

```
uracy: 0.9107 - val_mse: 0.0220
Epoch 120/300
- 0s - loss: 0.2583 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3093 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 121/300
- 0s - loss: 0.2581 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3093 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 122/300
- 0s - loss: 0.2578 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3093 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 123/300
- 0s - loss: 0.2575 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3098 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 124/300
- 0s - loss: 0.2571 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3122 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 125/300
- 0s - loss: 0.2572 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3074 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 126/300
- 0s - loss: 0.2571 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3080 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 127/300
- 0s - loss: 0.2580 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3054 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 128/300
- 0s - loss: 0.2566 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3073 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 129/300
- 0s - loss: 0.2556 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3129 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 130/300
- 0s - loss: 0.2571 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3083 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 131/300
- 0s - loss: 0.2571 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3060 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 132/300
- 0s - loss: 0.2548 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3087 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 133/300
- 0s - loss: 0.2565 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3047 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 134/300
- 0s - loss: 0.2548 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3060 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 135/300
- 0s - loss: 0.2545 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3114 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 136/300
- 0s - loss: 0.2555 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3064 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 137/300
- 0s - loss: 0.2535 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3047 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 138/300
- 0s - loss: 0.2541 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3063 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 139/300
- 0s - loss: 0.2537 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3054 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 140/300
- 0s - loss: 0.2528 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3048 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 141/300
- 0s - loss: 0.2533 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3082 - val_acc
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uracy: 0.9107 - val_mse: 0.0220
Epoch 142/300
- 0s - loss: 0.2525 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3053 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 143/300
- 0s - loss: 0.2516 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3029 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 144/300
- 0s - loss: 0.2516 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3042 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 145/300
- 0s - loss: 0.2514 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3044 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 146/300
- 0s - loss: 0.2506 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.3050 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 147/300
- 0s - loss: 0.2505 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.3064 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 148/300
- 0s - loss: 0.2505 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3017 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 149/300
- 0s - loss: 0.2505 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.3055 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 150/300
- 0s - loss: 0.2505 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3016 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 151/300
- 0s - loss: 0.2493 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.3033 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 152/300
- 0s - loss: 0.2487 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.3098 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 153/300
- 0s - loss: 0.2503 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3032 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 154/300
- 0s - loss: 0.2553 - accuracy: 0.9248 - mse: 0.0182 - val_loss: 0.3083 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 155/300
- 0s - loss: 0.2512 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3063 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 156/300
- 0s - loss: 0.2509 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.2984 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 157/300
- 0s - loss: 0.2511 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3009 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 158/300
- 0s - loss: 0.2480 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3194 - val_acc
uracy: 0.9107 - val_mse: 0.0222
Epoch 159/300
- 0s - loss: 0.2541 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3024 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 160/300
- 0s - loss: 0.2505 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.2996 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 161/300
- 0s - loss: 0.2485 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3078 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 162/300
- 0s - loss: 0.2504 - accuracy: 0.9248 - mse: 0.0181 - val_loss: 0.3048 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 163/300
- 0s - loss: 0.2488 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.2991 - val_acc
