**Assignment No. 17.1**

|  |  |
| --- | --- |
| **Weight Lifting Exercises monitored with Inertial Measurement Units Data Set**  *Download*: [Data Folder](https://archive.ics.uci.edu/ml/machine-learning-databases/00273/), [Data Set Description](https://archive.ics.uci.edu/ml/datasets/Weight+Lifting+Exercises+monitored+with+Inertial+Measurement+Units)  **Abstract**: Six young health subjects were asked to perform 5 variations of the biceps curl weight lifting exercise. One of the variations is the one predicted by the health professional. |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Set Characteristics:** | Multivariate | **Number of Instances:** | 39242 | **Area:** | Physical |
| **Attribute Characteristics:** | Real | **Number of Attributes:** | 152 | **Date Donated** | 2013-11-24 |
| **Associated Tasks:** | Classification | **Missing Values?** | Yes | **Number of Web Hits:** | 31151 |

<http://groupware.les.inf.puc-rio.br/har#dataset>

**5. Problem Statement**

1. Use the below given data set

Data Set

2. Perform the below given activities:

a. Create classification model using logistic regression model

> summary(bicepfit)

Call:

multinom(formula = classe ~ ., data = bicepsdata)

Coefficients:

(Intercept) roll\_belt pitch\_belt yaw\_belt total\_accel\_belt gyros\_belt\_y

B 0.0056481663 -0.09286857 0.01383189 -0.02786265 -0.3527971591 -0.017816086

C -0.0001184700 -0.24310229 0.03989850 0.03379039 0.0009707285 -0.001180997

D -0.0007867376 0.12788829 0.33505434 -0.09328333 -0.1715062203 -0.002259548

E 0.0012169529 -0.16301346 0.16921833 -0.02117848 0.6799481530 -0.002081574

gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y

B -0.0075178176 0.03355632 0.02522581 -0.057427846 -0.002683051 0.030013004

C 0.0007110598 0.01020269 0.07329316 0.056026215 0.064199230 0.051664690

D 0.0018989019 0.05654772 -0.04455943 -0.075267855 -0.022989725 0.011181413

E -0.0355316091 0.11840726 0.05177181 0.002109568 0.014223033 0.004462517

magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm

B 0.022582736 -0.0006042404 -0.014175685 -0.0031195337 -0.14078697

C -0.005387401 -0.0055909722 0.009601380 -0.0045521061 -0.13306868

D 0.077171817 -0.0021115384 -0.003244818 -0.0009766101 -0.10579357

E -0.010098988 0.0027346369 -0.002250155 -0.0079989005 0.04392469

var\_yaw\_arm gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y

B 3.315143e-05 -0.7046604 0.364038642 0.40188051 0.021058990 -0.03071184

C -1.581016e-03 0.2301291 -0.104599491 0.01511176 -0.015191278 -0.06114846

D -2.163272e-04 0.1860136 -0.107529391 -0.01210156 -0.002420023 -0.04936288

E -1.740859e-04 -0.1850022 -0.008379313 -0.11844586 -0.008054722 -0.01851050

accel\_arm\_z magnet\_arm\_x magnet\_arm\_y magnet\_arm\_z roll\_dumbbell pitch\_dumbbell

