	-0.351	1.339	-0.259	0.810	0.431	-0.102
##	264	11	-2.804	1.021	0.254	0.331	-0.654	0.854	-0.085	0.678	0.259	-0.031
##	265	1	-3.034	-1.274	0.263	1.521	0.660	1.622	-0.361	-0.468	-0.740	0.517
##	266	2	-3.118	0.356	0.377	1.447	0.868	0.407	-0.915	-0.546	-0.637	0.169
##	267	3	-2.611	0.434	0.231	1.343	0.323	-0.378	-0.618	-0.219	-0.285	0.347
##	268	4	-1.566	0.930	-0.181	-0.155	-0.164	-0.277	0.144	-0.047	-0.694	0.282
##	269	5	-2.758	2.067	-0.310	-0.543	-0.687	0.091	0.881	0.172	-0.454	-0.093
##	270	6	-2.497	1.607	-0.621	-0.446	-0.226	-0.152	1.160	0.122	-0.809	0.495
##	271	7	-3.533	2.319	1.085	0.247	-1.053	-0.429	-0.026	1.305	-0.243	-0.671
##	272	8	-3.893	3.690	0.079	-0.151	-1.093	-0.518	0.198	1.583	-0.257	-0.169
##	273	9	-4.079	2.663	-0.048	-0.315	0.234	0.861	0.335	0.435	-0.546	-0.928
##	274	10	-4.160	2.814	0.557	0.604	0.584	0.477	-0.272	0.784	-0.999	-0.781
##	275	11	-2.910	0.918	-0.138	-0.382	0.115	0.290	0.418	0.757	-0.898	-0.189
##	276	1	-3.162	-1.137	0.300	1.440	0.688	1.645	-0.447	-0.518	-0.520	0.641
##	277	2	-3.224	0.487	0.822	1.324	0.753	0.352	-0.976	-0.562	-0.489	0.172
##	278	3	-2.681	0.531	0.252	1.239	0.469	-0.339	-0.652	-0.417	-0.246	0.412
##	279	4	-1.577	0.907	-0.291	0.007	-0.256	-0.233	0.187	-0.052	-0.627	0.238

##	280	5	-2.861	2.091	-0.411	-0.438	-0.643	0.317	0.817	0.104	-0.481	-0.252
##	281	6	-2.445	1.503	-0.677	-0.460	-0.140	-0.002	1.014	0.061	-0.599	0.175
##	282	7	-3.406	2.403	1.025	0.108	-1.100	-0.316	0.099	1.541	-0.304	-0.671
##	283	8	-3.958	3.922	0.150	-0.265	-1.201	-0.249	0.202	1.163	-0.049	-0.039
##	284	9	-4.071	2.754	-0.232	-0.262	0.356	0.694	0.381	0.500	-0.721	-0.859
##	285	10	-4.188	2.637	0.502	0.552	0.735	0.395	-0.026	0.803	-0.874	-0.913
##	286	11	-2.923	0.919	-0.231	-0.307	0.075	0.265	0.403	0.691	-1.012	-0.157
##	287	1	-3.390	-0.956	0.476	1.547	0.658	1.504	-0.650	-0.604	-0.295	0.616
##	288	2	-3.128	0.280	0.955	1.264	0.753	0.437	-0.841	-0.517	-0.473	0.000
##	289	3	-2.689	0.528	0.157	1.501	0.349	-0.412	-0.490	-0.512	-0.277	0.422
##	290	4	-1.693	0.807	-0.038	-0.051	-0.174	-0.372	0.117	0.053	-0.611	0.300
##	291	5	-2.927	2.202	-0.532	-0.486	-0.519	0.585	0.813	-0.133	-0.475	-0.349
##	292	6	-2.555	1.421	-0.800	-0.233	-0.078	0.244	0.771	-0.112	-0.707	0.165
##	293	7	-3.439	2.711	1.067	0.029	-1.120	-0.212	0.062	1.440	-0.353	-0.420
##	294	8	-4.067	3.908	-0.065	-0.378	-1.163	0.065	0.508	1.003	0.030	-0.187
##	295	9	-4.068	2.566	-0.068	-0.152	0.126	0.548	0.453	0.577	-0.543	-0.896
##	296	10	-4.314	2.322	0.580	0.279	0.702	0.532	-0.068	0.814	-0.917	-1.109
##	297	11	-3.020	1.033	-0.238	-0.286	0.088	0.235	0.372	0.563	-1.027	-0.151
##	298	1	-3.485	-0.860	0.582	1.501	0.578	1.480	-0.663	-0.602	-0.318	0.575
##	299	2	-3.049	0.084	0.981	1.193	0.761	0.495	-0.714	-0.466	-0.568	-0.149
##	300	3	-2.837	0.528	0.241	1.629	0.230	-0.545	-0.643	-0.231	-0.186	0.450
##	301	4	-1.611	0.831	-0.056	-0.048	-0.044	-0.423	0.289	-0.092	-0.633	0.221
##	302	5	-2.939	2.157	-0.451	-0.209	-0.880	0.697	0.823	-0.035	-0.744	-0.193
##	303	6	-2.842	1.343	-0.713	0.003	0.126	0.411	