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uracy: 0.9107 - val_mse: 0.0218
Epoch 164/300
- 0s - loss: 0.2484 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3011 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 165/300
- 0s - loss: 0.2468 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3137 - val_acc
uracy: 0.9107 - val_mse: 0.0221
Epoch 166/300
- 0s - loss: 0.2503 - accuracy: 0.9248 - mse: 0.0180 - val_loss: 0.3011 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 167/300
- 0s - loss: 0.2459 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.2988 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 168/300
- 0s - loss: 0.2475 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3025 - val_acc
uracy: 0.9107 - val_mse: 0.0219
Epoch 169/300
- 0s - loss: 0.2460 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3048 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 170/300
- 0s - loss: 0.2468 - accuracy: 0.9248 - mse: 0.0179 - val_loss: 0.2985 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 171/300
- 0s - loss: 0.2458 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2997 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 172/300
- 0s - loss: 0.2454 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.3084 - val_acc
uracy: 0.9107 - val_mse: 0.0220
Epoch 173/300
- 0s - loss: 0.2466 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3006 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 174/300
- 0s - loss: 0.2445 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2987 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 175/300
- 0s - loss: 0.2450 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.3030 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 176/300
- 0s - loss: 0.2448 - accuracy: 0.9248 - mse: 0.0178 - val_loss: 0.3010 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 177/300
- 0s - loss: 0.2442 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2978 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 178/300
- 0s - loss: 0.2447 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.3005 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 179/300
- 0s - loss: 0.2434 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.3047 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 180/300
- 0s - loss: 0.2441 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2998 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 181/300
- 0s - loss: 0.2437 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2997 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 182/300
- 0s - loss: 0.2431 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.3028 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 183/300
- 0s - loss: 0.2436 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2981 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 184/300
- 0s - loss: 0.2429 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2978 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 185/300
- 0s - loss: 0.2429 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.3023 - val_acc
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uracy: 0.9107 - val_mse: 0.0218
Epoch 186/300
- 0s - loss: 0.2429 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.2995 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 187/300
- 0s - loss: 0.2423 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2989 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 188/300
- 0s - loss: 0.2423 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.3018 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 189/300
- 0s - loss: 0.2424 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2979 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 190/300
- 0s - loss: 0.2419 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2976 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 191/300
- 0s - loss: 0.2418 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.3006 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 192/300
- 0s - loss: 0.2418 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2975 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 193/300
- 0s - loss: 0.2416 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2989 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 194/300
- 0s - loss: 0.2412 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2996 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 195/300
- 0s - loss: 0.2412 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2966 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 196/300
- 0s - loss: 0.2414 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2998 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 197/300
- 0s - loss: 0.2412 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2965 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 198/300
- 0s - loss: 0.2408 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2976 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 199/300
- 0s - loss: 0.2405 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2990 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 200/300
- 0s - loss: 0.2406 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2965 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 201/300
- 0s - loss: 0.2407 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2998 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 202/300
- 0s - loss: 0.2408 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2951 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 203/300
- 0s - loss: 0.2408 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2984 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 204/300
- 0s - loss: 0.2403 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2959 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 205/300
- 0s - loss: 0.2399 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2968 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 206/300
- 0s - loss: 0.2397 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2978 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 207/300
