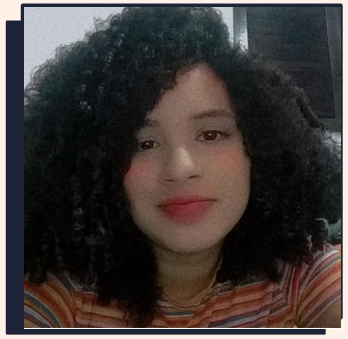
Classificação de fibrilação atrial a partir de uma amostra de ECG de derivação única

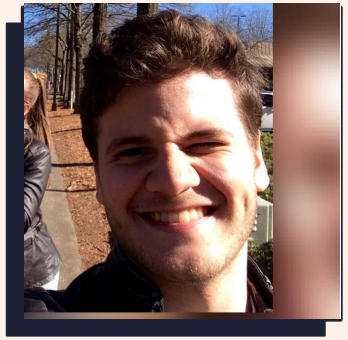
Processamento Digital de Sinais

Equipe



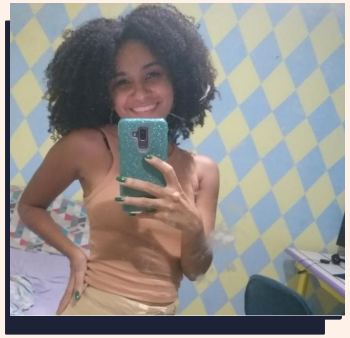
Letícia T.

Eng. Biomédica



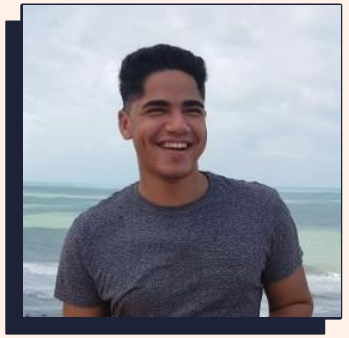
Arthur B.

Eng. Eletrônica



Thaís B.

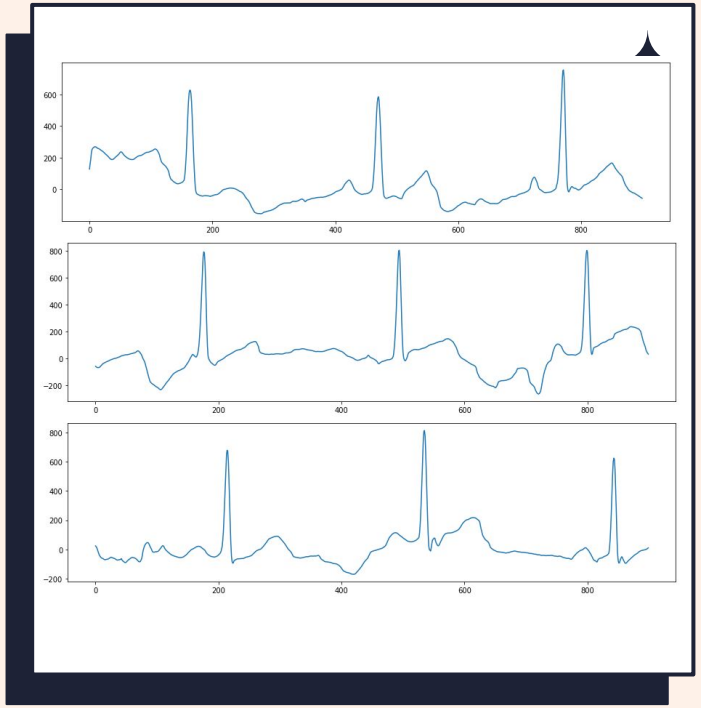
Eng. Biomédica



Pedro G.