B 0.01119531 0.0003421558 0.043090980 -0.019012901 0.01088145 -0.06324445

C 0.04486945 0.0066588674 0.017287035 -0.016187450 0.03745435 0.08567962

D 0.02481373 0.0032976117 0.007117672 -0.003207793 0.06258036 -0.04387779

E 0.01025192 0.0018981064 0.016811603 -0.010807575 -0.01946442 -0.04212946

yaw\_dumbbell gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x

B 0.010475802 -0.257432783 0.07930944 -0.043493246 0.07410576

C 0.007188031 0.001273788 0.04325286 -0.022063072 0.01815038

D 0.013156692 -0.043359236 0.10419646 -0.000797721 0.12433592

E -0.001762275 0.180716737 -0.16984633 0.037003971 0.03764797

accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y

B -0.0003944291 -0.039519570 -0.008906665 0.0007222726

C -0.1071737433 -0.060748428 0.004998982 -0.0168698785

D -0.0609385997 -0.119832835 -0.023106518 -0.0018231759

E 0.0238630410 -0.003854708 -0.001691874 -0.0023966141

magnet\_dumbbell\_z roll\_forearm pitch\_forearm yaw\_forearm gyros\_forearm\_x

B -0.0068290503 0.003325624 0.03593980 0.0052592834 -0.05700406

C 0.0187792956 0.007157630 0.04848256 0.0011504516 0.01018190

D 0.0229797622 0.004252770 0.08179933 -0.0001888666 0.03387739

E 0.0004870698 0.011218555 0.04439026 0.0044349352 -0.01431443

gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z

B -0.4306166 -0.17331357 -0.003193898 -0.000174241 0.01481866

C -0.0855400 -0.03751879 0.008135991 0.017329089 0.03513355

D -0.2127364 -0.05695025 0.012611051 0.023625407 -0.02087074

E -0.2735988 -0.24059118 -0.007300572 0.013058261 0.01406542

magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z

B 0.00980364 -0.004884802 0.0093823399

C 0.01255805 -0.013387816 0.0106049827

D 0.01051197 -0.016402290 0.0168426879

E 0.01203847 -0.006825398 0.0007426991

Std. Errors:

(Intercept) roll\_belt pitch\_belt yaw\_belt total\_accel\_belt gyros\_belt\_y

B 0.0011497414 0.1860659 0.19099487 0.05506796 0.05782388 0.0023801498

C 0.0005124009 0.0405869 0.07344609 0.12061617 0.05683777 0.0006912567

D 0.0007119439 0.1380838 0.16014997 0.10247240 0.08838704 0.0008372429

E 0.0011041331 0.1477386 0.20272835 0.05623543 0.08269157 0.0027399323

gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y

B 0.0071892574 0.1187525 0.1657727 0.10604890 0.03886599 0.02207080

C 0.0009990013 0.2348537 0.2442921 0.18327112 0.07986167 0.03685975

D 0.0020386317 0.2163190 0.2811401 0.11802916 0.07326054 0.03356922

E 0.0079431346 0.1376154 0.1547003 0.09809898 0.03387149 0.02135629

magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm var\_yaw\_arm

B 0.02934872 0.008461488 0.02879813 0.007903019 0.1202977 0.0001091965

C 0.07953594 0.015712280 0.03774484 0.024618228 0.2353393 0.0017641114

D 0.05929711 0.021288244 0.05542565 0.022665884 0.2238382 0.0010911770

E 0.02909722 0.011261784 0.03252430 0.012496952 0.1195496 0.0003306235

gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z

B 0.16059745 0.07515453 0.031827059 0.02645585 0.06003341 0.03560594

C 0.05122825 0.02620804 0.011594129 0.03602275 0.10988277 0.06518824

D 0.03619708 0.01783299 0.004167055 0.03990870 0.11516409 0.06509060

E 0.15563685 0.07221285 0.027938394 0.01937821 0.06243972 0.04035475

magnet\_arm\_x magnet\_arm\_y magnet\_arm\_z roll\_dumbbell pitch\_dumbbell yaw\_dumbbell