- 0s - loss: 0.2397 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2953 - val_acc
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uracy: 0.9107 - val_mse: 0.0216
Epoch 208/300
- 0s - loss: 0.2400 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2992 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 209/300
- 0s - loss: 0.2405 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2940 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 210/300
- 0s - loss: 0.2415 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2987 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 211/300
- 0s - loss: 0.2404 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2945 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 212/300
- 0s - loss: 0.2394 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2962 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 213/300
- 0s - loss: 0.2390 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2980 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 214/300
- 0s - loss: 0.2393 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2946 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 215/300
- 0s - loss: 0.2404 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.3003 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 216/300
- 0s - loss: 0.2415 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2933 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 217/300
- 0s - loss: 0.2426 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2951 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 218/300
- 0s - loss: 0.2391 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2990 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 219/300
- 0s - loss: 0.2401 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2976 - val_acc
uracy: 0.9107 - val_mse: 0.0218
Epoch 220/300
- 0s - loss: 0.2445 - accuracy: 0.9248 - mse: 0.0177 - val_loss: 0.3007 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 221/300
- 0s - loss: 0.2409 - accuracy: 0.9248 - mse: 0.0176 - val_loss: 0.2938 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 222/300
- 0s - loss: 0.2386 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2931 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 223/300
- 0s - loss: 0.2395 - accuracy: 0.9247 - mse: 0.0175 - val_loss: 0.2973 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 224/300
- 0s - loss: 0.2391 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2948 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 225/300
- 0s - loss: 0.2382 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2952 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 226/300
- 0s - loss: 0.2381 - accuracy: 0.9247 - mse: 0.0174 - val_loss: 0.2968 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 227/300
- 0s - loss: 0.2386 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2931 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 228/300
- 0s - loss: 0.2390 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2946 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 229/300
- 0s - loss: 0.2382 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2940 - val_acc
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uracy: 0.9107 - val_mse: 0.0215
Epoch 230/300
- 0s - loss: 0.2377 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2940 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 231/300
- 0s - loss: 0.2381 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2984 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 232/300
- 0s - loss: 0.2389 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2946 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 233/300
- 0s - loss: 0.2398 - accuracy: 0.9249 - mse: 0.0175 - val_loss: 0.2974 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 234/300
- 0s - loss: 0.2390 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2920 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 235/300
- 0s - loss: 0.2382 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2929 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 236/300
- 0s - loss: 0.2373 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2971 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 237/300
- 0s - loss: 0.2383 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2950 - val_acc
uracy: 0.9108 - val_mse: 0.0217
Epoch 238/300
- 0s - loss: 0.2398 - accuracy: 0.9246 - mse: 0.0175 - val_loss: 0.2979 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 239/300
- 0s - loss: 0.2390 - accuracy: 0.9248 - mse: 0.0175 - val_loss: 0.2921 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 240/300
- 0s - loss: 0.2379 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2924 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 241/300
- 0s - loss: 0.2370 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2956 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 242/300
- 0s - loss: 0.2377 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2944 - val_acc
uracy: 0.9105 - val_mse: 0.0217
Epoch 243/300
- 0s - loss: 0.2394 - accuracy: 0.9249 - mse: 0.0175 - val_loss: 0.2980 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 244/300
- 0s - loss: 0.2389 - accuracy: 0.9249 - mse: 0.0175 - val_loss: 0.2926 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 245/300
- 0s - loss: 0.2378 - accuracy: 0.9251 - mse: 0.0174 - val_loss: 0.2930 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 246/300
- 0s - loss: 0.2365 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2940 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 247/300
- 0s - loss: 0.2368 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2930 - val_acc
uracy: 0.9108 - val_mse: 0.0216
Epoch 248/300
- 0s - loss: 0.2378 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2963 - val_acc
uracy: 0.9107 - val_mse: 0.0216
Epoch 249/300
- 0s - loss: 0.2376 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2929 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 250/300
- 0s - loss: 0.2367 - accuracy: 0.9253 - mse: 0.0174 - val_loss: 0.2931 - val_acc
uracy: 0.9110 - val_mse: 0.0215