Eng. Eletrônica

Introdução

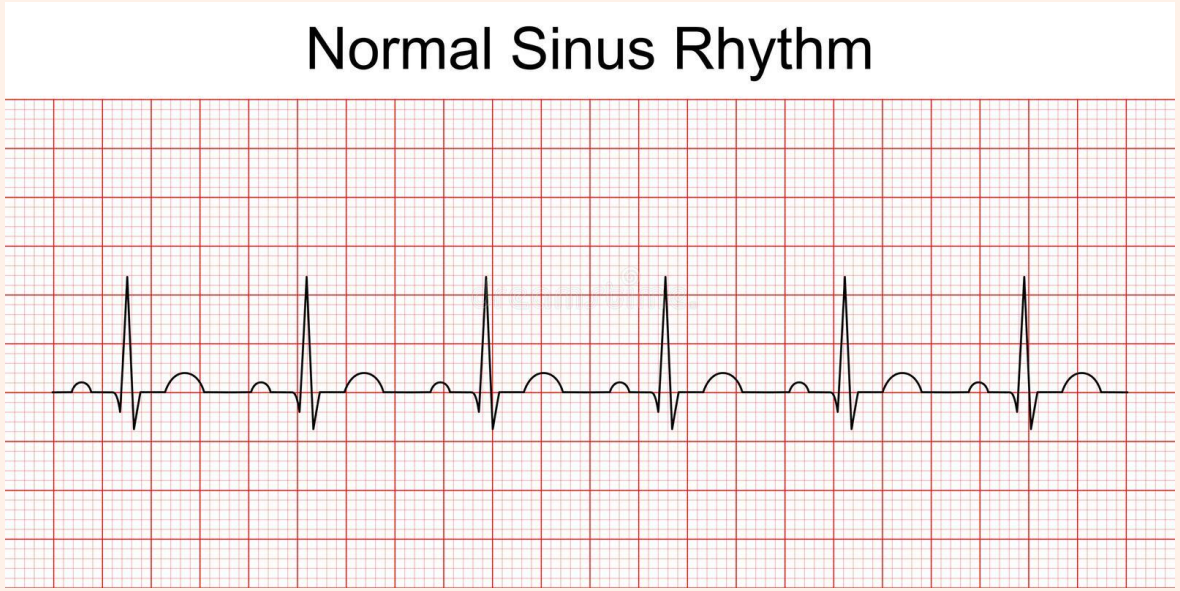


O que é um ECG

Eletrocardiograma

É uma reprodução gráfica do comportamento elétrico do coração, durante seu funcionamento.

Sinal Normal



AF Rhythm

O que foi feito com as amostras?

01 Leitura

Transformamos cada amostra .mat em uma lista de pontos.

02 Janelamento

Trabalhamos com janelas de tempo de 3s.

03 Filtragem

Utilizamos um Butterworth de 7ª ordem.

04 Atributos

Geramos valor das janelas com a coleta de atributos.

05 Exportação

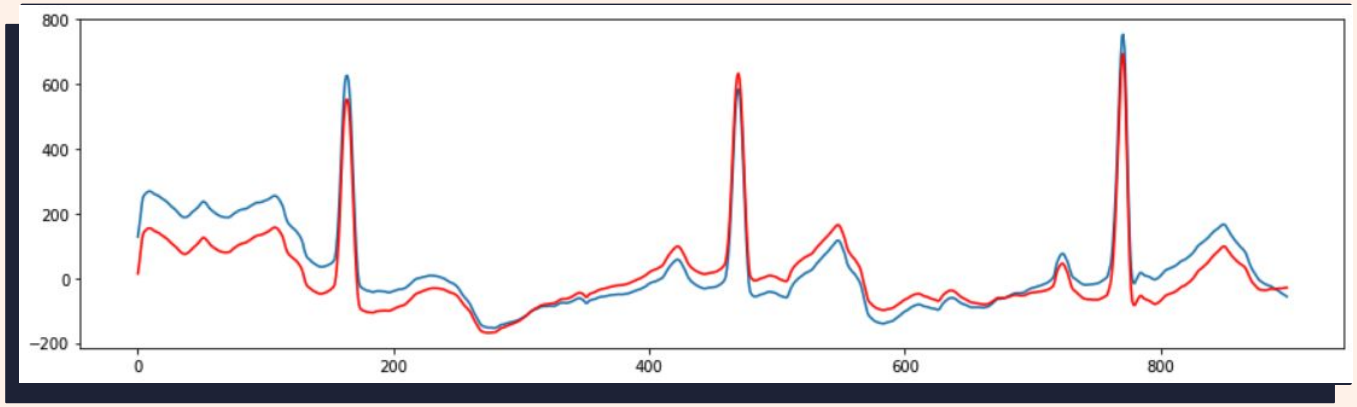
Exportamos os dados para um .csv para implementação no Weka.

