

Fitness Models

Joseph R. Taylor

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JHU/Coursera Data Science Specialization

Practical Machine Learning - Project

Background

“Using devices such as Jawbone Up, Nike FuelBand, and Fitbit it is now possible to collect a large amount of data about personal activity relatively inexpensively. These type of devices are part of the quantified self movement - a group of enthusiasts who take measurements about themselves regularly to improve their health, to find patterns in their behavior, or because they are tech geeks. One thing that people regularly do is quantify how much of a particular activity they do, but they rarely quantify how well they do it. In this project, your goal will be to use data from accelerometers on the belt, forearm, arm, and dumbbell of 6 participants. They were asked to perform barbell lifts correctly and incorrectly in 5 different ways. More information is available from the website <http://groupware.les.inf.puc-rio.br/har>

Data

The training data for this project are available here:

<https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv>

The test data are available here:

<https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv>

I downloaded the data externally and will now begin operations on them.

```
setwd("~/Coursera/Practical Machine Learning")
train <- read.csv(file="pml-training.csv",head=TRUE,sep=",")
test <- read.csv(file="pml-testing.csv",head=TRUE,sep=",")
```

A look at the training data reveals:

```
dim(train)
```

```
## [1] 19622 160
```

19622 observations and 160 features.

The distribution of the five classes sitting-down, standing-up, standing, walking, and sitting), labeled A Through E, respectively, are:

```
table(train$classe)
```

```
##  
##      A      B      C      D      E  
## 5580 3797 3422 3216 3607
```

Preprocessing

Partitioning Separate the training data and test data so that we can validate our model

```
library(caret)
```

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

```
set.seed(314159)  
trainset <- createDataPartition(train$classe, p = 0.7, list = FALSE)  
training <- train[trainset, ]  
testing <- train[-trainset, ]
```

Selecting Features Clean up near-zero variance features, columns with missing values and descriptive fields.

```
# exclude near zero variance features  
nzvcol <- nearZeroVar(training)  
training <- training[, -nzvcol]  
  
# exclude columns with 40% or more missing values exclude descriptive  
# columns like name etc  
cntlength <- sapply(training, function(x) {  
  sum(!(is.na(x) | x == ""))  
})  
nullcol <- names(cntlength[cntlength < 0.6 * length(training$classe)])  
descriptcol <- c("X", "user_name", "raw_timestamp_part_1",  
  "raw_timestamp_part_2", "cvtd_timestamp", "new_window",  
  "num_window")  
excludecols <- c(descriptcol, nullcol)  
training <- training[, !names(training) %in% excludecols]
```

Train the Model

Using RandomForest

```
library(randomForest)
```

```
## randomForest 4.6-10  
## Type rfNews() to see new features/changes/bug fixes.
```

With ten trees

```
ranformodel <- randomForest(classe ~ ., data = training, importance = TRUE,  
                             ntrees = 10)
```

Validation

```
ptraining <- predict(ranformodel, training)  
print(confusionMatrix(ptraining, training$classe))
```

Accuracy of Training Set

```
## Confusion Matrix and Statistics  
##  
##           Reference  
## Prediction    A    B    C    D    E  
##           A 3906    0    0    0    0  
##           B    0 2658    0    0    0  
##           C    0    0 2396    0    0  
##           D    0    0    0 2252    0  
##           E    0    0    0    0 2525  
##  
## Overall Statistics  
##  
##           Accuracy : 1  
##           95% CI : (0.9997, 1)  
##           No Information Rate : 0.2843  
##           P-Value [Acc > NIR] : < 2.2e-16  
##  
##           Kappa : 1  
##           McNemar's Test P-Value : NA  
##  
## Statistics by Class:  
##  
##           Class: A Class: B Class: C Class: D Class: E  
## Sensitivity           1.0000  1.0000  1.0000  1.0000  1.0000  
## Specificity           1.0000  1.0000  1.0000  1.0000  1.0000  
## Pos Pred Value        1.0000  1.0000  1.0000  1.0000  1.0000  
## Neg Pred Value        1.0000  1.0000  1.0000  1.0000  1.0000  
## Prevalence            0.2843  0.1935  0.1744  0.1639  0.1838  
## Detection Rate        0.2843  0.1935  0.1744  0.1639  0.1838  
## Detection Prevalence  0.2843  0.1935  0.1744  0.1639  0.1838  
## Balanced Accuracy      1.0000  1.0000  1.0000  1.0000  1.0000
```

One would expect this level of performance against the training set

```
pctest <- predict(ranformodel, testing)  
print(confusionMatrix(pctest, testing$classe))
```

Accuracy of Test Set

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   A     B     C     D     E
##           A 1674     6     0     0     0
##           B     0 1132     7     0     0
##           C     0     1 1019     8     0
##           D     0     0     0  955     1
##           E     0     0     0     1 1081
##
## Overall Statistics
##
##           Accuracy : 0.9959
##           95% CI : (0.9939, 0.9974)
##           No Information Rate : 0.2845
##           P-Value [Acc > NIR] : < 2.2e-16
##
##           Kappa : 0.9948
##           McNemar's Test P-Value : NA
##
## Statistics by Class:
##
##           Class: A Class: B Class: C Class: D Class: E
## Sensitivity       1.0000   0.9939   0.9932   0.9907   0.9991
## Specificity       0.9986   0.9985   0.9981   0.9998   0.9998
## Pos Pred Value    0.9964   0.9939   0.9912   0.9990   0.9991
## Neg Pred Value     1.0000   0.9985   0.9986   0.9982   0.9998
## Prevalence        0.2845   0.1935   0.1743   0.1638   0.1839
## Detection Rate    0.2845   0.1924   0.1732   0.1623   0.1837
## Detection Prevalence 0.2855   0.1935   0.1747   0.1624   0.1839
## Balanced Accuracy  0.9993   0.9962   0.9957   0.9952   0.9994
```

The cross-validation accuracy is 99.6%. The out-of-sample error is 0.4%. The model performs well.

Test Set Prediction