0.538	-0.077	-0.995	0.092
##	304	7	-3.587	3.128	0.885	-0.188	-1.164	-0.215	0.051	1.344	-0.641	-0.253
##	305	8	-4.222	3.886	0.016	-0.144	-1.132	-0.053	0.519	1.024	0.075	-0.226
##	306	9	-4.087	2.555	0.123	-0.151	0.118	0.474	0.365	0.495	-0.473	-0.886
##	307	10	-4.442	2.607	0.596	0.191	0.636	0.679	-0.140	0.774	-0.828	-1.122
##	308	11	-2.976	1.033	-0.222	-0.099	0.081	0.052	0.479	0.517	-1.105	-0.125
##	309	1	-3.689	-0.599	0.692	1.307	0.605	1.514	-0.752	-0.697	-0.355	0.702
##	310	2	-3.278	0.324	1.047	1.152	0.725	0.168	-0.839	-0.381	-0.687	0.013
##	311	3	-3.249	1.042	0.589	1.408	0.023	-0.821	-0.581	0.031	0.068	0.325
##	312	4	-1.596	0.885	-0.199	0.199	-0.115	-0.474	0.428	-0.113	-0.610	0.131
##	313	5	-2.986	2.072	-0.311	-0.083	-0.878	0.449	0.916	0.082	-0.905	-0.109
##	314	6	-3.003	1.163	-0.450	0.328	0.097	0.574	0.427	-0.017	-1.146	-0.060
##	315	7	-3.682	3.672	0.041	-0.508	-0.905	0.028	0.492	0.654	-0.722	-0.318
##	316	8	-4.210	3.869	0.164	-0.047	-1.251	-0.102	0.276	0.919	0.091	-0.159
##	317	9	-4.129	2.686	0.308	-0.125	0.117	0.393	0.199	0.308	-0.478	-0.909
##	318	10	-4.497	3.018	0.609	0.115	0.673	0.709	-0.030	0.861	-0.704	-1.038
##	319	11	-2.846	1.010	-0.219	-0.083	0.091	0.076	0.442	0.509	-1.181	-0.021
##	320	1	-3.693	-0.568	0.727	1.236	0.612	1.502	-0.804	-0.763	-0.346	0.788
##	321	2	-3.543	0.624	0.674	1.413	0.653	-0.445	-0.803	-0.256	-0.650	0.423
##	322	3	-3.293	0.930	0.522	1.480	0.249	-0.661	-0.643	-0.094	-0.132	0.198
##	323	4	-1.708	0.944	-0.140	0.151	-0.092	-0.481	0.220	0.034	-0.692	0.190
##	324	5	-2.942	2.091	-0.353	-0.364	-0.610	0.401	0.864	0.191	-0.764	-0.235
##	325	6	-3.253	1.025	-0.286	0.713	-0.036	0.539	0.476	-0.116	-0.945	-0.108
##	326	7	-3.661	3.266	-0.117	-0.237	-0.755	0.092	0.686	0.381	-0.580	-0.687
##	327	8	-4.216	3.638	0.192	-0.023	-1.231	-0.320	0.128	1.030	0.061	-0.179
##	328	9	-4.077	2.542	0.039	0.082	0.218	0.393	0.324	0.399	-0.658	-0.964
##	329	10	-4.544	3.046	1.028	-0.016	0.447	0.884	-0.094	0.885	-0.459	-1.099
##	330	11	-2.711	0.971	-0.023	0.053	0.101	-0.148	0.382	0.476	-1.050	-0.256
##	331	1	-3.322	-0.303	-0.500	0.963	0.921	0.981	1.059	-1.079	-1.004	0.112
##	332	2	-3.844	1.056	-0.190	1.685	0.617	1.245	-0.811	-0.506	-1.128	0.076
##	333	3	-2.665	0.772	-1.009	1.307	0.287	0.855	-0.466	-0.190	-0.721	0.407

##	334	4	-2.493	1.382	-0.929	0.465	-0.369	0.002	0.187	-0.696	-0.310	0.348
##	335	5	-2.905	2.311	-0.658	0.022	-1.121	0.250	0.467	0.484	-0.157	-0.676
##	336	6	-2.685	1.971	-0.857	0.033	-0.638	0.484	0.143	0.159	-0.218	-0.343
##	337	7	-3.389	2.762	-0.710	-0.026	-0.641	0.112	0.775	0.443	-0.110	-0.979
##	338	8	-4.243	3.354	-0.415	0.898	-1.027	-0.281	0.576	0.480	0.564	-0.085
##	339	9	-3.741	2.700	-1.593	0.782	-0.298	1.378	0.184	1.458	-0.134	-1.297
##	340	10	-4.694	3.229	-1.153	0.702	0.452	0.298	0.454	0.001	-0.264	-1.399
##	341	11	-3.012	1.628	-0.834	0.975	-0.299	0.926	0.174	0.836	-0.239	-1.144
##	342	1	-3.268	-0.079	-0.693	0.763	1.043	1.194	0.892	-1.293	-1.033	0.199
##	343	2	-3.618	0.916	-0.400	1.771	0.666	1.535	-0.389	-0.342	-1.279	-0.109