06 Classificação

Utilizamos *Random Forest* para classificação do modelo.

Janelamento

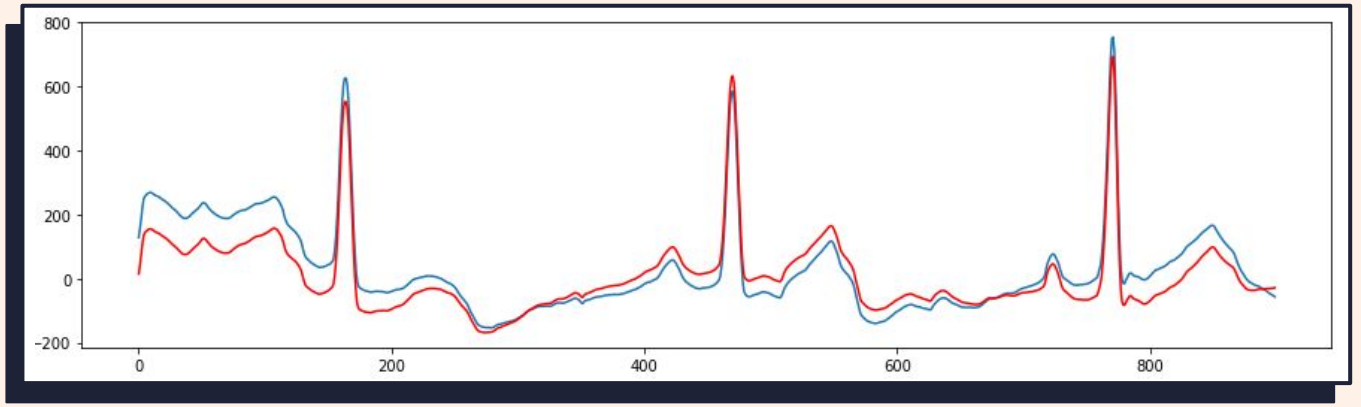
Para realizar a leitura dos dados os mesmo foram divididos em janelas de 3s, possibilitando uma otimização da leitura dos mesmos.



Filtragem

Após o janelamento os sinais foram filtrados utilizando um Filtro Butterworth passa-faixa de 7º ordem.