```
predtest <- predict(ranformodel, testing)
predtest
```

```
##      3      6      7      8     10     16     20     24     27     29     34     35
##      A      A      A      A      A      A      A      A      A      A      A      A
##     39     42     44     45     47     49     52     53     58     63     64     67
##      A      A      A      A      A      A      A      A      A      A      A      A
##     75     78     81     82     83     85     86     94     95     98    100    104
##      A      A      A      A      A      A      A      A      A      A      A      A
##    109    110    113    116    124    126    128    131    133    140    142    144
##      A      A      A      A      A      A      A      A      A      A      A      A
##    146    150    155    164    165    166    167    173    179    181    184    185
##      A      A      A      A      A      A      A      A      A      A      A      A
##    187    188    190    193    194    197    200    202    205    206    210    227
```

##	A	A	A	A	A	A	A	A	A	A	A	A
##	229	232	240	244	249	253	265	271	273	275	277	291
##	A	A	A	A	A	A	A	A	A	A	A	A
##	293	300	307	308	309	310	314	316	317	318	329	330
##	A	A	A	A	A	A	A	A	A	A	A	A
##	334	335	337	339	344	352	354	355	357	362	370	372
##	A	A	A	A	A	A	A	A	A	A	A	A
##	382	383	384	386	387	388	392	403	405	409	414	415
##	A	A	A	A	A	A	A	A	A	A	A	A
##	416	418	420	421	425	426	429	432	437	440	445	446
##	A	A	A	A	A	A	A	A	A	A	A	A
##	450	455	461	462	464	466	467	475	478	480	482	483
##	A	A	A	A	A	A	A	A	A	A	A	A
##	484	488	490	491	497	500	505	509	511	512	515	516
##	A	A	A	A	A	A	A	A	A	A	A	A
##	528	532	536	537	539	542	547	548	549	552	554	559
##	A	A	A	A	A	A	A	A	A	A	A	A
##	560	561	562	563	573	574	585	602	608	610	611	615
##	A	A	A	A	A	A	A	A	A	A	A	A
##	616	617	618	623	626	627	632	633	639	642	650	655
##	A	A	A	A	A	A	A	A	A	A	A	A
##	658	661	665	671	678	685	686	687	694	699	701	703
##	A	A	A	A	A	A	A	A	A	A	A	A
##	708	710	724	729	730	741	742	744	748	749	750	751
##	A	A	A	A	A	A	A	A	A	A	A	A
##	752	758	760	762	763	766	769	774	775	776	777	778
##	A	A	A	A	A	A	A	A	A	A	A	A
##	781	782	786	787	791	794	795	803	804	808	816	821
##	A	A	A	A	A	A	A	A	A	A	A	A
##	822	826	830	841	843	844	845	850	857	858	863	866
##	A	A	A	A	A	A	A	A	A	A	A	A
##	869	870	871	876	878	882	884	887	893	897	901	905
##	A	A	A	A	A	A	A	A	A	A	A	A
##	909	921	922	926	932	937	938	939	940	943	952	953
##	A	A	A	A	A	A	A	A	A	A	A	A
##	955	956	965	971	975	980	983	990	995	1000	1002	1005
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1007	1015	1023	1024	1027	1036	1038	1043	1064	1065	1067	1068
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1070	1072	1081	1082	1084	1086	1089	1093	1096	1097	1098	1102
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1106	1111	1113	1116	1117	1120	1122	1123	1124	1130	1132	1133
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1139	1140	1141	1142	1154	1163	1164	1172	1173	1174	1179	1181
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1189	1193	1194	1196	1198	1200	1213	1217	1218	1224	1226	1228
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1230	1231	1243	1250	1251	1253	1256	1258	1261	1265	1269	1276
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1277	1288	1289	1291	1295	1297	1302	1306	1312	1323	1325	1328
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1329	1330	1332	1333	1335	1338	1339	1346	1349	1350	1351	1352
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1354	1357	1358	1359	1363	1366	1367	1369	1371	1373	1377	1378

##	A	A	A	A	A	A	A	A	A	A	A	A
##	1381	1384	1385	1387	1394	1399	1407	1409	1413	1415	1422	1423
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1429	1431	1434	1436	1437	1440	1442	1443	1444	1449	1450	1451
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1452	1454	1455	1460	1461	1467	1469	1470	1471	1475	1480	1481
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1483	1486	1489	1497	1498	1500	1501	1504	1505	1506	1509	1511
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1512	1514	1517	1518	1519	1523	1525	1527	1528	1547	1548	1549
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1550	1552	1562	1563	1564	1575	1577	1579	1583	1586	1588	1592
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1596	1597	1599	1602	1603	1607	1609	1615	1617	1619	1622	1625
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1627	1628	1629	1631	1635	1644	1645	1647	1652	1656	1659	1663
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1666	1670	1676	1677	1679	1683	1684	1688	1689	1697	1698	1704
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1712	1713	1714	1718	1720	1722	1724	1734	1735	1742	1743	1745
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1755	1756	1757	1758	1762	1763	1764	1765	1782	1785	1786	1791
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1792	1795	1799	1801	1805	1813	1817	1819	1820	1822	1828	1834
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1835	1841	1848	1854	1865	1866	1868	1869	1872	1874	1875	1876
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1879	1884	1885	1886	1891	1895	1897	1898	1902	1904	1911	1912
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1917	1918	1921	1922	1923	1927	1928	1929	1931	1937	1939	1943
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1945	1947	1957	1959	1961	1967	1971	1981	1982	1983	1984	1986
##	A	A	A	A	A	A	A	A	A	A	A	A
##	1990	1992	1993	1994	1996	1998	1999	2002	2009	2013	2015	2017
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2018	2019	2023	2025	2028	2030	2032	2035	2040	2042	2047	2050
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2051	2052	2057	2058	2060	2062	2063	2064	2066	2070	2071	2072
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2077	2087	2090	2093	2101	2103	2104	2109	2111	2114	2119	2122
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2123	2134	2137	2139	2151	2152	2154	2155	2156	2161	2162	2164
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2172	2173	2176	2183	2185	2188	2194	2202	2205	2214	2218	2219
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2222	2226	2230	2234	2235	2238	2240	2242	2246	2247	2248	2249
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2258	2265	2271	2272	2275	2276	2278	2280	2282	2283	2286	2291
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2292	2298	2316	2324	2325	2328	2330	2335	2337	2339	2341	2342
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2347	2351	2352	2364	2380	2387	2388	2392	2393	2394	2395	2410
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2412	2415	2422	2432	2433	2436	2438	2439	2440	2443	2448	2451

##	A	A	A	A	A	A	A	A	A	A	A	A
##	2465	2466	2468	2472	2474	2485	2487	2493	2497	2503	2508	2510
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2511	2513	2518	2523	2525	2526	2527	2528	2530	2531	2533	2534
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2538	2539	2541	2542	2543	2545	2548	2551	2556	2559	2562	2563
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2565	2567	2568	2569	2571	2572	2588	2590	2595	2600	2610	2622
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2624	2635	2637	2638	2641	2642	2643	2644	2645	2647	2649	2650
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2653	2654	2665	2668	2669	2670	2673	2675	2678	2680	2681	2684
