# KAUNO TECHNOLOGIJOS UNIVERSITETAS INFORMATIKOS FAKULTETAS

# Mašininio mokymosi metodai (P160B124) *Laboratorinių darbų ataskaita*

Atliko:

IFF-1/4 gr. studentas

Mildaras Karvelis

2023 m. gruodžio 4 d.

Priėmė:

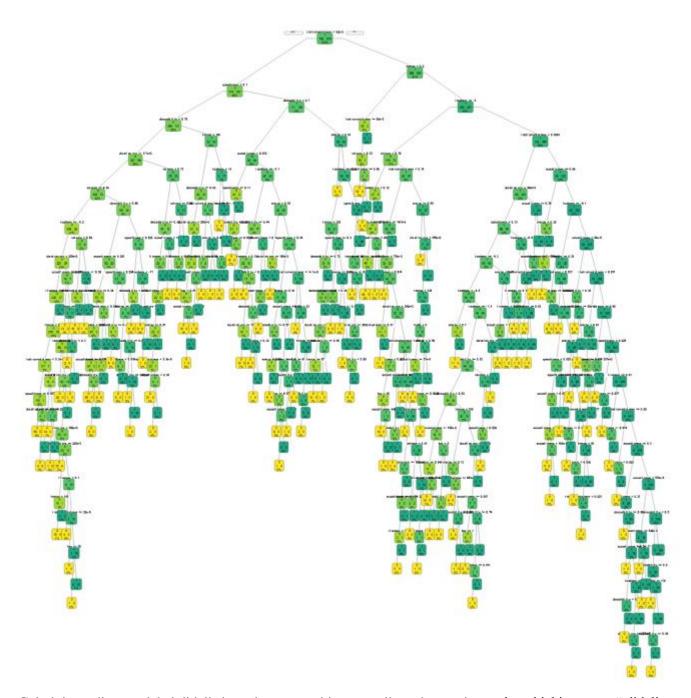
Doc. Iešmantas Tomas

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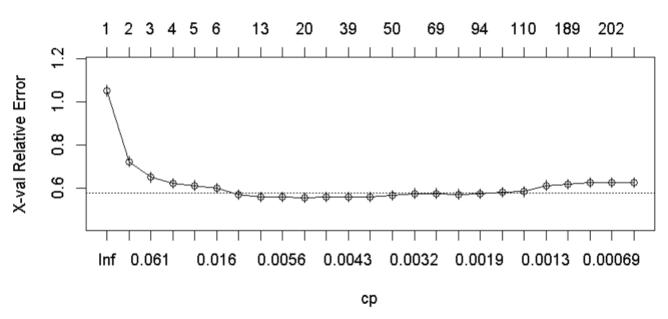
# 1. Lab 5.2 I

# 1.1. Task 1



Galutinis medis gavo labai didelis ir sunku pamatyti jame pateiktus duomenis, nes lapų kiekis yra ypač didelis.

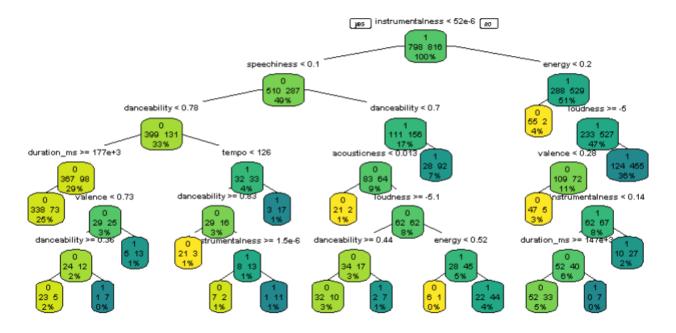
## size of tree



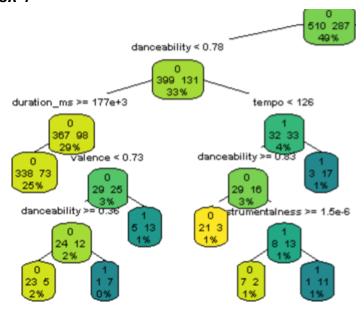
1 pav. Medžio šakų dydis ir sudėtingumas

#### 1.2. Task 2 and 3

Po "prune" funkcijos panaudojimo, medis dabar yra įskaitomas, medis turi tik 39 lapus. Cross-Validation error -1.