##	344	3	-2.693	0.771	-0.870	1.341	0.317	0.925	-0.328	-0.169	-0.936	0.399
##	345	4	-2.515	1.340	-0.840	0.511	-0.492	0.098	0.047	-0.680	-0.283	0.168
##	346	5	-2.882	2.165	-0.589	0.173	-1.165	0.014	0.571	0.502	-0.093	-0.616
##	347	6	-2.591	1.809	-0.659	-0.016	-0.673	0.588	0.084	0.182	-0.094	-0.372
##	348	7	-3.354	2.850	-0.887	0.010	-0.551	0.293	0.901	0.320	-0.302	-1.023
##	349	8	-4.228	3.111	-0.380	1.160	-1.188	-0.362	0.516	0.507	0.669	-0.074
##	350	9	-3.901	2.485	-0.950	0.702	-0.470	1.146	-0.109	1.597	0.146	-1.197
##	351	10	-4.708	3.269	-1.121	0.701	0.437	0.176	0.552	0.004	-0.168	-1.484
##	352	11	-3.000	1.524	-0.866	1.015	-0.400	0.861	0.174	0.938	-0.216	-1.010
##	353	1	-3.347	-0.159	-0.414	0.922	0.973	0.978	0.929	-1.211	-1.268	0.278
##	354	2	-3.518	0.716	-0.365	1.788	0.584	1.678	-0.109	-0.016	-1.501	0.002
##	355	3	-2.875	0.868	-0.728	1.439	0.355	0.846	-0.378	-0.233	-1.072	0.505
##	356	4	-2.612	1.403	-0.870	0.470	-0.448	0.172	-0.060	-0.656	-0.334	0.087
##	357	5	-2.859	2.255	-0.676	0.098	-1.086	0.041	0.732	0.305	-0.141	-0.636
##	358	6	-2.497	1.692	-0.607	0.020	-0.710	0.612	0.093	0.272	-0.060	-0.507
##	359	7	-3.236	2.745	-0.806	-0.200	-0.386	0.358	0.889	0.516	-0.297	-1.075
##	360	8	-4.188	3.229	-0.456	1.077	-1.385	-0.104	0.459	0.558	0.701	-0.320
##	361	9	-3.775	2.188	-1.017	0.687	-0.464	1.189	-0.157	1.673	-0.024	-1.144
##	362	10	-4.744	3.385	-0.886	0.571	0.235	0.183	0.357	0.040	0.203	-1.680
##	363	11	-3.046	1.462	-0.823	0.935	-0.440	0.849	0.085	0.865	-0.178	-0.954
##	364	1	-3.594	-0.137	-0.028	1.018	1.069	0.723	0.695	-0.982	-1.433	0.249
##	365	2	-3.426	0.584	-0.469	1.776	0.566	1.686	0.070	0.081	-1.483	-0.141
##	366	3	-3.086	1.010	-0.627	1.508	0.338	0.747	-0.479	-0.323	-1.087	0.645
##	367	4	-2.750	1.475	-0.848	0.364	-0.275	0.020	-0.003	-0.782	-0.291	0.167
##	368	5	-2.846	2.430	-0.780	-0.153	-0.905	0.240	0.746	0.140	-0.114	-0.746
##	369	6	-2.511	1.511	-0.555	0.226	-0.735	0.631	-0.006	0.520	-0.138	-0.651
##	370	7	-3.124	2.733	-0.857	-0.334	-0.312	0.587	0.849	0.475	-0.174	-0.899
##	371	8	-4.175	3.320	-0.446	0.988	-1.480	0.133	0.507	0.605	0.691	-0.462
##	372	9	-3.777	2.064	-0.983	0.846	-0.373	0.960	-0.040	1.331	0.247	-1.090
##	373	10	-4.788	3.632	-0.710	0.300	0.366	-0.121	0.403	-0.016	0.124	-1.320
##	374	11	-3.006	1.407	-0.875	0.945	-0.495	0.721	0.212	0.750	-0.037	-1.054
##	375	1	-3.781	-0.011	0.102	1.115	1.036	0.651	0.615	-1.082	-1.272	0.050
##	376	2	-3.394	0.557	-0.573	1.704	0.608	1.644	0.109	0.200	-1.507	-0.225
##	377	3	-3.091	0.935	-0.574	1.360	0.416	0.764	-0.480	-0.144	-1.295	0.696
##	378	4	-2.850	1.446	-0.792	0.482	-0.365	0.046	-0.029	-0.761	-0.251	0.113
##	379	5	-2.884	2.424	-0.764	-0.108	-1.015	0.361	0.712	0.133	-0.017	-0.847
##	380	6	-2.656	1.263	-0.527	0.464	-0.612	0.668	-0.160	0.857	-0.416	-0.596
##	381	7	-3.246	2.796	-0.867	-0.205	-0.316	0.808	0.824	0.062	-0.118	-0.749
##	382	8	-4.172	3.188	-0.375	1.028	-1.410	0.008	0.513	0.635	0.802	-0.280
##	383	9	-3.862	1.801	-0.717	1.133	-0.230	0.922	-0.223	1.264	0.194	-0.935
##	384	10	-4.836	3.871	