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2691	2696	2698	2703	2707	2709	2711	2714	2717	2723	2733	2738
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2739	2741	2742	2750	2759	2767	2768	2774	2775	2776	2777	2779
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2780	2788	2789	2797	2800	2804	2805	2806	2807	2808	2809	2810
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2812	2817	2821	2823	2827	2832	2837	2839	2840	2841	2847	2848
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2850	2851	2852	2853	2855	2856	2860	2865	2866	2871	2879	2881
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2884	2889	2890	2892	2896	2900	2904	2906	2914	2934	2942	2946
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2947	2949	2950	2951	2952	2954	2959	2960	2961	2965	2969	2972
##	A	A	A	A	A	A	A	A	A	A	A	A
##	2973	2982	2987	2996	2998	2999	3000	3002	3004	3005	3006	3008
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3009	3010	3011	3014	3020	3021	3022	3026	3027	3029	3032	3038
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3039	3041	3047	3050	3060	3061	3062	3068	3071	3072	3073	3074
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3081	3086	3087	3089	3090	3092	3095	3098	3115	3116	3117	3118
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3121	3124	3125	3130	3131	3133	3134	3135	3137	3146	3147	3149
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3154	3157	3163	3174	3177	3184	3185	3186	3191	3192	3197	3198
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3199	3203	3207	3208	3217	3218	3219	3222	3224	3227	3229	3231
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3235	3240	3242	3249	3254	3261	3264	3265	3266	3271	3272	3279
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3280	3283	3285	3298	3299	3302	3317	3318	3319	3322	3325	3328
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3332	3333	3338	3345	3346	3349	3356	3361	3363	3364	3365	3366
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3368	3370	3371	3374	3375	3376	3380	3384	3386	3388	3389	3398
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3406	3409	3424	3428	3431	3432	3434	3439	3440	3441	3442	3444
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3445	3451	3453	3459	3466	3469	3471	3472	3486	3487	3492	3495
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3496	3516	3517	3519	3521	3522	3528	3529	3530	3531	3542	3545

##	A	A	A	A	A	A	A	A	A	A	A	A
##	3547	3548	3559	3560	3561	3562	3568	3569	3570	3572	3575	3577
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3580	3583	3589	3590	3595	3596	3597	3599	3600	3602	3604	3605
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3607	3609	3612	3613	3614	3618	3619	3623	3625	3626	3627	3628
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3631	3633	3643	3648	3655	3657	3659	3661	3664	3666	3667	3672
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3679	3680	3687	3688	3693	3696	3697	3698	3699	3704	3705	3715
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3716	3718	3725	3727	3728	3729	3730	3731	3734	3736	3738	3741
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3744	3747	3748	3752	3755	3761	3764	3765	3766	3769	3771	3775
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3777	3778	3782	3784	3791	3793	3797	3799	3800	3801	3810	3812
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3813	3821	3823	3843	3844	3846	3849	3850	3852	3853	3855	3859
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3861	3864	3867	3870	3871	3882	3886	3889	3891	3896	3898	3900
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3905	3907	3908	3910	3915	3918	3924	3928	3933	3942	3945	3946
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3959	3963	3964	3968	3973	3976	3979	3982	3984	3985	3987	3993
##	A	A	A	A	A	A	A	A	A	A	A	A
##	3995	3999	4001	4006	4009	4012	4013	4022	4027	4032	4036	4039
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4044	4047	4052	4056	4059	4067	4068	4077	4079	4085	4089	4093
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4094	4097	4104	4113	4115	4116	4119	4125	4128	4129	4131	4134
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4135	4138	4142	4145	4147	4148	4151	4152	4153	4162	4166	4169
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4173	4174	4175	4178	4179	4182	4192	4195	4199	4208	4213	4216
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4217	4219	4220	4221	4222	4224	4227	4233	4237	4241	4242	4244
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4248	4250	4254	4261	4263	4267	4268	4269	4275	4283	4284	4287
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4290	4293	4296	4299	4301	4306	4314	4316	4317	4320	4321	4323
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4330	4335	4336	4337	4343	4344	4345	4347	4349	4353	4354	4355
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4356	4357	4359	4361	4365	4366	4368	4370	4373	4374	4375	4377
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4381	4382	4390	4393	4397	4404	4405	4411	4416	4419	4421	4423
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4425	4427	4430	4431	4433	4435	4436	4438	4440	4442	4454	4455
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4459	4460	4462	4470	4473	4475	4480	4487	4488	4495	4496	4506
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4509	4511	4515	4520	4526	4534	4543	4546	4552	4553	4561	4562
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4564	4569	4577	4580	4586	4587	4588	4589	4590	4594	4598	4601

##	A	A	A	A	A	A	A	A	A	A	A	A
##	4605	4606	4607	4609	4610	4611	4612	4615	4624	4626	4631	4633
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4634	4636	4640	4643	4648	4652	4654	4656	4657	4660	4661	4665
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4668	4669	4670	4671	4676	4679	4683	4684	4685	4686	4689	4693
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4697	4699	4707	4711	4712	4713	4714	4722	4726	4727	4728	4733
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4734	4738	4741	4744	4749	4752	4753	4773	4774	4775	4778	4782
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4783	4785	4787	4795	4800	4801	4808	4809	4812	4816	4819	4823
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4826	4828	4832	4837	4846	4847	4850	4854	4858	4863	4864	4866
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4870	4872	4874	4878	4880	4882	4883	4884	4887	4888	4891	4909
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4920	4928	4929	4930	4934	4937	4939	4940	4945	4948	4949	4951
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4953	4954	4955	4956	4957	4962	4963	4971	4972	4974	4976	4978
##	A	A	A	A	A	A	A	A	A	A	A	A
##	4980	4987	4989	4990	4992	4999	5004	5005	5008	5014	5015	5023
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5025	5026	5027	5028	5035	5036	5039	5042	5044	5045	5046	5049
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5051	5060	5063	5065	5066	5068	5070	5072	5073	5077	5082	5084
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5087	5090	5093	5099	5100	5103	5105	5116	5118	5121	5124	5125
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5127	5129	5130	5133	5138	5143	5144	5147	5151	5152	5159	5162
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5163	5172	5174	5176	5178	5180	5183	5185	5187	5191	5198	5201