#### 1.3. Task 4



Iš viso panaudotos klasės: acousticness, danceability, duration\_ms, energy, instru mentalness key, liveness, loudness, mode, speechiness, tempo, time\_signature, vale nce.

#### 1.4. Task 5

Accuracy on the pruned tree: 69.97519 % Accuracy on the unpruned: 65.26055 %

## 2. Lab 5.2 II

## 2.1. Task 1

Kadangi programa gražino 150, imame pirmus 20 C dydžius, mano manymu geriau yra naudoti 19 C dydį, nes jis mažiausias

n         CP         nsplit         rel error         xerror         xstd           1         3.34467         0         1.000000000         1.0022553         0.00           3 se-02         2.69676         1         0.966553266         0.9666679         0.00           3 log-02         3         0.912618019         0.9128091         0.00           3 se-02         4         0.895646191         0.8963342         0.00           2 se-02         2         0.878827262         0.8876190         0.00           2 se-02         2         0.878827262         0.8876190         0.00           2 se-02         2         0.86237682         0.8641489         0.00           2 se-03         2         0.8473682         0.8443682         0.00           2 se-02         2         0.82373682         0.8473682         0.00           2 se-03         3 se-02         2         0.82473682         0.00           2 se-03         10.06647         9         0.820534383         0.8287527         0.00           2 se-03         1e-03         12         0.790413211         0.7903750         0.00           2 se-03         1e-03         12         0.790413211	dydį, nes jis mažiausias						
3e-02	n	CP	nsplit	rel error	xerror	xstd	
2         2.69676         1         0.966553266         0.9666679         0.00           3         1.69718         3         0.912618019         0.9128091         0.00           3e-02         1.68189         4         0.895646191         0.8963342         0.00           2235901         0.00         2235901         0.00         2235901           5         1.65895         5         0.878827262         0.8876190         0.00           2287446         6         1.40858         6         0.862237682         0.8641489         0.00           2287446         0.00         22477485         0.00         2497485         0.00           8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9.72822         10         0.809869653         0.8094874         0.00           10         9.09751         12         0.790413211         0.7903750         259977           10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         11         7.64496         13         0.781315699         0.7844501         0.00           2e-03         12         7.33916	1	3.34467	0	1.000000000	1.0022553	0.00	
2e-02		3e-02				1312758	
3         1.69718         3         0.912618019         0.9128091         0.00           3e-02         1.68189         4         0.895646191         0.8963342         0.00           3e-02         2235901         0.00         2235901         0.00           5         1.65895         5         0.878827262         0.8876190         0.00           28e-02         2287446         0.00         2287446         0.00         2415114           7         1.35315         8         0.834065976         0.8473682         0.00         2497485           8         1.06647         9         0.820534383         0.8287527         0.00         2497485           9         9.72822         10         0.809869653         0.8094874         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00         2731049           11         7.64496         13         0.781315699         0.7844501         0.00         2802036           12         7.33916         14         0.773670731         0.7692366         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.0	2	2.69676	1	0.966553266	0.9666679	0.00	
3e-02		2e-02				1707379	
4         1.68189         4         0.895646191         0.8963342         0.00           5         1.65895         5         0.878827262         0.8876190         0.00           8e-02         2287446         0         0.862237682         0.8641489         0.00           5e-02         1.35315         8         0.834065976         0.8473682         0.00           9e-02         2497485         0.00         2497485         0.00           8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         1e-03         0.809869653         0.8094874         0.00           1e-03         12         0.790413211         0.7903750         0.00           2e-03         13         0.781315699         0.7844501         0.00           8e-03         2731049         0.00         2731049           11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         13         0.792366         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.00           4e-03         14         5.98218         17	3	1.69718	3	0.912618019	0.9128091	0.00	