B 0.008042508 0.02531594 0.01521553 0.03580360 0.09539577 0.03234547

C 0.011873781 0.04944589 0.03151365 0.07127886 0.18025613 0.08519956

D 0.013171113 0.05134282 0.02856481 0.05255579 0.14427327 0.04610722

E 0.006515851 0.02435435 0.01626604 0.03846230 0.10048476 0.03483726

gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x

B 0.022580758 0.04596801 0.022786430 0.08065967

C 0.007472754 0.01439092 0.012900473 0.16101464

D 0.009303077 0.03314011 0.004117131 0.12296023

E 0.019801935 0.04457976 0.023641321 0.08475135

accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y

B 0.05713705 0.05687778 0.01085517 0.02154062

C 0.12354794 0.12499191 0.02261638 0.03725776

D 0.09988679 0.08638342 0.01991574 0.04285199

E 0.06093101 0.06140890 0.01096487 0.02220952

magnet\_dumbbell\_z roll\_forearm pitch\_forearm yaw\_forearm gyros\_forearm\_x

B 0.02797771 0.01044872 0.08336474 0.009522295 0.021748522

C 0.04827904 0.01887736 0.17075865 0.017834989 0.015885588

D 0.04295955 0.01982104 0.12739341 0.018411221 0.006999473

E 0.02665975 0.01111303 0.08404911 0.009828166 0.021107930

gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z

B 0.20463413 0.06370935 0.01690451 0.01963553 0.03371855

C 0.04105812 0.02053358 0.04160702 0.03345972 0.06180440

D 0.07514952 0.02038037 0.03464780 0.03890291 0.06573469

E 0.18158014 0.05427058 0.01835869 0.02141137 0.03415326

magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z

B 0.01126477 0.009548935 0.01123754

C 0.02287231 0.017402157 0.01894196

D 0.01922038 0.018297853 0.01414329

E 0.01300440 0.010113007 0.01319171

Residual Deviance: 50.72021

AIC: 458.7202

b. verify model goodness of fit

> z <- summary(bicepfit)$coefficients/summary(bicepfit)$standard.errors

> p <- (1 - pnorm(abs(z), 0, 1)) \* 2

> p

(Intercept) roll\_belt pitch\_belt yaw\_belt total\_accel\_belt gyros\_belt\_y

B 8.989784e-07 6.176972e-01 0.94226750 0.6128788 1.052512e-09 7.149836e-14

C 8.171550e-01 2.102625e-09 0.58696789 0.7793639 9.863736e-01 8.754766e-02

D 2.691355e-01 3.543604e-01 0.03642701 0.3626504 5.233110e-02 6.959074e-03

E 2.703836e-01 2.698573e-01 0.40388394 0.7064679 2.220446e-16 4.474236e-01

gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y

B 2.956988e-01 0.7775036 0.8790520 0.5881476 0.9449630 0.1738769

C 4.766068e-01 0.9653486 0.7641599 0.7598321 0.4214661 0.1610180

D 3.516162e-01 0.7937772 0.8740664 0.5236653 0.7536670 0.7390699

E 7.704042e-06 0.3895568 0.7378825 0.9828432 0.6745500 0.8344829

magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm var\_yaw\_arm

B 0.4416189 0.9430709 0.6225474 0.6930445 0.2418716 0.7614370

C 0.9459962 0.7219645 0.7992051 0.8533012 0.5717791 0.3701400

D 0.1931068 0.9209890 0.9533156 0.9656320 0.6364742 0.8428485

E 0.7285331 0.8081414 0.9448433 0.5221283 0.7133071 0.5985142

gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z

B 1.145329e-05 1.273356e-06 0.000000e+00 0.4260291 0.6089456 0.7532001

C 7.048142e-06 6.576142e-05 1.924390e-01 0.6732341 0.5778772 0.4912602

D 2.763348e-07 1.641625e-09 3.683067e-03 0.9516467 0.6681919 0.7030413

E 2.345661e-01 9.076238e-01 2.239812e-05 0.6776597 0.7668834 0.7994609

magnet\_arm\_x magnet\_arm\_y magnet\_arm\_z roll\_dumbbell pitch\_dumbbell yaw\_dumbbell