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5202	5205	5210	5215	5219	5222	5225	5231	5234	5235	5242	5252
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5253	5264	5269	5273	5274	5280	5295	5302	5303	5304	5306	5309
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5310	5312	5315	5317	5324	5327	5328	5330	5334	5335	5336	5337
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5345	5348	5350	5351	5357	5360	5361	5362	5363	5374	5377	5378
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5382	5384	5388	5396	5397	5399	5400	5403	5405	5410	5411	5412
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5414	5415	5421	5424	5425	5426	5436	5444	5449	5460	5466	5467
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5470	5472	5480	5483	5485	5486	5489	5491	5499	5500	5506	5507
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5509	5511	5517	5518	5520	5521	5522	5526	5527	5531	5533	5534
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5538	5540	5543	5544	5545	5546	5550	5554	5555	5556	5557	5560
##	A	A	A	A	A	A	A	A	A	A	A	A
##	5566	5570	5572	5573	5577	5578	5582	5585	5588	5589	5590	5592
##	A	A	A	A	A	A	A	B	B	B	B	B
##	5593	5594	5595	5600	5603	5604	5606	5612	5613	5614	5615	5619

##	B	B	B	B	B	B	B	B	B	B	B	B
##	5620	5621	5622	5626	5627	5628	5629	5631	5632	5633	5641	5642
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5646	5649	5654	5664	5669	5670	5672	5677	5681	5685	5687	5692
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5700	5707	5708	5709	5710	5713	5718	5722	5723	5734	5735	5740
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5741	5742	5746	5748	5749	5753	5756	5757	5759	5763	5764	5766
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##	5768	5771	5773	5779	5783	5784	5786	5790	5793	5794	5798	5799
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##	5804	5805	5809	5817	5821	5826	5833	5835	5836	5840	5842	5849
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5853	5855	5860	5862	5871	5873	5877	5879	5880	5884	5886	5888
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##	5889	5893	5896	5900	5903	5906	5908	5911	5914	5916	5920	5921
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5925	5926	5927	5928	5936	5944	5948	5950	5953	5954	5960	5961
##	B	B	B	B	B	B	B	B	B	B	B	B
##	5967	5969	5977	5979	5981	5987	5992	5998	6002	6006	6007	6008
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6009	6019	6025	6029	6032	6034	6038	6045	6047	6049	6058	6063
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6065	6070	6071	6075	6076	6078	6080	6083	6092	6099	6101	6103
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6112	6116	6122	6126	6127	6129	6130	6133	6136	6139	6141	6143
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##	6145	6147	6149	6151	6156	6158	6160	6162	6164	6167	6168	6171
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6172	6176	6178	6182	6184	6187	6190	6193	6195	6201	6208	6211
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6212	6213	6215	6220	6222	6228	6235	6238	6240	6241	6248	6254
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6258	6263	6264	6278	6280	6281	6289	6294	6298	6304	6307	6308
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6309	6313	6314	6318	6319	6327	6329	6332	6333	6334	6336	6337
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6340	6343	6344	6349	6350	6353	6354	6356	6360	6362	6363	6367
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6374	6375	6382	6385	6391	6392	6394	6399	6400	6403	6406	6413
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6415	6420	6425	6427	6429	6432	6436	6439	6440	6442	6453	6454
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6455	6456	6458	6461	6466	6475	6476	6485	6488	6495	6496	6497
##	B	B	B	B	B	B	A	B	B	B	B	B
##	6507	6512	6514	6521	6523	6524	6535	6540	6544	6550	6552	6558
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6561	6564	6566	6578	6583	6584	6585	6589	6596	6599	6601	6602
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6605	6608	6611	6618	6620	6626	6627	6629	6631	6633	6634	6643
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6644	6645	6649	6651	6652	6658	6661	6662	6665	6667	6671	6678
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6681	6684	6685	6686	6689	6690	6691	6698	6700	6705	6707	6708

##	B	B	B	B	B	B	B	B	B	B	B	B
##	6709	6713	6714	6717	6718	6719	6728	6741	6744	6746	6747	6750
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6754	6757	6759	6763	6772	6773	6779	6780	6783	6789	6791	6797
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6801	6802	6804	6807	6814	6817	6820	6828	6835	6837	6841	6844
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6846	6849	6850	6857	6859	6864	6866	6875	6876	6878	6882	6886
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6891	6892	6893	6898	6902	6903	6904	6905	6906	6908	6910	6912
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##	6914	6916	6917	6920	6922	6925	6927	6928	6930	6932	6933	6939
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##	6941	6945	6950	6954	6955	6957	6959	6961	6964	6969	6976	6978
##	B	B	B	B	B	B	B	B	B	B	B	B
##	6979	6980	6981	6985	6986	6989	6990	6992	6995	6998	7000	7001
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7002	7004	7009	7012	7021	7022	7024	7027	7029	7032	7033	7037
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7040	7042	7049	7050	7051	7052	7055	7056	7057	7063	7067	7070
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7073	7076	7080	7083	7086	7087	7092	7098	7100	7102	7110	7111
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7112	7118	7119	7122	7123	7125	7130	7131	7135	7138	7139	7142
##	B	B	B	C	B	B	B	B	B	B	B	B
##	7152	7153	7155	7157	7163	7176	7183	7184	7186	7187	7191	7193
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7194	7195	7197	7199	7203	7214	7216	7218	7220	7221	7227	7228
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7230	7240	7241	7242	7245	7248	7249	7253	7255	7256	7258	7265
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7273	7276	7278	7284	7286	7288	7289	7291	7295	7299	7305	7308
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7312	7316	7318	7319	7324	7332	7338	7339	7340	7342	7343	7347
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7348	7349	7350	7355	7357	7360	7361	7365	7372	7373	7374	7377
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7378	7380	7382	7386	7387	7388	7391	7394	7396	7397	7404	7405
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7406	7412	7413	7418	7419	7423	7425	7427	7428	7429	7431	7433
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7435	7438	7441	7446	7448	7450	7451	7454	7455	7462	7466	7472
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7475	7479	7484	7491	7493	7494	7503	7505	7506	7511	7513	7515
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7520	7527	7531	7538	7539	7542	7544	7546	7547	7548	7552	7553
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7562	7563	7570	7571	7573	7574	7575	7584	7593	7596	7598	7599
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7602	7603	7608	7611	7614	7618	7621	7623	7624	7626	7630	7634
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7635	7641	7642	7644	7645	7649	7650	7654	7657	7660	7666	7669