Epoch 251/300
- 0s - loss: 0.2361 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2927 - val_acc
```

```
uracy: 0.9107 - val_mse: 0.0215
Epoch 252/300
- 0s - loss: 0.2361 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2920 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 253/300
- 0s - loss: 0.2363 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2945 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 254/300
- 0s - loss: 0.2366 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2927 - val_acc
uracy: 0.9110 - val_mse: 0.0215
Epoch 255/300
- 0s - loss: 0.2367 - accuracy: 0.9252 - mse: 0.0174 - val_loss: 0.2948 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 256/300
- 0s - loss: 0.2366 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2922 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 257/300
- 0s - loss: 0.2365 - accuracy: 0.9252 - mse: 0.0173 - val_loss: 0.2943 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 258/300
- 0s - loss: 0.2363 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2923 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 259/300
- 0s - loss: 0.2359 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2935 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 260/300
- 0s - loss: 0.2356 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2930 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 261/300
- 0s - loss: 0.2354 - accuracy: 0.9250 - mse: 0.0173 - val_loss: 0.2925 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 262/300
- 0s - loss: 0.2354 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2940 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 263/300
- 0s - loss: 0.2358 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2924 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 264/300
- 0s - loss: 0.2366 - accuracy: 0.9252 - mse: 0.0173 - val_loss: 0.2967 - val_acc
uracy: 0.9105 - val_mse: 0.0216
Epoch 265/300
- 0s - loss: 0.2377 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2942 - val_acc
uracy: 0.9105 - val_mse: 0.0217
Epoch 266/300
- 0s - loss: 0.2395 - accuracy: 0.9252 - mse: 0.0175 - val_loss: 0.2990 - val_acc
uracy: 0.9107 - val_mse: 0.0217
Epoch 267/300
- 0s - loss: 0.2395 - accuracy: 0.9247 - mse: 0.0175 - val_loss: 0.2930 - val_acc
uracy: 0.9113 - val_mse: 0.0216
Epoch 268/300
- 0s - loss: 0.2383 - accuracy: 0.9248 - mse: 0.0174 - val_loss: 0.2935 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 269/300
- 0s - loss: 0.2354 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2940 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 270/300
- 0s - loss: 0.2355 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2936 - val_acc
uracy: 0.9099 - val_mse: 0.0216
Epoch 271/300
- 0s - loss: 0.2376 - accuracy: 0.9254 - mse: 0.0174 - val_loss: 0.2966 - val_acc
uracy: 0.9105 - val_mse: 0.0216
Epoch 272/300
- 0s - loss: 0.2373 - accuracy: 0.9249 - mse: 0.0174 - val_loss: 0.2920 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 273/300
- 0s - loss: 0.2353 - accuracy: 0.9250 - mse: 0.0173 - val_loss: 0.2919 - val_acc
```

```
uracy: 0.9105 - val_mse: 0.0215
Epoch 274/300
- 0s - loss: 0.2350 - accuracy: 0.9249 - mse: 0.0173 - val_loss: 0.2952 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 275/300
- 0s - loss: 0.2364 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2931 - val_acc
uracy: 0.9098 - val_mse: 0.0216
Epoch 276/300
- 0s - loss: 0.2371 - accuracy: 0.9253 - mse: 0.0174 - val_loss: 0.2940 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 277/300
- 0s - loss: 0.2357 - accuracy: 0.9247 - mse: 0.0173 - val_loss: 0.2920 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 278/300
- 0s - loss: 0.2346 - accuracy: 0.9250 - mse: 0.0173 - val_loss: 0.2922 - val_acc
uracy: 0.9110 - val_mse: 0.0215
Epoch 279/300
- 0s - loss: 0.2352 - accuracy: 0.9251 - mse: 0.0173 - val_loss: 0.2959 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 280/300
- 0s - loss: 0.2362 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2933 - val_acc
uracy: 0.9104 - val_mse: 0.0216
Epoch 281/300
- 0s - loss: 0.2362 - accuracy: 0.9252 - mse: 0.0173 - val_loss: 0.2944 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 282/300
- 0s - loss: 0.2352 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2920 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 283/300
- 0s - loss: 0.2344 - accuracy: 0.9249 - mse: 0.0172 - val_loss: 0.2921 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 284/300
- 0s - loss: 0.2343 - accuracy: 0.9249 - mse: 0.0172 - val_loss: 0.2941 - val_acc
uracy: 0.9107 - val_mse: 0.0215
Epoch 285/300
- 0s - loss: 0.2348 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2930 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 286/300
- 0s - loss: 0.2352 - accuracy: 0.9250 - mse: 0.0173 - val_loss: 0.2951 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 287/300
- 0s - loss: 0.2355 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2928 - val_acc
uracy: 0.9111 - val_mse: 0.0215
Epoch 288/300
- 0s - loss: 0.2357 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2948 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 289/300
- 0s - loss: 0.2354 - accuracy: 0.9248 - mse: 0.0173 - val_loss: 0.2931 - val_acc
uracy: 0.9111 - val_mse: 0.0215
Epoch 290/300
- 0s - loss: 0.2354 - accuracy: 0.9250 - mse: 0.0173 - val_loss: 0.2950 - val_acc
uracy: 0.9105 - val_mse: 0.0215
Epoch 291/300
- 0s - loss: 0.2351 - accuracy: 0.9247 - mse: 0.0173 - val_loss: 0.2933 - val_acc
uracy: 0.9111 - val_mse: 0.0215
Epoch 292/300
- 0s - loss: 0.2347 - accuracy: 0.9251 - mse: 0.0173 - val_loss: 0.2939 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 293/300
- 0s - loss: 0.2342 - accuracy: 0.9248 - mse: 0.0172 - val_loss: 0.2926 - val_acc
uracy: 0.9110 - val_mse: 0.0215
Epoch 294/300
- 0s - loss: 0.2338 - accuracy: 0.9250 - mse: 0.0172 - val_loss: 0.2926 - val_acc
uracy: 0.9108 - val_mse: 0.0215
Epoch 295/300
- 0s - loss: 0.2337 - accuracy: 0.9250 - mse: 0.0172 - val_loss: 0.2932 - val_acc
```

```
uracy: 0.9108 - val_mse: 0.0215
Epoch 296/300
- 0s - loss: 0.2338 - accuracy: 0.9249 - mse: 0.0172 - val_loss: 0.2929 - val_acc
```