3e-02         2235901           5         1.65895         5         0.878827262         0.8876190         0.00           8e-02         2287446         0.862237682         0.8641489         0.00           5e-02         1.35315         8         0.834065976         0.8473682         0.00           9e-02         2497485         2497485         2497485         2497485           8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9.72822         10         0.809869653         0.8094874         0.00           2e-03         1e-03         2659977         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         13         0.781315699         0.7844501         0.00           8e-03         14         0.773670731         0.7692366         0.00           9e-03         14         0.773670731         0.7692366         0.00           4e-03         14         0.758992393         0.7545201         0.00           2847040         14         0.79247522         0.7429762         0.00           2861564		3e-02				2131523	
5         1.65895         5         0.878827262         0.8876190         0.00           6         1.40858         6         0.862237682         0.8641489         0.00           5e-02         2415114         0.00         2415114         0.00         2415114           7         1.35315         8         0.834065976         0.8473682         0.00         2497485           8         1.06647         9         0.820534383         0.8287527         0.00         2581148           9         9.72822         10         0.809869653         0.8094874         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00         2731049           11         7.64496         13         0.781315699         0.7844501         2751727           12         7.33916         14         0.773670731         0.7692366         0.00           9e-03         13         6.19242         16         0.758992393         0.7545201         2847040           14         5.98218         17         0.752799969         0.7495126         0.00           2879934         16         5.65727         22         0.723175720         0.7	4	1.68189	4	0.895646191	0.8963342	0.00	
8e-02         2287446           6         1.40858         6         0.862237682         0.8641489         0.00           5e-02         1.35315         8         0.834065976         0.8473682         0.00           9e-02         2497485         0.00         2497485         0.00         2497485           8         1.06647         9         0.820534383         0.8287527         0.00           2581148         9         9.72822         10         0.809869653         0.8094874         0.00           1e-03         1e-03         2659977         0.00         2581148         0.00           2e-03         13         0.790413211         0.7903750         0.00           3e-03         13         0.781315699         0.7844501         0.00           3e-03         14         0.773670731         0.7692366         0.00           3e-03         14         0.773670731         0.7692366         0.00           3e-03         14         0.758992393         0.7545201         0.00           4e-03         2847040         2847040           14         5.98218         17         0.752799969         0.7429762         0.00           2879934		3e-02				2235901	
6         1.40858         6         0.862237682         0.8641489         0.00           9e-02         1.35315         8         0.834065976         0.8473682         0.00           8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9.72822         10         0.809869653         0.8094874         0.00           1e-03         12         0.790413211         0.7903750         0.00           2e-03         11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         12         0.773670731         0.7692366         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.00         2847040           14         5.98218         17         0.752799969         0.7495126         0.00         2861564           15         5.69550         21         0.728871221         0.7429762         0.00         2879934           16         5.65727         22         0.723175720         0.7364397         0.00         2897651           17         5.61905         23         0.717518443         0.7351019         0.00	5	1.65895	5	0.878827262	0.8876190		