-0.684	0.182	0.349	-0.176	0.317	0.059	-0.024	-1.130
##	385	11	-2.973	1.304	-0.849	0.984	-0.508	0.590	0.248	0.728	0.073	-1.107
##	386	1	-3.858	0.115	0.050	1.170	0.975	0.703	0.585	-1.191	-1.172	-0.076
##	387	2	-3.404	0.506	-0.591	1.627	0.660	1.456	0.068	0.381	-1.494	-0.453

##	388	3	-2.952	0.777	-0.740	1.311	0.424	0.853	-0.319	-0.082	-1.456	0.616
##	389	4	-3.005	1.472	-0.716	0.535	-0.392	0.054	-0.054	-0.686	-0.290	0.153
##	390	5	-2.898	2.421	-0.810	-0.043	-1.164	0.448	0.690	0.218	-0.078	-0.876
##	391	6	-2.906	1.102	-0.491	0.575	-0.386	0.771	-0.134	0.977	-0.540	-0.604
##	392	7	-3.462	2.648	-0.447	0.000	-0.416	0.767	0.569	-0.072	-0.080	-0.798
##	393	8	-4.076	3.336	-0.688	0.677	-1.472	0.461	0.682	0.724	0.717	-0.409
##	394	9	-3.846	1.426	-0.607	1.434	-0.072	1.130	-0.535	1.159	-0.123	-0.385
##	395	10	-4.885	3.967	-0.948	0.373	0.255	-0.121	0.430	-0.013	0.018	-1.518
##	396	11	-2.980	1.290	-0.842	0.955	-0.491	0.572	0.267	0.692	0.084	-1.100
##	397	1	-3.208	-0.608	-0.516	1.098	1.529	1.069	0.186	-0.947	-0.248	-0.059
##	398	2	-2.569	-0.110	-0.841	0.732	1.112	0.961	-0.075	0.148	-0.893	0.314
##	399	3	-2.210	0.661	-0.581	1.139	0.238	0.074	-0.625	-0.366	-0.326	0.557
##	400	4	-1.885	2.214	-0.673	0.147	-0.148	-0.400	0.252	-0.098	-0.874	0.245
##	401	5	-2.488	2.822	-0.239	-0.330	-1.355	0.284	0.101	0.934	-0.966	-0.310
##	402	6	-2.335	2.896	-0.295	-0.420	-0.645	0.351	0.120	0.447	-1.126	0.110
##	403	7	-2.715	2.325	0.701	0.239	-1.426	-0.218	-0.317	1.516	-0.162	-0.703
##	404	8	-4.210	3.289	-0.106	-1.247	-0.683	0.539	0.579	0.832	-0.035	-0.764
##	405	9	-3.984	2.290	-0.103	-0.707	0.297	0.317	0.857	1.403	-1.253	-0.298
##	406	10	-4.964	2.780	0.474	0.047	0.417	-0.328	0.334	0.474	-1.260	-0.221
##	407	11	-2.528	1.288	-0.144	-0.171	-0.077	0.260	-0.045	0.681	-1.399	-0.066
##	408	1	-3.431	-0.500	-0.362	1.173	1.590	0.956	0.162	-0.853	-0.364	0.084
##	409	2	-2.659	-0.101	-0.687	0.697	1.081	1.045	-0.149	0.184	-0.927	0.327
##	410	3	-2.103	0.655	-0.840	1.195	0.377	0.135	-0.504	-0.549	-0.404	0.602
##	411	4	-1.926	2.172	-0.571	0.257	-0.159	-0.493	0.270	-0.153	-0.673	-0.005
##	412	5	-2.512	2.826	-0.171	-0.385	-1.495	0.381	0.067	0.899	-0.902	-0.412
##	413	6	-2.353	2.897	-0.433	-0.193	-0.715	0.359	0.260	0.273	-1.206	0.360
##	414	7	-2.708	2.396	0.728	0.336	-1.437	-0.344	-0.411	1.469	-0.022	-0.717
##	415	8	-4.341	3.514	-0.453	-1.047	-0.469	0.510	0.618	0.801	-0.399	-0.777
##	416	9	-4.045	2.193	0.200	-0.745	0.215	0.387	0.625	1.477	-1.207	-0.270
##	417	10	-5.020	2.551	0.562	-0.136	0.531	-0.064	0.373	0.631	-1.407	-0.267
##	418	11	-2.665	1.633	-0.384	-0.111	-0.001	0.234	0.033	0.478	-1.558	0.219
##	419	1	-3.586	-0.380	-0.359	1.307	1.587	0.990	0.180	-0.831	-0.471	0.198
##	420	2	-2.889	-0.039	-0.494	0.719	1.104	1.003	-0.415	0.097	-0.855	0.356
##	421	3	-2.282	0.673	-0.798	1.286	0.308	0.010	-0.411	-0.610	-0.266	0.584
##	422	4	-1.985	2.161	-0.601	0.424	-0.295	-0.489	0.208	-0.216	-0.562	0.079
##	423	5	-2.563	2.829	-0.283	-0.368	-1.593	0.408	0.121	0.933	-0.946	-0.356
##	424	6	-2.415	2.517	-0.285	0.085	