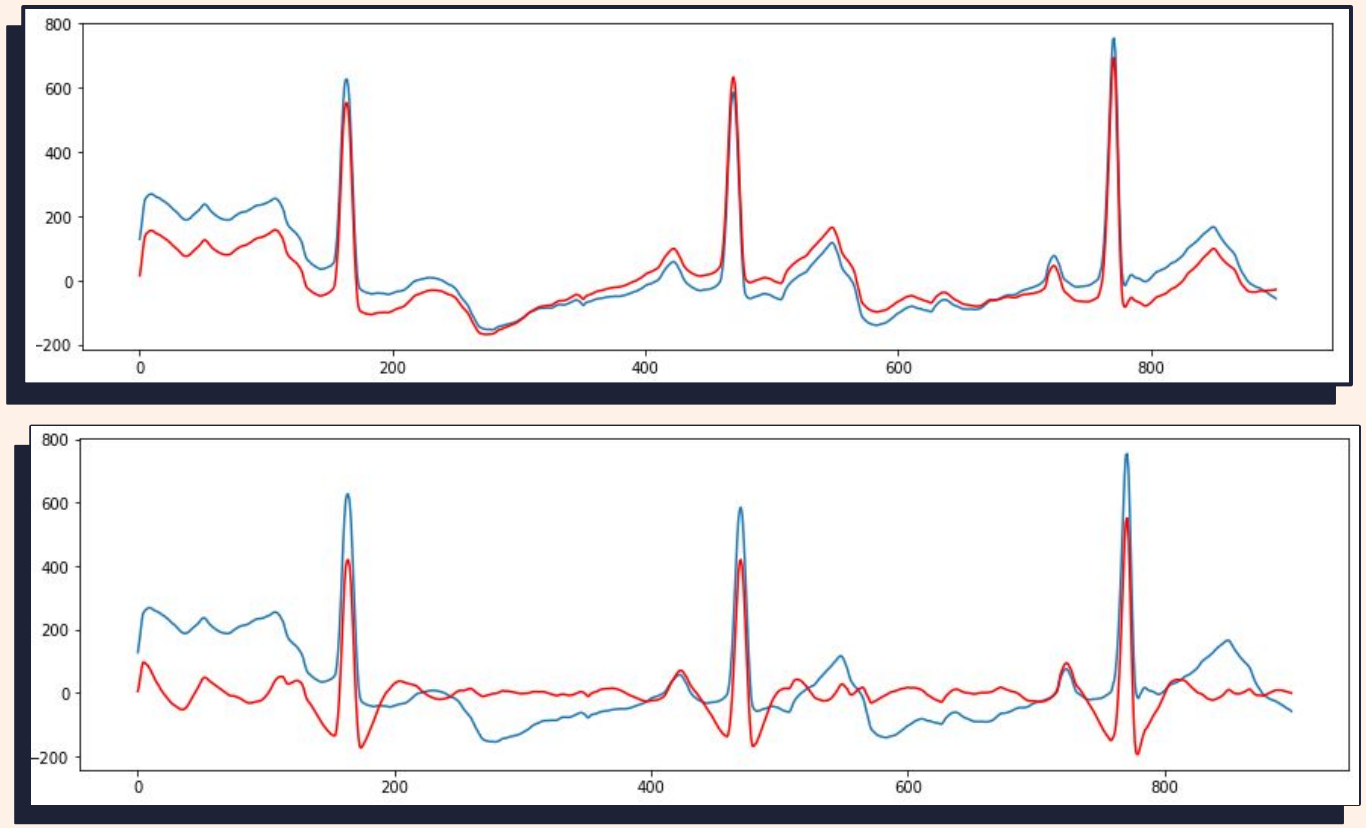
TIPO DE RUÍDO	ORIGEM	FAIXA DE FREQUÊNCIA
Flutuação da linha de base	Respiração e movimentos do corpo	(0.15 - 0.5) Hz
Ruído de EMG	Gerado pela atividade elétrica dos músculos	> 100 Hz
Artefatos de movimento	Ocorre devido ao estiramento da pele, o que leva a uma mudança na voltagem da pele na segunda camada da pele.	(0.15 - 15) Hz



Filtragem

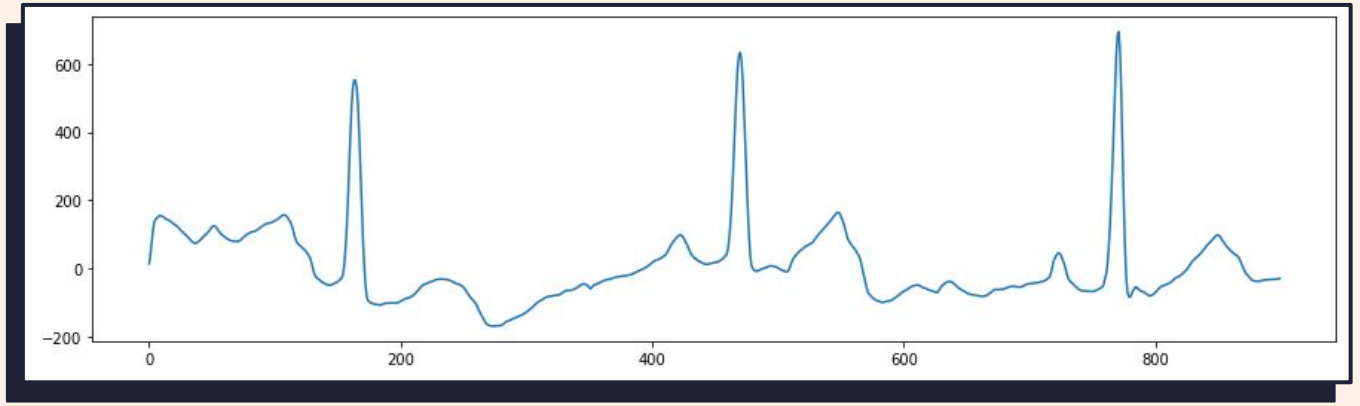
Os dados foram filtrados utilizando dois filtros diferentes e os resultados foram comparados.