5e-02         2415114           7         1.35315         8         0.834065976         0.8473682         0.00           2497485         8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         2581148         0.00         258148         0.00           1e-03         2659977         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         13         0.781315699         0.7844501         0.00           2e-03         13         0.781315699         0.7844501         0.00           2e-03         12         0.773670731         0.7692366         0.00           2e-03         13         0.752799393         0.7545201         0.00           2e-03         14         0.773670731         0.7692366         0.00           2802036         13         0.752799969         0.7425201         0.00           2847040         14         5.98218         17         0.752799969         0.7429762         0.00           1e-03         28         0.7228871221         0.7429762         0.00           2879934         0.6 </td <td></td> <td>8e-02</td> <td></td> <td></td> <td></td> <td>2287446</td>		8e-02				2287446	
7         1.35315         8         0.834065976         0.8473682         0.00           2497485         8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9.72822         10         0.809869653         0.8094874         0.00           1e-03         2659977         0.00         2659977         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00         2731049           11         7.64496         13         0.781315699         0.7844501         0.00         2751727           12         7.33916         14         0.773670731         0.7692366         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.00         2847040           14         5.98218         17         0.752799969         0.7495126         0.00         2861564           15         5.69550         21         0.728871221         0.7429762         0.00         2897651         0.00         2897651         0.00         2897651         0.00         2897651         0.00         2905219         0.00         2905219         0.00	6	1.40858	6	0.862237682	0.8641489	0.00	
9e-02         2497485           8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9         0.809869653         0.8094874         0.00           1e-03         2659977         0.00         2659977           10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         13         0.781315699         0.7844501         0.00           8e-03         2751727         0.00         2751727         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.00           2847040         4e-03         0.7495126         0.00         2847040           14         5.98218         17         0.752799969         0.7495126         0.00           7e-03         21         0.728871221         0.7429762         0.00           1e-03         287651         0.00         2897651           17         5.61905         23         0.717518443         0.7351019         0.00           1e-03         0.7649505         0.00         0.7429762         0.00         0.00           1e-03         0.711899392 <td></td> <td></td> <td></td> <td></td> <td></td> <td>2415114</td>						2415114	
8         1.06647         9         0.820534383         0.8287527         0.00           3e-02         9.72822         10         0.809869653         0.8094874         0.00           1e-03         2659977         0.790413211         0.7903750         0.00           2e-03         11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         2751727         0.00         2751727         0.00         2802036         0.00           12         7.33916         14         0.773670731         0.7692366         0.00         2802036           13         6.19242         16         0.758992393         0.7545201         0.00         2847040           14         5.98218         17         0.752799969         0.7495126         0.00         2861564           15         5.69550         21         0.728871221         0.7429762         0.00         2879934           16         5.65727         22         0.723175720         0.7364397         0.00         2897651           17         5.61905         23         0.717518443         0.7351019         0.00         2901198           18         5.50437         24 <t< td=""><td>7</td><td>1.35315</td><td>8</td><td>0.834065976</td><td>0.8473682</td><td>0.00</td></t<>	7	1.35315	8	0.834065976	0.8473682	0.00	
3e-02						2497485	
9         9.72822         10         0.809869653         0.8094874         0.00           1e-03         9.09751         12         0.790413211         0.7903750         0.00           2e-03         7.64496         13         0.781315699         0.7844501         0.00           8e-03         2751727         12         7.33916         14         0.773670731         0.7692366         0.00           9e-03         13         6.19242         16         0.758992393         0.7545201         2802036           13         6.19242         16         0.758992393         0.7545201         0.00           4e-03         2847040         2847040         2847040           14         5.98218         17         0.752799969         0.7495126         0.00           7e-03         21         0.728871221         0.7429762         0.00           2879934         16         5.65727         22         0.723175720         0.7364397         0.00           1e-03         23         0.717518443         0.7351019         0.00           1e-03         2901198         2901198         290129           18         5.50437         24         0.711899392         0.7335729	8	1.06647	9	0.820534383	0.8287527	0.00	