-0.902	0.283	0.302	0.247	-1.207	0.371
##	425	7	-2.776	2.563	0.532	0.277	-1.470	-0.368	-0.278	1.479	-0.164	-0.797
##	426	8	-4.384	3.721	-0.905	-0.965	-0.160	0.498	0.809	0.660	-0.613	-0.831
##	427	9	-4.107	2.170	0.206	-0.811	0.334	0.633	0.402	1.097	-1.327	-0.040
##	428	10	-5.069	2.119	0.826	-0.274	0.576	0.145	0.308	1.001	-1.412	-0.306
##	429	11	-2.812	1.954	-0.661	0.109	-0.011	0.110	0.187	0.096	-1.538	0.592
##	430	1	-3.760	-0.320	-0.240	1.273	1.751	1.125	0.230	-0.723	-0.501	0.315
##	431	2	-3.152	0.086	-0.325	0.868	1.084	0.753	-0.522	-0.005	-0.821	0.483
##	432	3	-2.558	0.755	-0.660	1.366	0.038	-0.011	-0.443	-0.531	-0.062	0.418
##	433	4	-2.010	2.164	-0.626	0.389	-0.240	-0.441	0.103	-0.270	-0.647	0.165
##	434	5	-2.601	2.735	-0.322	-0.255	-1.670	0.229	0.202	1.010	-0.871	-0.461
##	435	6	-2.521	2.271	-0.277	0.270	-0.909	0.274	0.348	-0.028	-1.177	0.432
##	436	7	-2.922	2.621	0.214	0.122	-1.477	-0.173	0.045	1.380	-0.635	-0.757
##	437	8	-4.417	3.765	-1.225	-0.853	0.041	0.536	0.885	0.533	-0.757	-0.789
##	438	9	-4.070	2.254	-0.280	-0.722	0.696	0.683	0.243	0.689	-1.450	0.190
##	439	10	-5.080	2.241	0.971	-0.374	0.501	0.226	0.144	0.851	-1.319	-0.300
##	440	11	-2.930	2.014	-0.700	0.206	-0.088	0.153	0.142	-0.031	-1.437	0.615
##	441	1	-4.247	-0.034	0.248	1.372	1.831	1.167	0.087	-0.518	-0.316	0.347

##	442	2	-3.183	0.154	-0.413	0.923	1.091	0.582	-0.447	-0.085	-0.904	0.693
##	443	3	-2.514	0.558	-0.777	1.299	0.027	0.247	-0.487	-0.653	-0.028	0.481
##	444	4	-2.041	2.119	-0.585	0.549	-0.430	-0.291	-0.002	-0.234	-0.751	0.253
##	445	5	-2.640	2.704	-0.345	-0.230	-1.649	0.064	0.275	0.952	-0.651	-0.571
##	446	6	-2.729	2.104	-0.505	0.138	-0.533	0.455	0.148	-0.407	-1.059	0.625
##	447	7	-3.025	2.711	-0.147	-0.034	-1.340	0.049	0.364	1.099	-1.020	-0.652
##	448	8	-4.415	3.737	-1.313	-0.815	0.168	0.590	0.975	0.420	-0.825	-0.748
##	449	9	-4.036	2.141	-0.355	-0.602	0.837	0.663	-0.013	0.507	-1.412	0.210
##	450	10	-5.158	2.488	1.064	-0.343	0.352	0.180	-0.050	0.817	-1.308	-0.249
##	451	11	-2.907	1.992	-0.904	0.205	0.011	0.346	-0.031	-0.148	-1.262	0.487
##	452	1	-4.687	0.406	0.889	1.464	1.618	1.021	-0.121	-0.398	-0.307	0.293
##	453	2	-3.096	0.103	-0.452	0.879	1.067	0.497	-0.296	-0.067	-0.973	0.711
##	454	3	-2.452	0.279	-0.805	1.141	0.239	0.176	-0.104	-0.752	-0.334	0.731
##	455	4	-2.081	2.043	-0.521	0.578	-0.463	-0.246	-0.041	-0.162	-0.814	0.425
##	456	5	-2.658	2.739	-0.382	-0.310	-1.640	0.081	0.276	0.884	-0.535	-0.548
##	457	6	-2.982	2.001	-0.915	0.188	0.035	0.467	-0.130	-0.689	-0.684	0.664
##	458	7	-3.098	2.525	-0.316	-0.322	-1.082	0.285	0.445	0.847	-0.951	-0.707
##	459	8	-4.403	3.602	-0.945	-0.934	0.041	0.409	1.003	0.470	-0.477	-0.621
##	460	9	-4.200	2.201	-0.310	-0.392	0.968	0.700	-0.328	0.129	-0.896	0.150
##	461	10	-5.211	2.544	0.820	-0.333	0.447	0.226	0.127	0.890	-1.389	-0.304
##	462	11	-2.752	1.778	-0.718	0.057	-0.009	0.402	0.121	0.050	-1.435	0.281
##	463	1	-5.058	2.236	1.381	1.885	-0.259	-0.483	-0.562	0.123	-0.063	0.663
##	464	2	-4.181	1.646	0.736	1.286	0.724	-0.511	-1.126	-0.450	