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7672	7678	7681	7684	7699	7712	7715	7718	7720	7722	7724	7727

##	B	B	B	B	B	B	B	B	B	B	B	B
##	7728	7731	7736	7738	7757	7764	7774	7775	7784	7787	7791	7794
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7806	7811	7812	7813	7814	7820	7823	7825	7832	7834	7842	7847
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7853	7859	7861	7862	7864	7865	7866	7869	7870	7873	7874	7876
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7878	7884	7891	7895	7896	7902	7904	7905	7907	7911	7920	7923
##	B	B	B	B	B	B	B	B	B	B	B	B
##	7925	7933	7934	7950	7951	7957	7962	7966	7967	7968	7969	7972
##	B	B	B	B	B	A	B	B	B	B	B	B
##	7974	7976	7985	7986	7987	7989	7990	7993	7994	7996	7997	8000
##	B	B	A	A	B	B	B	B	B	B	B	B
##	8004	8009	8010	8013	8016	8022	8024	8031	8034	8038	8039	8044
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8058	8062	8065	8067	8068	8070	8089	8090	8092	8102	8109	8126
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8129	8134	8138	8139	8149	8152	8156	8157	8159	8162	8163	8167
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8173	8174	8182	8183	8188	8191	8193	8198	8200	8210	8217	8219
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##	8221	8222	8224	8225	8226	8227	8234	8235	8238	8243	8248	8252
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8261	8262	8263	8268	8269	8270	8279	8280	8281	8282	8283	8284
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8287	8290	8291	8294	8296	8300	8301	8306	8309	8312	8315	8316
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8322	8325	8326	8329	8336	8338	8340	8343	8345	8348	8349	8356
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8361	8362	8363	8373	8376	8382	8387	8390	8392	8393	8399	8400
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8402	8405	8417	8419	8423	8425	8428	8429	8431	8433	8434	8435
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8437	8438	8439	8441	8442	8443	8454	8457	8464	8465	8466	8469
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8471	8473	8475	8478	8482	8483	8488	8503	8504	8505	8507	8510
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8515	8522	8523	8530	8533	8539	8540	8545	8551	8552	8553	8556
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8558	8559	8565	8572	8577	8582	8584	8585	8587	8593	8600	8612
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8613	8614	8617	8619	8621	8622	8623	8625	8627	8635	8648	8661
##	B	B	B	A	B	B	B	B	B	B	B	B
##	8664	8669	8673	8674	8676	8680	8682	8686	8687	8689	8696	8704
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8705	8708	8714	8718	8722	8723	8725	8728	8730	8733	8736	8740
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8742	8749	8750	8751	8754	8758	8763	8765	8767	8770	8773	8777
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8781	8782	8789	8790	8793	8799	8804	8806	8807	8808	8809	8810
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8816	8818	8821	8824	8825	8826	8830	8836	8841	8842	8844	8846
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8848	8850	8853	8857	8859	8862	8863	8868	8873	8876	8881	8888

##	B	B	B	B	B	B	B	B	B	B	B	B
##	8898	8901	8904	8907	8916	8918	8924	8925	8928	8929	8932	8950
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8962	8966	8977	8979	8980	8982	8985	8986	8988	8990	8992	8995
##	B	B	B	B	B	B	B	B	B	B	B	B
##	8996	8997	8998	9002	9003	9007	9008	9011	9012	9015	9017	9019
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9023	9026	9031	9033	9038	9041	9045	9049	9053	9054	9057	9058
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9060	9061	9063	9066	9068	9072	9081	9084	9085	9089	9092	9094
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9097	9098	9099	9104	9107	9110	9111	9114	9116	9120	9121	9123
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9124	9126	9128	9135	9137	9140	9144	9151	9152	9156	9160	9161
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9163	9172	9176	9178	9180	9182	9184	9191	9193	9198	9200	9202
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9203	9206	9207	9208	9213	9217	9218	9219	9225	9228	9229	9237
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9240	9242	9244	9245	9258	9265	9267	9269	9274	9275	9276	9279
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9281	9283	9288	9294	9296	9297	9298	9300	9302	9303	9310	9324
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9325	9327	9336	9348	9349	9350	9351	9355	9357	9360	9361	9362
##	B	B	B	B	B	B	B	B	B	B	B	B
##	9365	9367	9371	9374	9377	9380	9381	9382	9387	9389	9391	9394
##	B	B	B	B	B	C	C	C	C	C	C	C
##	9396	9400	9405	9406	9407	9416	9418	9420	9423	9425	9427	9433
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9441	9445	9452	9460	9461	9462	9468	9470	9479	9482	9486	9488
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9497	9499	9500	9508	9512	9514	9517	9521	9526	9527	9532	9547
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9548	9549	9550	9551	9555	9557	9559	9563	9565	9571	9572	9573
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9574	9575	9577	9581	9582	9584	9597	9601	9609	9611	9612	9617
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9618	9620	9627	9630	9633	9635	9640	9643	9644	9645	9648	9650
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9654	9659	9664	9668	9677	9681	9683	9685	9687	9688	9689	9691
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9692	9693	9697	9703	9706	9710	9714	9715	9716	9718	9719	9721
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9730	9733	9734	9735	9742	9743	9745	9746	9747	9750	9754	9759
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9763	9766	9767	9772	9775	9776	9777	9779	9780	9790	9791	9792
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9798	9799	9801	9817	9818	9819	9820	9825	9829	9832	9833	9834
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9839	9840	9844	9846	9854	9855	9856	9861	9863	9866	9871	9872
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9877	9878	9879	9881	9882	9883	9889	9890	9893	9894	9896	9900
##	C	C	C	C	C	C	C	C	C	C	C	C
##	9903	9911	9915	9918	9932	9934	9935	9937	9945	9948	9949	9951

##	C	C	C	C	C	C	C	C	C	C	C	C
##	9957	9960	9962	9969	9977	9980	9986	9987	9990	9994	9997	9999
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10000	10002	10003	10009	10012	10016	10019	10020	10023	10027	10034	10039
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10040	10048	10054	10056	10058	10059	10060	10061	10064	10065	10067	10069
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10070	10075	10076	10079	10080	10083	10091	10095	10110	10111	10113	10116
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10120	10121	10125	10127	10130	10135	10140	10143	10145	10149	10157	10158
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10160	10162	10164	10165	10169	10173	10179	10186	10187	10188	10190	10196
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10199	10202	10205	10210	10213	10215	10221	10228	10229	10232	10235	10240
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10243	10246	10248	10254	10257	10259	10263	10264	10268	10269	10270	10274
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10283	10292	10293	10294	10298	10302	10303	10309	10312	10314	10315	10318
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10325	10330	10331	10334	10338	10346	10348	10349	10353	10359	10369	10371