1e-03         2659977           10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         2751727         0.00         2751727         0.7692366         0.00           9e-03         14         0.773670731         0.7692366         0.00           2802036         0.00         2802036         0.00           13         6.19242         16         0.758992393         0.7545201         0.00           2847040         0.00         2847040         0.00         2861564         0.00           7e-03         21         0.728871221         0.7429762         0.00         2879934           16         5.65727         22         0.723175720         0.7364397         0.00         2897651           17         5.61905         23         0.717518443         0.7351019         0.00         2901198           18         5.50437         24         0.711899392         0.7335729         0.00         2905219           19         5.23680         25         0.706395015         0.7242842         0.00 <td></td> <td></td> <td></td> <td></td> <td></td> <td>2581148</td>						2581148	
10         9.09751         12         0.790413211         0.7903750         0.00           2e-03         7.64496         13         0.781315699         0.7844501         0.00           8e-03         7.33916         14         0.773670731         0.7692366         0.00           9e-03         2802036         0.758992393         0.7545201         0.00           4e-03         16         0.758992393         0.7545201         0.00           7e-03         2847040         0.7495126         0.00           1e-03         2861564         0.7429762         0.00           1e-03         2879934         0.7364397         0.00           1e-03         2897651         0.717518443         0.7351019         0.00           1e-03         2897651         0.7769236         0.7335729         0.00           1e-03         2901198         0.77242842         0.77242842         0.00	9	9.72822	10	0.809869653	0.8094874	0.00	
2e-03         2731049           11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         2751727         0.7692366         0.00         2802036           12         7.33916         14         0.773670731         0.7692366         0.00           9e-03         2802036         0.00         2802036         0.00           13         6.19242         16         0.758992393         0.7545201         0.00           2847040         0.00         2847040         0.00         2847040           14         5.98218         17         0.752799969         0.7495126         0.00           7e-03         21         0.728871221         0.7429762         0.00           2879934         0.00         2879934         0.00         2879651           17         5.61905         23         0.717518443         0.7351019         0.00           1e-03         2901198         0.00         2905219         0.00         2905219           19         5.23680         25         0.706395015         0.7242842         0.00							
11         7.64496         13         0.781315699         0.7844501         0.00           8e-03         7.33916         14         0.773670731         0.7692366         0.00           9e-03         6.19242         16         0.758992393         0.7545201         0.00           4e-03         5.98218         17         0.752799969         0.7495126         0.00           7e-03         2861564         0.00         2861564         0.00           15         5.69550         21         0.728871221         0.7429762         0.00           16e-03         5.65727         22         0.723175720         0.7364397         0.00           17         5.61905         23         0.717518443         0.7351019         0.00           1e-03         0.7692360         0.00         2901198         0.00           18         5.50437         24         0.711899392         0.7335729         0.00           7e-03         0.766395015         0.7242842         0.00	10	9.09751	12	0.790413211	0.7903750	0.00	
8e-03     2751727       12     7.33916     14     0.773670731     0.7692366     0.00       9e-03     16     0.758992393     0.7545201     0.00       13     6.19242     16     0.758992393     0.7545201     0.00       2847040     2847040     2847040       14     5.98218     17     0.752799969     0.7495126     0.00       2861564     15     5.69550     21     0.728871221     0.7429762     0.00       1e-03     22     0.723175720     0.7364397     0.00       6e-03     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     25     0.706395015     0.7242842     0.00		2e-03				2731049	