-0.648	0.995
##	465	3	-3.753	0.828	-0.042	1.406	0.209	-0.530	-0.520	-0.400	-0.386	1.070
##	466	4	-3.494	1.207	-0.607	0.242	-0.430	0.131	0.236	0.545	-0.593	0.678
##	467	5	-2.813	2.327	-1.246	-0.184	-0.755	0.491	1.202	-0.558	-0.669	0.054
##	468	6	-3.133	1.983	-1.398	0.254	-0.667	0.532	0.389	-0.178	-0.584	0.844
##	469	7	-3.749	3.018	-0.755	-0.452	-0.666	0.209	0.741	0.900	-1.613	0.128
##	470	8	-4.373	4.643	-0.792	-1.332	-0.202	0.597	0.192	1.133	-1.131	-0.280
##	471	9	-4.468	4.121	-0.420	-1.197	0.338	0.600	-0.110	0.314	-1.248	-0.012
##	472	10	-4.902	4.490	-0.564	-0.536	-0.164	-0.298	0.842	-0.158	-0.906	0.358
##	473	11	-4.125	2.300	-0.167	-0.270	0.103	0.320	-0.467	-0.254	-0.415	0.863
##	474	1	-5.124	2.319	1.413	1.804	-0.277	-0.330	-0.746	0.221	0.060	0.460
##	475	2	-4.393	2.137	0.570	1.397	0.293	-0.836	-0.966	-0.461	-0.277	1.184
##	476	3	-3.961	1.078	0.110	1.232	0.210	-0.670	-0.536	-0.330	-0.268	1.098
##	477	4	-3.654	1.222	-0.574	0.248	-0.299	0.158	0.154	0.553	-0.580	0.617
##	478	5	-3.001	2.263	-1.178	-0.116	-0.922	0.536	1.286	-0.506	-0.566	-0.102
##	479	6	-3.417	1.984	-1.148	0.234	-0.778	0.411	0.494	0.130	-0.704	0.764
##	480	7	-3.887	3.172	-0.739	-0.690	-0.548	0.330	0.569	0.980	-1.609	0.283
##	481	8	-4.474	4.569	-1.069	-1.409	0.137	1.049	0.071	0.877	-1.355	-0.167
##	482	9	-4.471	4.096	-0.809	-0.881	0.646	0.539	0.040	0.142	-1.555	-0.023
##	483	10	-4.947	4.637	-0.444	-0.953	-0.119	-0.249	0.594	0.270	-0.783	0.265
##	484	11	-4.173	2.299	-0.298	-0.130	0.122	0.319	-0.388	-0.328	-0.480	0.990
##	485	1	-5.131	2.192	1.364	1.936	-0.591	-0.354	-0.677	0.150	0.178	0.380
##	486	2	-4.395	1.864	0.503	1.718	0.241	-0.817	-0.672	-0.687	-0.449	1.396
##	487	3	-4.058	1.072	0.157	1.136	0.385	-0.687	-0.583	-0.185	-0.300	1.177
##	488	4	-3.631	1.195	-0.719	0.130	-0.065	0.348	-0.061	0.555	-0.594	0.806
##	489	5	-3.434	2.260	-1.065	-0.122	-0.795	0.363	1.403	-0.507	-0.375	0.015
##	490	6	-3.765	1.970	-0.955	0.304	-0.735	0.410	0.380	0.146	-0.536	0.738
##	491	7	-3.975	3.066	-0.506	-0.827	-0.478	0.434	0.356	0.939	-1.309	0.204
##	492	8	-4.497	4.500	-1.446	-1.127	0.443	0.986	0.136	0.597	-1.087	-0.073
##	493	9	-4.475	4.064	-0.927	-0.678	0.599	0.445	0.224	0.103	-1.336	-0.192
##	494	10	-5.011	4.976	-0.868	-1.215	0.170	-0.018	0.543	0.154	-0.841	0.707
##	495	11	-4.151	2.069	-0.605	0.111	0.410	0.354	-0.284	-0.381	-0.507	0.737

```
## 496 1 -5.125 2.077 1.283 2.003 -0.734 -0.513 -0.557 0.055 0.295 0.269
## 497 2 -4.316 1.409 0.441 1.819 0.500 -0.617 -0.633 -0.621 -0.671 1.193
## 498 3 -4.149 1.129 -0.008 1.215 0.390 -0.474 -0.400 -0.343 -0.344 0.886
## 499 4 -3.581 1.188 -0.958 0.189 -0.077 0.451 0.049 0.449 -0.676 0.919
## 500 5 -3.828 2.367 -0.836 -0.343 -0.466 0.116 1.172 -0.175 -0.275 0.117
## 501 6 -3.820 1.705 -1.130 0.450 -0.471 0.665 0.298 -0.175 -0.473 0.848
## 502 7 -3.949 2.990 -0.643 -0.986 -0.175 0.768 0.249 0.803 -1.479 0.168
## 503 8 -4.471 4.461 -1.887 -0.799 0.719 0.938 0.239 0.342 -1.036 -0.060
## 504 9 -4.580 4.116 -0.753 -0.849 0.516 0.498 0.117 0.181 -1.256 -0.119