In [149...]

```
model_neuronal2.summary()
```

Model: "sequential\_4"

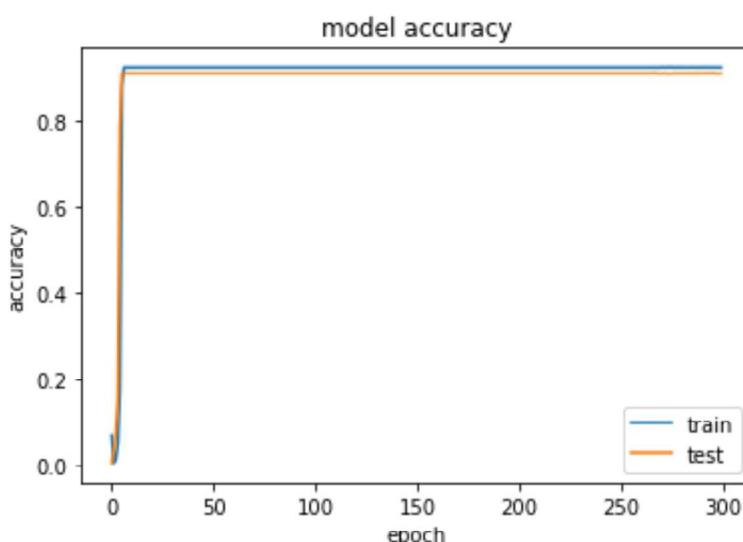
Layer (type)	Output Shape	Param #
<hr/>		
dense_16 (Dense)	(None, 64)	2880
dense_17 (Dense)	(None, 32)	2080
dense_18 (Dense)	(None, 10)	330
dense_19 (Dense)	(None, 8)	88
dense_20 (Dense)	(None, 7)	63
<hr/>		
Total params: 5,441		
Trainable params: 5,441		
Non-trainable params: 0		

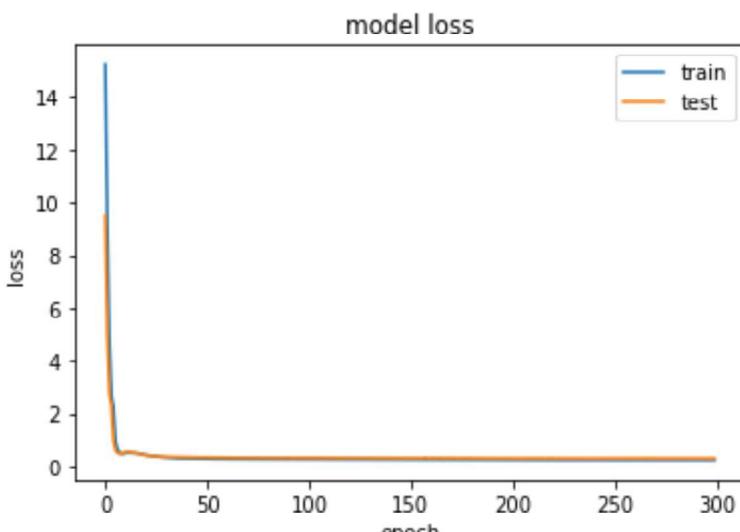
In [150...]

```
%matplotlib inline
```

```
# Visualizamos la evolución de la accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='lower right')
plt.show()

# Visualizamos la evolución del error cometido por la red
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper right')
plt.show()
```





In [157...]

```
# Predicciones sobre conjunto train y test
y_predict_train_NN2 = model_neuronal2.predict(x_train)
y_predict_test_NN2 = model_neuronal2.predict(x_test)
```

In [160...]

```
y_predict_train_NN2 = pd.DataFrame(y_predict_train_NN2)
y_predict_train_NN2 = round(y_predict_train_NN2).astype('int')

y_predict_test_NN2 = pd.DataFrame(y_predict_test_NN2)
y_predict_test_NN2 = round(y_predict_test_NN2).astype('int')
```

In [177...]

```
# Precisión sobre train y test
score_train = accuracy_score(y_train_transf2, y_predict_train_NN2)
print('El grado de precisión del modelo para el conjunto train es {}.'.
      format(round(score_train,4)))
score_test = accuracy_score(y_test_transf2, y_predict_test_NN2)
print('El grado de precisión del modelo para el conjunto test es {}.'.
      format(round(score_test,4)))
```

El grado de precisión del modelo para el conjunto train es 0.9169.  
El grado de precisión del modelo para el conjunto test es 0.9009.