12     7.33916     14     0.773670731     0.7692366     0.00       13     6.19242     16     0.758992393     0.7545201     0.00       2847040     14     5.98218     17     0.752799969     0.7495126     0.00       7e-03     2861564       15     5.69550     21     0.728871221     0.7429762     0.00       16     5.65727     22     0.723175720     0.7364397     0.00       6e-03     2897651       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00	11	7.64496	13	0.781315699	0.7844501	0.00	
9e-03       2802036         13       6.19242       16       0.758992393       0.7545201       0.00         2847040       2847040       2847040         14       5.98218       17       0.752799969       0.7495126       0.00         2861564       15       5.69550       21       0.728871221       0.7429762       0.00         1e-03       22       0.723175720       0.7364397       0.00         6e-03       2897651         17       5.61905       23       0.717518443       0.7351019       0.00         1e-03       2901198         18       5.50437       24       0.711899392       0.7335729       0.00         7e-03       25       0.706395015       0.7242842       0.00		8e-03				2751727	
13       6.19242       16       0.758992393       0.7545201       0.00         2847040       2847040       2847040         14       5.98218       17       0.752799969       0.7495126       0.00         7e-03       2861564         15       5.69550       21       0.728871221       0.7429762       0.00         16       5.65727       22       0.723175720       0.7364397       0.00         6e-03       23       0.717518443       0.7351019       0.00         1e-03       2901198         18       5.50437       24       0.711899392       0.7335729       0.00         7e-03       25       0.706395015       0.7242842       0.00	12	7.33916	14	0.773670731	0.7692366		
4e-03       2847040         14       5.98218       17       0.752799969       0.7495126       0.00         7e-03       2861564         15       5.69550       21       0.728871221       0.7429762       0.00         16       5.65727       22       0.723175720       0.7364397       0.00         6e-03       2897651         17       5.61905       23       0.717518443       0.7351019       0.00         1e-03       24       0.711899392       0.7335729       0.00         7e-03       24       0.706395015       0.7242842       0.00							
14     5.98218     17     0.752799969     0.7495126     0.00       15     5.69550     21     0.728871221     0.7429762     0.00       16     5.65727     22     0.723175720     0.7364397     0.00       6e-03     2897651       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     25     0.706395015     0.7242842     0.00	13	6.19242	16	0.758992393	0.7545201	0.00	
7e-03       2861564         15       5.69550       21       0.728871221       0.7429762       0.00         16       5.65727       22       0.723175720       0.7364397       0.00         6e-03       2897651         17       5.61905       23       0.717518443       0.7351019       0.00         1e-03       2901198         18       5.50437       24       0.711899392       0.7335729       0.00         7e-03       25       0.706395015       0.7242842       0.00		4e-03				2847040	
15     5.69550     21     0.728871221     0.7429762     0.00       16     5.65727     22     0.723175720     0.7364397     0.00       6e-03     2897651       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     25     0.706395015     0.7242842     0.00	14	5.98218	17	0.752799969	$0.749512\overline{6}$	0.00	
1e-03     2879934       16     5.65727     22     0.723175720     0.7364397     0.00       6e-03     2897651       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00						2861564	
16     5.65727     22     0.723175720     0.7364397     0.00       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00	15	5.69550	21	0.728871221	$0.74297\overline{62}$	0.00	
6e-03     2897651       17     5.61905     23     0.717518443     0.7351019     0.00       1e-03     2901198       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00		1e-03				2879934	
17     5.61905     23     0.717518443     0.7351019     0.00       18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     25     0.706395015     0.7242842     0.00	16	5.65727	22	0.723175720	0.7364397	0.00	
1e-03     2901198       18     5.50437 7e-03     24     0.711899392     0.7335729     0.00 2905219       19     5.23680     25     0.706395015     0.7242842     0.00		6e-03				2897651	
18     5.50437     24     0.711899392     0.7335729     0.00       7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00	17	5.61905	23	0.717518443	$0.7\overline{351019}$	0.00	
7e-03     2905219       19     5.23680     25     0.706395015     0.7242842     0.00						2901198	
19         5.23680         25         0.706395015         0.7242842         0.00	18	5.50437	24	0.711899392	0.7335729	0.00	
		7e-03				2905219	
3e-03 2928902	19	5.23680	25	0.706395015	0.7242842	0.00	
		3e-03				2928902	