## 505 10 -5.049 4.846 -0.678 -0.877 -0.090 0.005 0.253 -0.078 -0.178 0.131
## 506 11 -4.115 1.856 -0.738 0.132 0.658 0.329 -0.252 -0.123 -0.530 0.456
## 507 1 -5.143 2.051 1.216 1.898 -0.555 -0.466 -0.842 0.011 0.461 0.193
## 508 2 -4.403 1.409 0.551 1.496 0.673 -0.616 -0.787 -0.382 -0.696 1.139
## 509 3 -4.316 1.272 -0.087 1.285 0.126 -0.128 -0.286 -0.463 -0.294 0.691
## 510 4 -3.622 1.111 -0.972 0.399 -0.402 0.527 0.271 0.373 -0.716 0.943
## 511 5 -3.850 2.280 -1.055 -0.335 -0.164 0.410 0.913 -0.391 -0.338 0.260
## 512 6 -3.962 1.724 -1.290 0.531 -0.170 0.528 0.282 -0.149 -0.603 1.139
## 513 7 -3.894 2.910 -0.968 -0.671 -0.131 0.519 0.591 0.708 -1.515 0.121
## 514 8 -4.469 4.348 -1.740 -0.886 0.447 0.883 0.374 0.577 -0.908 -0.089
## 515 9 -4.661 4.235 -0.497 -1.021 0.295 0.457 -0.019 0.345 -1.355 0.062
## 516 10 -5.040 5.074 -1.721 -0.264 0.279 0.176 0.003 -0.609 -0.177 0.422
## 517 11 -4.169 1.799 -0.621 0.025 0.706 0.362 -0.343 -0.049 -0.339 0.220
## 518 1 -5.105 1.968 1.140 1.719 -0.443 -0.432 -0.969 -0.173 0.551 0.176
## 519 2 -4.544 1.672 0.643 1.281 0.504 -0.803 -0.709 -0.229 -0.546 1.058
## 520 3 -4.426 1.167 0.008 1.315 0.189 -0.297 -0.124 -0.244 -0.423 0.684
## 521 4 -3.622 0.988 -1.108 0.685 -0.693 0.754 0.442 0.166 -0.458 0.738
## 522 5 -3.597 2.146 -1.492 -0.142 -0.297 0.815 0.870 -0.490 -0.471 0.410
## 523 6 -4.122 1.735 -1.340 0.615 0.030 0.353 0.345 -0.104 -0.540 0.988
## 524 7 -4.065 2.876 -0.856 -0.221 -0.533 0.232 0.855 0.633 -1.452 0.272
## 525 8 -4.513 4.265 -1.477 -1.090 0.215 0.829 0.342 0.693 -0.601 -0.056
## 526 9 -4.651 4.246 -0.823 -0.831 0.666 0.546 -0.300 0.094 -1.343 0.185
## 527 10 -5.034 4.993 -1.633 -0.285 0.398 0.181 -0.211 -0.508 -0.283 0.304
## 528 11 -4.261 1.827 -0.482 -0.194 0.731 0.354 -0.478 0.050 -0.112 0.321
```

```
?randomForest
vowel.train$y=factor(vowel.train$y)
```

#Q3:

```
random_forest_model=randomForest(y ~ ., data=vowel.train)
```

#Q4:

```
set.seed(123)
vowel_flds <- createFolds(vowel.train, k=5)
#vowel_flds

cvrf <- function(mtry,node, flds=vowel_flds) {
  cverr <- rep(NA, length(flds))
  for(tst_idx in 1:length(flds)) { ## for each fold

    ## get training and testing data
    vowel_trn <- vowel.train[-flds[[tst_idx]],]
```

```

vowel_tst <- vowel.train[ flds[[tst_idx]],]

## fit kNN model to training data
rf_fit <- randomForest(y ~ ., mtry=mtry,nodeSize = node, data=vowel_trn)

#calculate classification error
cverr[tst_idx]=mean(rf_fit$err.rate[,1])
}
return(mean(cverr))
}

err_table <- expand.grid(mtry = c(3,4,5),node= c(1,5,10,20,40,80),error = NA)
for (i in 1:nrow(err_table)) {
  err_table[i,3] <- cvrf(mtry=err_table[i,1],node=err_table[i,2],flds = vowel_flds)
}
err_table

```

```