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10373	10380	10387	10392	10396	10400	10401	10403	10406	10407	10415	10418
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10431	10432	10437	10443	10447	10449	10451	10454	10457	10458	10459	10461
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10465	10468	10474	10475	10477	10485	10486	10487	10489	10493	10498	10500
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10502	10503	10505	10506	10512	10515	10516	10520	10522	10526	10530	10541
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10545	10546	10548	10549	10551	10552	10553	10555	10558	10559	10568	10572
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10575	10576	10578	10581	10582	10586	10587	10589	10595	10596	10597	10599
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10600	10602	10603	10605	10610	10611	10615	10623	10626	10630	10636	10647
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10648	10649	10658	10664	10667	10672	10678	10681	10684	10689	10690	10693
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10694	10697	10698	10707	10709	10710	10714	10716	10718	10720	10728	10732
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10733	10738	10741	10742	10743	10746	10748	10750	10751	10754	10757	10765
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10773	10776	10777	10783	10785	10799	10800	10812	10817	10821	10824	10826
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10827	10829	10830	10834	10836	10837	10839	10840	10844	10846	10855	10857
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10863	10867	10869	10871	10872	10877	10878	10879	10882	10883	10884	10887
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10891	10897	10900	10901	10903	10905	10907	10911	10921	10923	10930	10931
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10934	10935	10936	10940	10941	10943	10948	10949	10950	10953	10963	10967
##	C	C	C	C	C	C	C	C	C	C	C	C
##	10971	10972	10975	10976	10977	10980	10982	10986	10989	10996	10999	11001
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11009	11010	11012	11016	11018	11020	11023	11028	11030	11031	11034	11039

##	C	C	C	C	C	C	C	C	C	C	C	C
##	11040	11046	11053	11056	11062	11063	11064	11067	11070	11076	11088	11091
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11093	11100	11103	11109	11111	11112	11115	11120	11121	11123	11126	11132
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11135	11136	11137	11146	11150	11154	11163	11164	11165	11169	11170	11173
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11176	11177	11182	11186	11188	11191	11192	11196	11203	11204	11210	11211
##	C	C	C	C	C	C	C	C	C	C	B	C
##	11213	11215	11216	11219	11222	11223	11228	11235	11245	11247	11249	11253
##	C	C	C	C	C	C	C	B	C	C	C	C
##	11255	11263	11267	11270	11274	11276	11277	11279	11280	11282	11283	11285
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11293	11301	11302	11304	11311	11312	11315	11319	11320	11322	11329	11331
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11333	11341	11343	11345	11350	11355	11360	11361	11368	11371	11372	11378
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11380	11381	11385	11391	11394	11395	11403	11406	11409	11411	11414	11415
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11425	11426	11427	11434	11435	11438	11440	11443	11444	11447	11455	11460
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11463	11467	11468	11474	11478	11485	11489	11491	11492	11494	11495	11496
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11497	11499	11507	11513	11515	11516	11522	11524	11525	11526	11529	11543
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11544	11545	11546	11553	11554	11555	11557	11558	11560	11562	11572	11577
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11580	11584	11586	11589	11594	11598	11601	11602	11607	11616	11617	11620
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11621	11624	11626	11627	11629	11631	11633	11637	11649	11657	11660	11662
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11664	11667	11668	11670	11677	11679	11681	11685	11686	11687	11688	11690
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11695	11699	11700	11705	11709	11710	11711	11714	11717	11730	11733	11734
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11735	11740	11742	11743	11745	11747	11749	11751	11752	11753	11762	11768
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11776	11777	11785	11787	11792	11796	11803	11805	11810	11811	11812	11815
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11817	11818	11821	11824	11827	11828	11834	11835	11838	11844	11845	11846
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11847	11850	11852	11858	11860	11870	11871	11873	11881	11883	11886	11887
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11891	11894	11895	11896	11898	11901	11902	11903	11905	11907	11908	11911
##	C	C	C	C	C	C	C	C	C	C	C	C
##	11919	11922	11924	11927	11928	11932	11933	11934	11935	11936	11938	11942
##	C	C	C	C	C	C	B	B	B	B	C	C
##	11951	11954	11958	11965	11966	11967	11969	11976	11977	11978	11980	11985
##	C	C	B	C	C	C	C	C	C	C	C	C
##	11989	11994	11995	11999	12001	12004	12006	12010	12012	12014	12018	12021
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12023	12025	12027	12029	12031	12040	12043	12046	12054	12057	12058	12062
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12071	12072	12074	12077	12078	12079	12085	12088	12089	12090	12091	12105

##	C	C	C	C	C	C	C	C	C	C	C	C
##	12113	12114	12117	12124	12125	12127	12136	12137	12147	12148	12149	12152
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12157	12158	12159	12160	12167	12178	12181	12183	12185	12187	12188	12189
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12190	12192	12195	12197	12199	12209	12210	12212	12214	12225	12227	12230
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12233	12235	12237	12245	12246	12252	12254	12256	12257	12260	12261	12262
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12263	12268	12277	12278	12281	12282	12284	12286	12295	12298	12304	12308
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12309	12311	12321	12327	12331	12334	12342	12343	12344	12345	12347	12352
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12356	12358	12369	12372	12374	12378	12379	12380	12381	12383	12384	12388
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12390	12395	12397	12401	12402	12403	12405	12408	12410	12412	12413	12419
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12423	12425	12426	12433	12435	12437	12443	12445	12447	12448	12449	12451
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12456	12462	12469	12471	12474	12478	12480	12481	12485	12496	12517	12528
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12531	12539	12542	12545	12546	12549	12550	12553	12556	12561	12562	12564
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12567	12569	12570	12571	12575	12578	12582	12587	12590	12603	12605	12607
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12611	12612	12618	12623	12628	12631	12633	12638	12640	12641	12643	12646
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12647	12649	12652	12657	12660	12661	12664	12679	12682	12683	12684	12685