#### 2.2. Task 2

Programa gražino, jog pruned medis turi 9536 lapus su panaudota C reikšme.

#### 2.3. Task 3

Accuracy on the pruned tree: 77.97433 % Accuracy on the unpruned: 68.98745 %

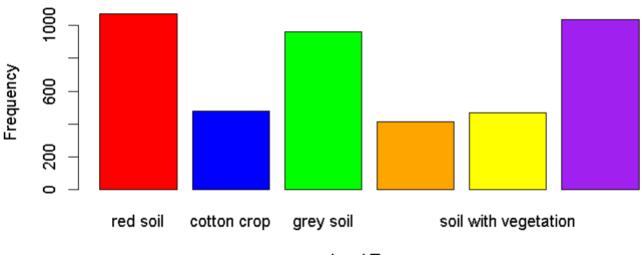
#### 2.4. Task 4

Panaikinus dalį pikselių programa pagreitėjo, tačiau mano manymu duomenys turėtu būti netikslūs.

### 3. Lab 6.1

#### 3.1. Task 1

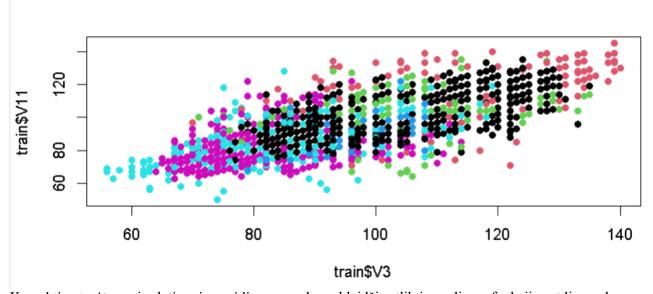
## Distribution of Land Types in Training Data



Land Type

Daugiausia yra red soil, grey soil ir very damp grey soil.

#### 3.2. Task 2



Kernel tipo turėtų pasirodyti geriau nei linear, nes kernel leidžia atlikti non-linear funkcija ant linear duomenų.

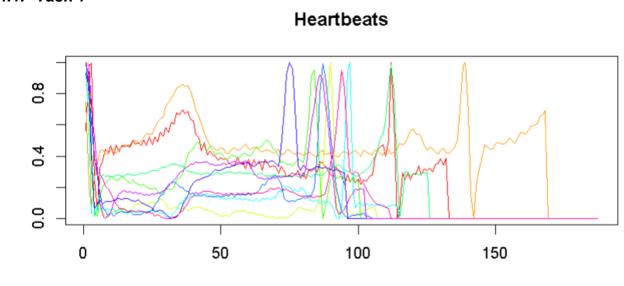
**3.3. Task 3**Overall Error Rate: 0.6055

pred					damp	
preu	red soil	cotton	crop	grey soil	grey soil	soil with vegetation
red soil	399		212	386	111	50
cotton crop	0		0	0	0	0
grey soil	0		0	0	0	0
damp grey soil	5		1	0	4	3
soil with vegetation	0		0	0	0	0
very damp grey soil	57		11	11	96	184

pred	very damp grey soil
red soil	74
cotton crop	0
grey soil	0
damp grey soil	10
soil with vegetation	0
very damp grey soil	386

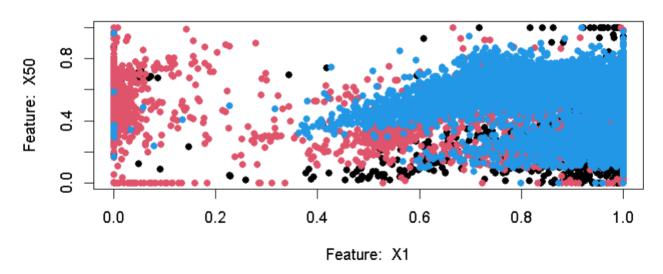
## 4. Lab 7.1

#### 4.1. Task 1



#### 4.2. Task 2

# **ECG Signal Points**



### 4.3. Task 3

Dabar prieš išmokinant naural network pasiskirstymas yra gan didelis tarp 0.6-1. Mano manymu pasiskirstymas turėtų išsilygin.

#### 4.4. Task 4

Testing Accuracy: 99.13109 %
Class 0 (Normal) Accuracy: 98.29322 %
Class 1 (Supraventricular) Accuracy: 99.24377 %
Class 2 (Ventricular) Accuracy: 99.4661 %
Class 4 (Unknown) Accuracy: 99.86005 %

## **Training Loss**