O primeiro filtro foi de 0.5Hz à 100Hz e o segundo de 5Hz à 100Hz.



Atributos

MVAL	Mean Value	WFL	Waveform Length
VAR	Variance	ZCS	Zero Crossings
STD	Standard Deviation	SSC	Slope Sign Changes
RMS	Root Mean Square	MNF	Mean Frequency
AAC	Average Amplitude Change	MDF	Median Frequency
DASDV	Difference Absolute Deviation	MNP	Mean Power
IAV	Integrated Absolute Value	PKF	Peak Frequency
LOGD	Logarithm Detector	PSR	Power Spectrum Ratio
SSI	Simple Square Integral	TTP	Total Power
MAV	Mean Absolute Value	SM1	1st Spectral Moments
MLOGK	Mean Logarithm Kernel	SM2	2nd Spectral Moments
KURT	Kurtosis	SM3	3rd Spectral Moments
MAX	Maximum Amplitude	VCF	Variance of Central Frequency
TM3	Third Moment		
TM4	Fourth Moment		
TM5	Fifth Moment		



Exportação/Importação

	AAC	DASDV	IAV	LOGD	MAV	MLOGK	RMS	KURT	SSC	SSI	...	MNF	MNP	PKF	TTP	SM1	SM2	SM3	VCF	MDF	rotulo
0	0.014918	0.249478	4.463497	0.991595	0.008702	0.004959	0.164839	3.540651	1	24.454593	...	0.063894	3091.679180	180596.416698	1.394347e+06	89089.832452	5941.970935	423.504146	0.003556	6.971737e+05	records_normal
1	0.181633	2.984973	-69.643427	1.006168	0.114152	0.077382	2.073964	3.198843	1	3871.193070	...	0.065477	4749.720058	224624.910502	2.142124e+06	140258.779188	9642.782895	708.588132	0.003718	1.071062e+06	records_normal
2	0.356967	5.912329	-149.431177	1.007403	0.217954	0.166035	4.151539	3.475106	1	15511.747058	...	0.065249	2699.256969	121304.453855	1.217365e+06	79431.710943	5450.440332	404.920814	0.003693	6.086824e+05	records_normal
3	0.508356	8.577030	-224.236325	1.010169	0.302464	0.249151	6.044954	3.861519	1	32887.320294	...	0.064060	5016.974783	244966.392467	2.262656e+06	144945.006617	9868.267169	729.265065	0.003564	1.131328e+06	records_normal
4	0.593252	10.327187	-268.537133	1.010313	0.343491	0.298375	7.276169	4.243820	1	47648.370623	...	0.065870	3961.774539	204432.282923	1.786760e+06	117694.514374	8165.575346	608.603445	0.003758	8.933802e+05	records_normal
5	0.591544	10.754421	-270.351932	1.009335	0.334437	0.300391	7.562431	4.517999	1	51471.326987	...	0.065675	4832.802343	216959.533497	2.179594e+06	143144.400025	9825.953723	715.724227	0.003741	1.089797e+06	records_normal
6	0.525643	9.977198	-241.371161	1.007271	0.289279	0.268190	7.013180	4.736470	1	44266.224829	...	0.065106	4420.300457	147869.255913	1.993556e+06	129793.100632	8832.649519	638.820651	0.003682	9.967778e+05	records_normal
7	0.426825	8.026196	-186.261925	1.004642	0.225710	0.206958	5.654655	4.914479	1	28777.611049	...	0.065965	4555.132455	107724.356646	2.054365e+06	135517.055934	9377.174653	692.539880	0.003770	1.027182e+06	records_normal
8	0.281952	4.899069	-98.161237	1.006210	0.151488	0.109068	3.466119	4.748996	1	10812.579903	...	0.066003	4725.436819	187857.680891	2.131172e+06	140663.220343	9748.449172	723.031798	0.003773	1.065586e+06	records_normal
9	0.110874	1.263494	11.292430	1.007316	0.091099	0.012547	1.140489	0.071950	1	1170.644187	...	0.065303	4210.444009	183623.770345	1.898910e+06	124005.247218	8456.530321	613.320349	0.003703	9.494551e+05	records_normal