B 0.9660655 0.08873127 0.2114559 0.7611884 0.5073503 0.7460347

C 0.5749310 0.72662752 0.6074865 0.5992619 0.6345578 0.9327647

D 0.8023036 0.88974228 0.9105865 0.2337551 0.7610291 0.7753761

E 0.7708173 0.49001086 0.5064179 0.6128112 0.6750245 0.9596555

gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x

B 0.000000e+00 0.0844701690 0.05629635 0.3582284

C 8.646503e-01 0.0026508777 0.08721910 0.9102486

D 3.150725e-06 0.0016658737 0.84636654 0.3119264

E 0.000000e+00 0.0001389991 0.11753032 0.6568859

accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y

B 0.9944921 0.4871709 0.4119312 0.9732514

C 0.3856863 0.6269538 0.8250662 0.6507012

D 0.5418110 0.1653746 0.2459617 0.9660635

E 0.6953240 0.9499487 0.8773736 0.9140676

magnet\_dumbbell\_z roll\_forearm pitch\_forearm yaw\_forearm gyros\_forearm\_x

B 0.8071619 0.7502723 0.6663847 0.5807342 8.765827e-03

C 0.6972953 0.7045655 0.7764683 0.9485679 5.215538e-01

D 0.5927077 0.8301117 0.5208082 0.9918153 1.298446e-06

E 0.9854236 0.3127369 0.5973975 0.6518112 4.976741e-01

gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z

B 0.035350140 6.520713e-03 0.8501417 0.9929199 0.6603131

C 0.037215878 6.767094e-02 0.8449673 0.6045218 0.5697203

D 0.004642559 5.200131e-03 0.7158741 0.5436574 0.7508645

E 0.131870602 9.285377e-06 0.6908787 0.5419446 0.6804622

magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z

B 0.3841406 0.6089628 0.4037683

C 0.5829708 0.4417038 0.5755700

D 0.5844354 0.3700364 0.2337083

E 0.3545898 0.4997312 0.9551025

> w <- (summary(bicepfit)$coefficients)^2/(summary(bicepfit)$standard.errors)^2

|  |
| --- |
| > w <- (summary(bicepfit)$coefficients)^2/(summary(bicepfit)$standard.errors)^2  > bicepfitcomp <- multinom(classe~.,data = compbicepsdata)  # weights: 260 (204 variable)  initial value 6476.378160  iter 10 value 2705.232017  iter 20 value 1505.079428  iter 30 value 1200.663807  iter 40 value 1077.016253  iter 50 value 1041.946052  iter 60 value 1012.673881  iter 70 value 994.620772  iter 80 value 981.990370  iter 90 value 975.324537  iter 100 value 967.878856  final value 967.878856  stopped after 100 iterations  > zc <- summary(bicepfitcomp)$coefficients/summary(bicepfit)$standard.errors;pc <- (1 - pnorm(abs(zc), 0, 1)) \* 2  > wc <- (summary(bicepfitcomp)$coefficients)^2/(summary(bicepfitcomp)$standard.errors)^2 |
|  |
| |  | | --- | | > | |

c. Report the accuracy measures

d. Report the variable importance

e. Report the unimportant variables

f. Interpret the results

g. Visualize the results

> head(compbicepsdata$predclass)

NULL

> colnames(compbicepsdata)

[1] "roll\_belt" "pitch\_belt" "yaw\_belt" "total\_accel\_belt"

[5] "gyros\_belt\_y" "gyros\_belt\_z" "accel\_belt\_x" "accel\_belt\_y"

[9] "accel\_belt\_z" "magnet\_belt\_x" "magnet\_belt\_y" "magnet\_belt\_z"

[13] "roll\_arm" "pitch\_arm" "yaw\_arm" "total\_accel\_arm"

[17] "var\_yaw\_arm" "gyros\_arm\_x" "gyros\_arm\_y" "gyros\_arm\_z"

[21] "accel\_arm\_x" "accel\_arm\_y" "accel\_arm\_z" "magnet\_arm\_x"

[25] "magnet\_arm\_y" "magnet\_arm\_z" "roll\_dumbbell" "pitch\_dumbbell"

[29] "yaw\_dumbbell" "gyros\_dumbbell\_x" "gyros\_dumbbell\_y" "gyros\_dumbbell\_z"

[33] "accel\_dumbbell\_x" "accel\_dumbbell\_y" "accel\_dumbbell\_z" "magnet\_dumbbell\_x"

[37] "magnet\_dumbbell\_y" "magnet\_dumbbell\_z" "roll\_forearm" "pitch\_forearm"

[41] "yaw\_forearm" "gyros\_forearm\_x" "gyros\_forearm\_y" "gyros\_forearm\_z"

[45] "accel\_forearm\_x" "accel\_forearm\_y" "accel\_forearm\_z" "magnet\_forearm\_x"

[49] "magnet\_forearm\_y" "magnet\_forearm\_z" "classe"