In [153...]

```
#Vemos el error del algoritmo a la hora de predecir, para comprobar si a ajustado
print('MAE in train:', mean_absolute_error(y_predict_train_NN2, y_train_transf2))
print('RMSE in train:', np.sqrt(mean_squared_error(y_predict_train_NN2, y_train_transf2)))
print('MAE in test:', mean_absolute_error(y_predict_test_NN2, y_test_transf2))
print('RMSE in test:', np.sqrt(mean_squared_error(y_predict_test_NN2, y_test_transf2)))
```

MAE in train: 0.020887145813923647  
RMSE in train: 0.1445238589781066  
MAE in test: 0.02590349761868845  
RMSE in test: 0.16094563560000144

In [155...]

```
# Función matriz confusión.

import itertools

def plot_confusion_matrix(cm, classes, normalize=False, title='Confusion matrix',
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=0)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
    else:
        1

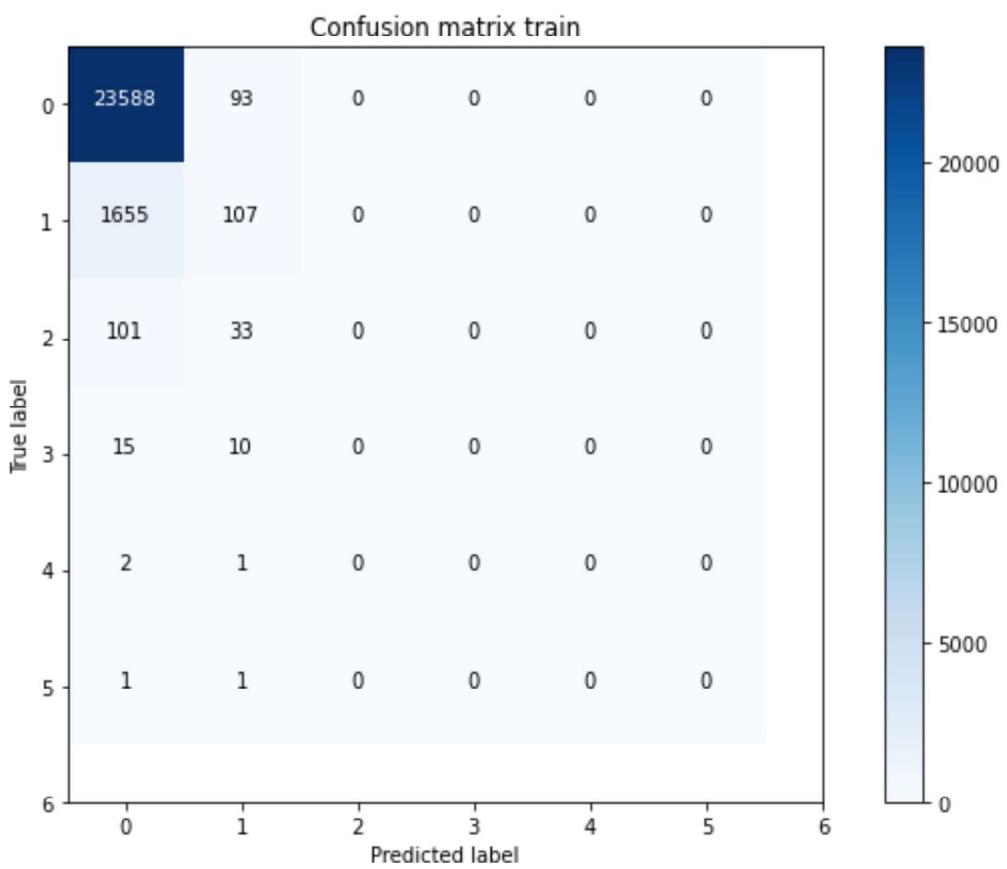
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
            horizontalalignment="center",
            color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

In [165...]

```
# Convertir dataframe a array
x = model_neuronal2.predict(x_train)
y = y_train_transf2.to_numpy()