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12687	12688	12690	12691	12694	12698	12700	12703	12704	12707	12708	12715
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12723	12724	12728	12731	12732	12736	12738	12743	12745	12750	12752	12753
##	C	C	C	C	C	C	C	C	C	C	C	C
##	12756	12757	12759	12765	12770	12771	12772	12783	12784	12789	12793	12800
##	C	C	C	C	C	C	C	C	C	C	C	D
##	12802	12804	12805	12810	12811	12812	12814	12815	12816	12820	12821	12836
##	D	D	D	D	D	D	D	D	D	D	D	D
##	12841	12842	12843	12845	12846	12848	12850	12855	12858	12859	12861	12865
##	D	D	D	D	D	D	D	D	D	D	D	D
##	12875	12876	12877	12878	12879	12886	12887	12895	12899	12901	12902	12904
##	D	D	D	D	D	D	D	D	D	D	D	D
##	12906	12908	12913	12924	12926	12936	12937	12940	12942	12943	12951	12957
##	D	D	D	D	D	D	D	D	D	D	D	D
##	12958	12959	12963	12979	12981	12987	12991	12997	12998	12999	13002	13003
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13007	13011	13012	13014	13016	13017	13018	13023	13026	13032	13038	13047
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13050	13054	13058	13060	13063	13064	13069	13071	13073	13078	13080	13081
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13082	13088	13090	13091	13096	13099	13102	13107	13110	13115	13116	13120
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13121	13122	13125	13126	13127	13129	13133	13137	13139	13141	13145	13146
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13147	13148	13149	13157	13158	13160	13165	13173	13179	13181	13182	13185

##	D	D	D	D	D	D	D	D	D	D	D	
##	13189	13190	13191	13192	13194	13198	13202	13203	13204	13212	13214	13217
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13226	13235	13238	13243	13250	13252	13259	13261	13262	13264	13265	13270
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13273	13276	13296	13306	13307	13313	13314	13315	13317	13319	13327	13329
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13330	13336	13338	13342	13346	13352	13354	13359	13372	13378	13379	13381
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13382	13384	13385	13387	13388	13395	13397	13398	13400	13402	13407	13412
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13415	13422	13427	13431	13443	13444	13446	13453	13456	13465	13470	13477
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13485	13487	13496	13503	13506	13507	13508	13509	13511	13512	13517	13519
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13523	13527	13532	13538	13539	13542	13543	13547	13548	13549	13550	13553
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13564	13566	13568	13571	13576	13577	13578	13581	13584	13587	13588	13592
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13593	13610	13617	13618	13620	13622	13624	13625	13629	13631	13638	13639
##	D	D	D	D	D	D	D	D	E	D	D	D
##	13645	13651	13652	13658	13661	13665	13666	13672	13674	13677	13679	13680
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13682	13683	13689	13692	13694	13696	13703	13704	13711	13712	13720	13721
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13722	13725	13727	13729	13732	13736	13740	13741	13751	13753	13758	13764
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13766	13768	13769	13771	13773	13775	13780	13781	13786	13787	13788	13790
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13792	13794	13797	13800	13801	13803	13810	13815	13824	13832	13840	13841
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13843	13846	13849	13850	13851	13853	13857	13858	13866	13871	13874	13877
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13880	13881	13887	13888	13891	13893	13894	13905	13907	13911	13917	13918
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13920	13921	13924	13927	13935	13937	13939	13942	13944	13949	13953	13954
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13958	13959	13960	13961	13963	13965	13969	13971	13973	13974	13977	13982
##	D	D	D	D	D	D	D	D	D	D	D	D
##	13987	13993	13997	13999	14000	14004	14007	14010	14013	14018	14019	14021
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14023	14025	14037	14038	14041	14043	14045	14047	14053	14054	14065	14067
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14069	14075	14076	14080	14083	14087	14088	14095	14103	14117	14118	14119
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14120	14128	14133	14138	14141	14144	14157	14158	14159	14164	14167	14169
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14170	14171	14172	14175	14182	14184	14185	14186	14191	14193	14197	14200
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14204	14209	14212	14213	14217	14219	14224	14226	14227	14233	14235	14239
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14240	14247	14248	14250	14251	14253	14261	14272	14274	14282	14283	14285
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14286	14288	14290	14291	14292	14297	14298	14299	14301	14303	14308	14313

##	D	D	D	D	D	D	D	D	D	D	D	D
##	14314	14320	14323	14326	14330	14342	14345	14348	14351	14354	14365	14367
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14373	14374	14378	14379	14384	14387	14393	14395	14401	14407	14409	14411
##	D	D	D	D	D	D	C	D	D	D	D	D
##	14412	14414	14416	14425	14430	14431	14435	14437	14438	14445	14447	14449
##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
##	14507	14508	14509	14522	14524	14531	14532	14533	14534	14539	14541	14544
##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
##	14584	14585	14591	14592	14593	14598	14599	14602	14603	14605	14606	14612
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14614	14615	14616	14627	14628	14630	14635	14637	14639	14641	14645	14648
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##	14653	14654	14661	14664	14670	14673	14678	14679	14682	14684	14693	14696
##	D	D	D	D	D	D	D	D	D	D	D	D
##	14697	14706	14707	14708	14709	14710	14716	14717	14719	14726	14735	14737
##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	15167	15169	15170	15172	15173	15174	15175	15176	15177	15190	15191	15193
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15194	15195	15202	15204	15206	15207	15209	15210	15216	15218	15219	15221
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15222	15224	15226	15235	15236	15237	15240	15241	15245	15247	15248	15249
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15251	15263	15264	15265	15268	15269	15270	15271	15273	15282	15283	15287
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15289	15291	15297	15300	15306	15314	15315	15316	15321	15322	15323	15324

##	D	D	D	D	D	C	C	C	C	C	C	C
##	15326	15328	15329	15333	15334	15337	15338	15340	15341	15343	15350	15354
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15359	15365	15369	15376	15388	15394	15395	15403	15405	15407	15409	15415
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15420	15421	15424	15431	15435	15441	15442	15449	15451	15454	15456	15457
##	D	D	D	D	D	D	D	D	D	D	D	D
##	15459	15461	15463	15464	15466	15469	15471	15472	15476	15485	15493	15495
##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	D	D	D	D	D	D	D	D	D	D	D	D
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	E	E	E	E	E	E	E	E	E	E	E	E
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##	18587	18588	18592	18593	18594	18595	18602	18606	18607	18611	18615	18618