export_data - Bloco de Notas

Arquivo Editar Formatar Exibir Ajuda

```
AAC,DASDV,IAV,LOGD,MAV,MLOGK,RMS,KURT,SSC,SSI,VAR,WFL,ZCS,TM3,TM4,TM5,STD,MVAL,MAX,PSR,MNF,MNP,PKF,TTP,SM1,SM2,SM3,VCF,MDF,rotulo
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```
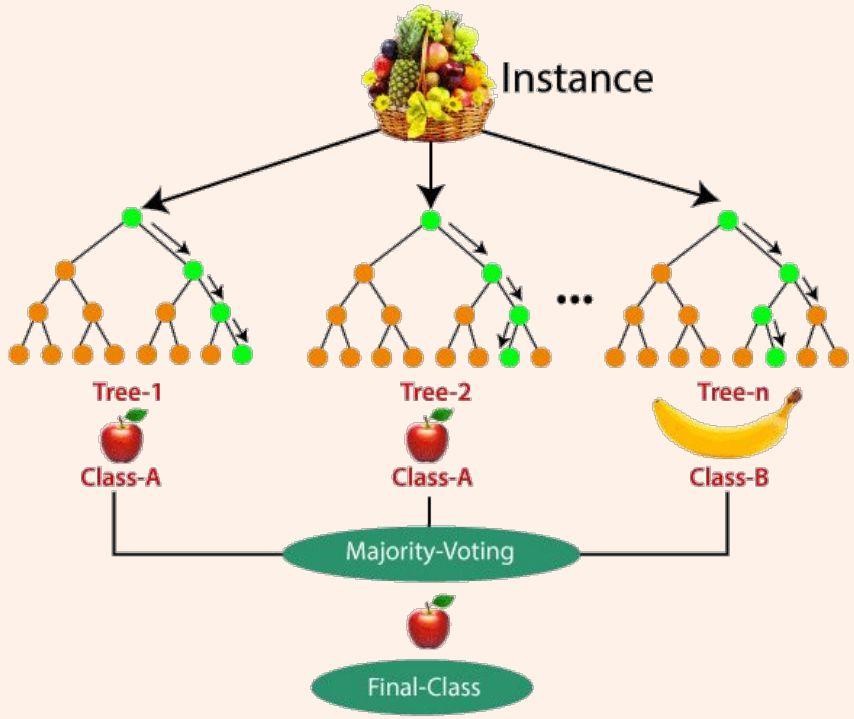
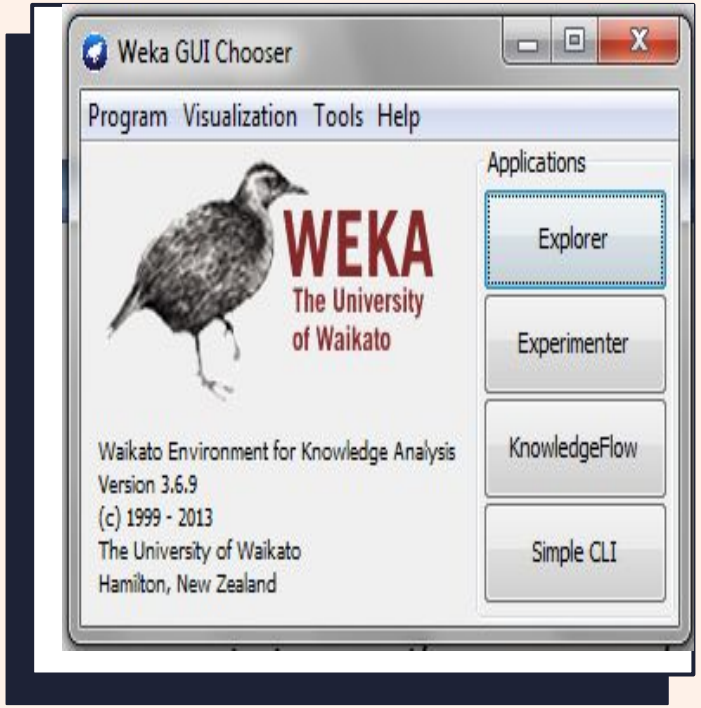

Random Forest

Um conjunto de árvores treinadas por subespaços aleatórios de dados.

A predição é dada pela predominância das predições das árvores geradas.





Resultados

Filtro de 5 à 100 Hz