##      mtry node      error
## 1         3      1 0.03716894
## 2         4      1 0.04199141
## 3         5      1 0.04710284
## 4         3      5 0.04810665
## 5         4      5 0.05439892
## 6         5      5 0.05713645
## 7         3     10 0.07278918
## 8         4     10 0.07396963
## 9         5     10 0.08288215
## 10        3     20 0.15097332
## 11        4     20 0.16807116
## 12        5     20 0.17331427
## 13        3     40 0.30545630
## 14        4     40 0.32130238
## 15        5     40 0.32657510
## 16        3     80 0.47344537
## 17        4     80 0.48685429
## 18        5     80 0.50153679

```

- After tuning the table, we found out that when the mtry is 3 and node is 1 gives the smallest error.

Question 5:

```

set.seed(10)
tune_model <- randomForest(y ~ ., data=vowel.train,mtry=3,nodeSize=1)
test_feature = vowel.test[,2:ncol(vowel.test)]
test_variable = as.factor(vowel.test$y)
predic_test = predict(tune_model, newdata = test_feature)
#cverr = rep(NA, length(test_feature))

confusionMatrix(predic_test, test_variable)

```

```

## Confusion Matrix and Statistics
##
##           Reference
## Prediction  1  2  3  4  5  6  7  8  9 10 11
##           1 35  0  0  0  0  0  0  0  0  3  0
##           2  6 24  3  0  0  0  0  0  1 15  1
##           3  1 14 28  3  0  0  0  0  0  1  0
##           4  0  0  5 30  3  0  0  0  0  0  1
##           5  0  0  0  0 18 10  9  0  0  0  0
##           6  0  0  2  9 17 23  3  0  0  0  5
##           7  0  0  0  0  4  0 27  7  5  0  4
##           8  0  0  0  0  0  0  0 30  6  0  0
##           9  0  4  0  0  0  0  3  5 23  1 14
##          10  0  0  0  0  0  0  0  0  2 22  0
##          11  0  0  4  0  0  9  0  0  5  0 17
##
## Overall Statistics
##
##           Accuracy : 0.5996
##           95% CI : (0.5533, 0.6446)
##       No Information Rate : 0.0909
##       P-Value [Acc > NIR] : < 2.2e-16
##
##           Kappa : 0.5595
##
## Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##           Class: 1 Class: 2 Class: 3 Class: 4 Class: 5 Class: 6
## Sensitivity      0.83333  0.57143  0.66667  0.71429  0.42857  0.54762
## Specificity      0.99286  0.93810  0.95476  0.97857  0.95476  0.91429
## Pos Pred Value   0.92105  0.48000  0.59574  0.76923  0.48649  0.38983
## Neg Pred Value   0.98349  0.95631  0.96627  0.97163  0.94353  0.95285
## Prevalence       0.09091  0.09091  0.09091  0.09091  0.09091  0.09091
## Detection Rate   0.07576  0.05195  0.06061  0.06494  0.03896  0.04978
## Detection Prevalence 0.08225  0.10823  0.10173  0.08442  0.08009  0.12771
## Balanced Accuracy 0.91310  0.75476  0.81071  0.84643  0.69167  0.73095
##
##           Class: 7 Class: 8 Class: 9 Class: 10 Class: 11
## Sensitivity      0.64286  0.71429  0.54762  0.52381  0.40476
## Specificity      0.95238  0.98571  0.93571  0.99524  0.95714
## Pos Pred Value   0.57447  0.83333  0.46000  0.91667  0.48571
## Neg Pred Value   0.96386  0.97183  0.95388  0.95434  0.94145
## Prevalence       0.09091  0.09091  0.09091  0.09091  0.09091
## Detection Rate   0.05844  0.06494  0.04978  0.04762  0.03680
## Detection Prevalence 0.10173  0.07792  0.10823  0.05195  0.07576
## Balanced Accuracy 0.79762  0.85000  0.74167  0.75952  0.68095

```

- Based on the confusion matrix, the misclassification rate is about 41%.