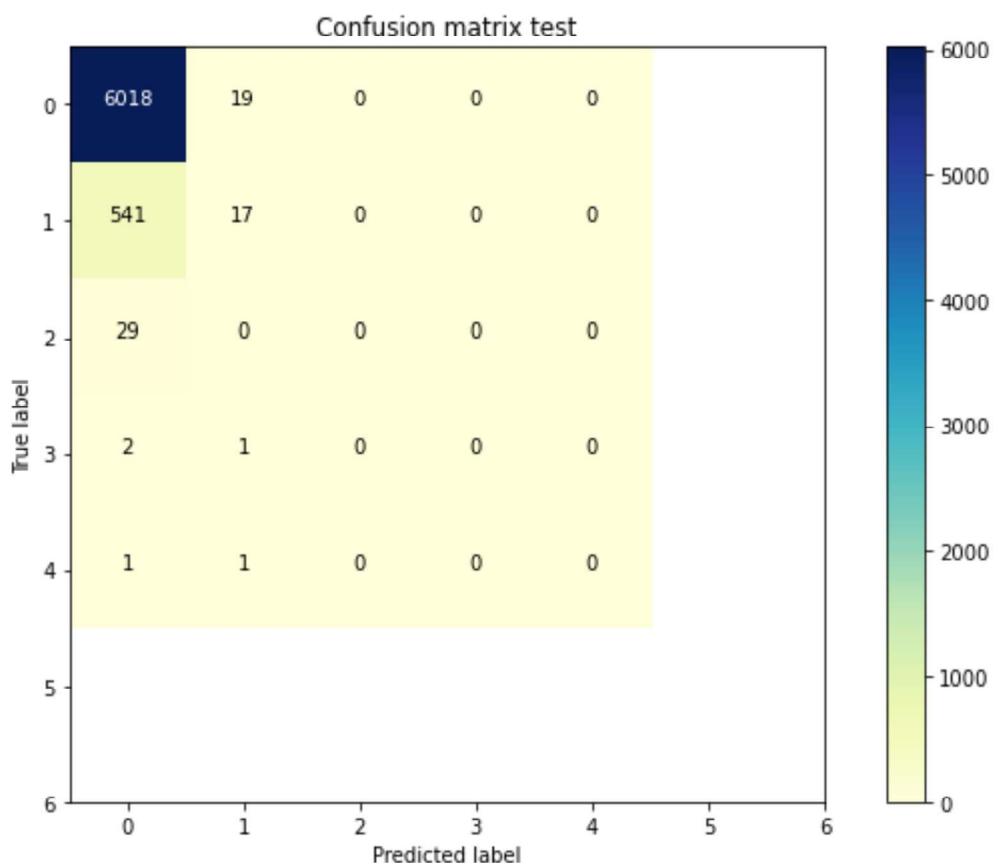
# Matriz de confusión train
cm = confusion_matrix(y.argmax(axis=1),
                      x.argmax(axis=1))
np.set_printoptions(precision=2)
class_names = ['0', '1', '2', '3', '4', '5', '6']
plt.figure(1, figsize=(9, 6))
plot_confusion_matrix(cm, classes=class_names,
                      title='Confusion matrix train')
plt.savefig('graph/matriz_confusion_NN2train_2.jpg')
plt.show()
```



In [166]:

```
# Convertir dataframe a array
x = model_neuronala2.predict(x_test)
y = y_test_transf2.to_numpy()

# Matriz de confusión test
cm = confusion_matrix(y.argmax(axis=1),
                      x.argmax(axis=1))
np.set_printoptions(precision=2)
class_names = ['0', '1', '2', '3', '4', '5', '6']
plt.figure(1, figsize=(9, 6))
plot_confusion_matrix(cm, classes=class_names,
                      title='Confusion matrix test',
                      cmap="YlGnBu")
plt.savefig('graph/matriz_confusion_NN2test_2.jpg')
plt.show()
```



### 3.4.6.2 Red neuronal para clasificar según clases de *udsVenta*.

Se implementa red neuronal con una última capa de salida con 28 categorías, una por cada uno de las clases de la variable *y\_train\_3*.

- 4 capas ocultas con 64, 32, 10, 8 neuronas
- Función de activación ReLU

```
In [188...]: # Número de clases
num_classes = 28

model_neuronal = Sequential()

# Añadir las capas indicadas
model_neuronal.add(Dense(64, input_shape=(44,), activation="relu", kernel_initializer="he_normal"))
model_neuronal.add(Dense(32, activation="relu"))
model_neuronal.add(Dense(10, activation="relu"))
model_neuronal.add(Dense(8, activation="relu"))
model_neuronal.add(Dense(num_classes, activation="softmax"))
```

Se compila el modelo con la función de pérdida más adecuada. La función de pérdida idónea es la Categorical-Crossentropy, dado que se generan salidas para cada clase de la variable objeto *udsVenta*.