```
=== Summary ===

Correctly Classified Instances       57835               63.2035 %
Incorrectly Classified Instances     33671               36.7965 %
Kappa statistic                          0.191
Mean absolute error                      0.2552
Root mean squared error                  0.3548
Relative absolute error                 91.8279 %
Root relative squared error             95.1839 %
Total Number of Instances            91506

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall  F-Measure  MCC      ROC Area  PRC Area  Class
                 0,936    0,758    0,638      0,936   0,759      0,256    0,668     0,711     records_normal
                 0,071    0,004    0,626      0,071   0,128      0,191    0,696     0,255     records_af
                 0,238    0,072    0,584      0,238   0,338      0,232    0,661     0,488     records_other
                 0,148    0,002    0,708      0,148   0,245      0,317    0,867     0,322     records_noisy
Weighted Avg.    0,632    0,468    0,623      0,632   0,565      0,244    0,673     0,595

=== Confusion Matrix ===

    a     b     c     d   <-- classified as
50407   137  3236    52 |     a = records_normal
 6459   578  1023    27 |     b = records_af
20632   180  6525    55 |     c = records_other
 1455    29   386   325 |     d = records_noisy
```

2.1 Random Forest com 10 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
60.02	0.155	0.623	0.556	0.60	0.179

2.2 Random Forest com 50 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
62.89	0.189	0.664	0.614	0.629	0.237

2.3 Random Forest com 100 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
63.20	0.191	0.673	0.623	0.632	0.244

1.1 Random Forest com 10 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
64.35	0.254	0.697	0.625	0.644	0.284

1.2 Random Forest com 50 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
67.26	0.297	0.754	0.689	0.673	0.350

1.3 Random Forest com 100 árvores

Acurácia	Kappa	AUROC	Precisão	Sensibilidade	MCC
67.64	0.302	0.766	0.699	0.676	0.360

Filtro de 0.5 à 100 Hz

BEST MODEL

100 Árvores

```
=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances       61899               67.6447 %
Incorrectly Classified Instances     29607               32.3553 %
Kappa statistic                          0.3024
Mean absolute error                      0.2385
Root mean squared error                  0.3357
Relative absolute error                 85.8129 %
Root relative squared error             90.0574 %
Total Number of Instances            91506

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0,948    0,674    0,668      0,948    0,784      0,364    0,760     0,798     records_normal
                 0,116    0,002    0,865      0,116    0,205      0,300    0,772     0,399     records_af
                 0,343    0,061    0,707      0,343    0,462      0,367    0,763     0,629     records_other
                 0,232    0,002    0,751      0,232    0,355      0,411    0,913     0,465     records_noisy
Weighted Avg.    0,676    0,415    0,699      0,676    0,626      0,360    0,766     0,704

=== Confusion Matrix ===

     a     b     c     d   <-- classified as
 51045    74  2619    94 |     a = records_normal
  6081   938  1045    23 |     b = records_af
 17866    68  9406    52 |     c = records_other
  1447     4   234   510 |     d = records_noisy
```

Melhor modelo

- 67.6447% de Acurácia.

BASE MODEL

Dummy Classifier

```
[ ]  X_train, X_test, y_train, y_test = train_test_split(All_Data.iloc[:,:29], All_Data.iloc[:,29], random_state = 3)

     dummy_clf.fit(X_train,y_train)

     print('Acurácia do nosso modelo que apenas chuta todas as predições na mais frequente: {:.2f}'

     .format(dummy_clf.score(X_test,y_test)))
```

```
Acurácia do nosso modelo que apenas chuta todas as predições na mais frequente: 0.59
```

Obrigado!