> head(predbicep)

A B C D E

1 0.001028824 7.529275e-14 1.911687e-09 1.503249e-06 0.9989697

2 0.002053749 2.547153e-14 3.001786e-09 3.048458e-06 0.9979432

3 0.001247461 4.057900e-14 3.724685e-09 4.251747e-06 0.9987483

4 0.002040355 2.025101e-14 7.987469e-09 9.508320e-06 0.9979501

5 0.002414314 2.232786e-14 8.871471e-09 1.126754e-05 0.9975744

6 0.002242910 1.520833e-14 2.293195e-08 1.555579e-05 0.9977415

> curve <- multiclass.roc(classe ~ predbicep, data = compbicepsdata)

Error in multiclass.roc(classe ~ predbicep, data = compbicepsdata) :

could not find function "multiclass.roc"

> predbicep <- predict(stepbicepcomp, compbicepsdata,type='probs')

> colnames(compbicepsdata)

[1] "roll\_belt" "pitch\_belt" "yaw\_belt" "total\_accel\_belt"

[5] "gyros\_belt\_y" "gyros\_belt\_z" "accel\_belt\_x" "accel\_belt\_y"

[9] "accel\_belt\_z" "magnet\_belt\_x" "magnet\_belt\_y" "magnet\_belt\_z"

[13] "roll\_arm" "pitch\_arm" "yaw\_arm" "total\_accel\_arm"

[17] "var\_yaw\_arm" "gyros\_arm\_x" "gyros\_arm\_y" "gyros\_arm\_z"

[21] "accel\_arm\_x" "accel\_arm\_y" "accel\_arm\_z" "magnet\_arm\_x"

[25] "magnet\_arm\_y" "magnet\_arm\_z" "roll\_dumbbell" "pitch\_dumbbell"

[29] "yaw\_dumbbell" "gyros\_dumbbell\_x" "gyros\_dumbbell\_y" "gyros\_dumbbell\_z"

[33] "accel\_dumbbell\_x" "accel\_dumbbell\_y" "accel\_dumbbell\_z" "magnet\_dumbbell\_x"

[37] "magnet\_dumbbell\_y" "magnet\_dumbbell\_z" "roll\_forearm" "pitch\_forearm"

[41] "yaw\_forearm" "gyros\_forearm\_x" "gyros\_forearm\_y" "gyros\_forearm\_z"

[45] "accel\_forearm\_x" "accel\_forearm\_y" "accel\_forearm\_z" "magnet\_forearm\_x"

[49] "magnet\_forearm\_y" "magnet\_forearm\_z" "classe"

> nrow(compbicepsdata)

[1] 4024

> nrow(predbicep)

[1] 4024

> predclass

[1] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[40] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[79] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[118] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[157] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[196] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[235] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[274] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

[313] E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E E

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[469] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A

[508] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A

[547] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A

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[625] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A

[664] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A

[703] A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A D

[742] D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D

[781] D D D D D D E D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D

[820] D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D

[859] D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D

[898] D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D D

[937] D D D D D D D D D D D D E D D D D D D D D D D D D D D D D D D D D D D D D D D

[976] D D D D D D D D D D D D D D D D D D D D D D D D D

[ reached getOption("max.print") -- omitted 3024 entries ]

Levels: A B C D E

> curve <- multiclass.roc(classe ~ predclass, data = compbicepsdata)

Error in multiclass.roc(classe ~ predclass, data = compbicepsdata) :

could not find function "multiclass.roc"

> curve <- multiclass.roc(compbicepsdata$classe ~ predclass)

Error in multiclass.roc(compbicepsdata$classe ~ predclass) :

could not find function "multiclass.roc"

> table(compbicepsdata$classe)

A B C D E

1365 901 112 276 1370

> table(predclass)

predclass

A B C D E

1372 892 114 274 1372

> original <- table(compbicepsdata$classe)

> predicted <- table(predclass)

> total <-rbind(original, predicted)

> total <- t(total)

> total

original predicted

A 1365 1372

B 901 892

C 112 114

D 276 274

E 1370 1372