```

##      E      E      E      E      E      E      E      E      E      E      E      E
## 18619 18620 18621 18622 18626 18627 18629 18631 18633 18634 18635 18637
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18638 18640 18644 18645 18649 18651 18654 18662 18665 18667 18675 18690
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18692 18697 18698 18699 18700 18701 18705 18706 18708 18712 18713 18720
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18721 18722 18729 18733 18736 18740 18743 18745 18746 18747 18752 18753
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18754 18756 18777 18779 18780 18786 18791 18794 18799 18801 18802 18803
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18817 18820 18826 18828 18830 18835 18836 18841 18843 18846 18847 18858
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18859 18865 18866 18867 18871 18873 18882 18891 18892 18893 18894 18895
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18899 18903 18904 18907 18911 18912 18913 18917 18919 18920 18931 18932
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18936 18937 18938 18939 18942 18951 18953 18957 18958 18960 18961 18965
##      E      E      E      E      E      E      E      E      E      E      E      E
## 18966 18971 18972 18973 18977 18992 18995 18998 19010 19011 19013 19018
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19025 19029 19030 19032 19036 19041 19046 19049 19050 19054 19064 19068
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19070 19072 19078 19082 19092 19097 19100 19102 19104 19105 19107 19109
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19114 19117 19119 19121 19122 19123 19125 19126 19129 19132 19137 19139
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19142 19152 19153 19154 19155 19158 19159 19160 19161 19164 19166 19170
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19171 19176 19187 19188 19189 19191 19198 19204 19207 19212 19213 19221
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19231 19232 19235 19242 19243 19245 19247 19248 19252 19254 19255 19256
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19258 19259 19261 19264 19265 19269 19275 19281 19287 19288 19290 19292
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19293 19303 19305 19308 19315 19316 19323 19327 19328 19329 19335 19336
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19338 19342 19345 19346 19348 19349 19352 19355 19356 19357 19358 19359
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19360 19364 19365 19366 19369 19371 19377 19381 19386 19389 19391 19392
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19394 19395 19407 19408 19415 19416 19420 19421 19422 19424 19428 19432
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19435 19436 19441 19448 19451 19456 19457 19460 19463 19466 19467 19469
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19481 19491 19494 19495 19497 19499 19501 19503 19507 19512 19521 19524
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19525 19526 19532 19534 19536 19539 19540 19547 19554 19556 19557 19559
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19562 19564 19567 19570 19571 19572 19580 19583 19588 19589 19591 19594
##      E      E      E      E      E      E      E      E      E      E      E      E
## 19607 19608 19615 19616 19621
##      E      E      E      E      E
## Levels: A B C D E

```

Saving the output to files according to project instructions.

```
answers <- as.vector(pptest)

pml_write_files = function(x) {
  n = length(x)
  for (i in 1:n) {
    filename = paste0("problem_id_", i, ".txt")
    write.table(x[i], file = filename, quote = FALSE, row.names = FALSE,
               col.names = FALSE)
  }
}
pml_write_files(answers)
```