```
In [189...]: ohe = OneHotEncoder()
y_train_transf = pd.get_dummies(
    y_train_3, columns=['udsVenta'])
y_test_transf = pd.get_dummies(
    y_test_3, columns=['udsVenta'])
```

In [190...]

```
# Se compila el modelo con la función de perdida más adecuada.
model_neuronal.compile(
    optimizer=Adam(lr=0.01),
    loss='categorical_crossentropy',
    metrics=['accuracy', 'mse'])
```

In [191...]

```
batch = x_train.shape[0]
history = model_neuronal.fit(
    x_train, y_train_transf,
    validation_data=(x_test, y_test_transf),
    epochs=200,
    batch_size=batch,
    verbose=2)
```

```
Train on 25607 samples, validate on 6629 samples
Epoch 1/200
- 0s - loss: 6.1206 - accuracy: 0.0300 - mse: 0.0402 - val_loss: 4.3010 - val_accuracy: 0.0071 - val_mse: 0.0371
Epoch 2/200
- 0s - loss: 4.0946 - accuracy: 0.0054 - mse: 0.0367 - val_loss: 3.5309 - val_accuracy: 0.0106 - val_mse: 0.0352
Epoch 3/200
- 0s - loss: 3.4764 - accuracy: 0.0072 - mse: 0.0351 - val_loss: 3.1547 - val_accuracy: 0.0146 - val_mse: 0.0338
Epoch 4/200
- 0s - loss: 3.0956 - accuracy: 0.0131 - mse: 0.0337 - val_loss: 3.0550 - val_accuracy: 0.0388 - val_mse: 0.0334
Epoch 5/200
- 0s - loss: 3.0151 - accuracy: 0.0431 - mse: 0.0334 - val_loss: 3.0145 - val_accuracy: 0.2827 - val_mse: 0.0332
Epoch 6/200
- 0s - loss: 2.9820 - accuracy: 0.3412 - mse: 0.0332 - val_loss: 2.9340 - val_accuracy: 0.2079 - val_mse: 0.0326
Epoch 7/200
- 0s - loss: 2.9139 - accuracy: 0.2082 - mse: 0.0328 - val_loss: 2.9699 - val_accuracy: 0.1546 - val_mse: 0.0319
Epoch 8/200
- 0s - loss: 2.8923 - accuracy: 0.1309 - mse: 0.0321 - val_loss: 2.8372 - val_accuracy: 0.2634 - val_mse: 0.0316
Epoch 9/200
- 0s - loss: 2.7598 - accuracy: 0.2961 - mse: 0.0315 - val_loss: 2.8694 - val_accuracy: 0.2978 - val_mse: 0.0316
Epoch 10/200
- 0s - loss: 2.7300 - accuracy: 0.3562 - mse: 0.0310 - val_loss: 2.8647 - val_accuracy: 0.2978 - val_mse: 0.0314
Epoch 11/200
- 0s - loss: 2.6706 - accuracy: 0.3562 - mse: 0.0304 - val_loss: 2.7350 - val_accuracy: 0.2975 - val_mse: 0.0307
Epoch 12/200
- 0s - loss: 2.5731 - accuracy: 0.3521 - mse: 0.0301 - val_loss: 2.6686 - val_accuracy: 0.2620 - val_mse: 0.0305
Epoch 13/200
- 0s - loss: 2.5409 - accuracy: 0.3012 - mse: 0.0302 - val_loss: 2.5945 - val_accuracy: 0.2972 - val_mse: 0.0305
Epoch 14/200
- 0s - loss: 2.4823 - accuracy: 0.3561 - mse: 0.0301 - val_loss: 2.5687 - val_accuracy: 0.2978 - val_mse: 0.0305
Epoch 15/200
- 0s - loss: 2.4515 - accuracy: 0.3562 - mse: 0.0300 - val_loss: 2.5336 - val_accuracy: 0.2978 - val_mse: 0.0303
Epoch 16/200
- 0s - loss: 2.3963 - accuracy: 0.3562 - mse: 0.0296 - val_loss: 2.5172 - val_accuracy: 0.2978 - val_mse: 0.0302
```

Epoch 17/200  
- 0s - loss: 2.3508 - accuracy: 0.3562 - mse: 0.0292 - val\_loss: 2.5195 - val\_accuracy: 0.2842 - val\_mse: 0.0302  
Epoch 18/200  
- 0s - loss: 2.3379 - accuracy: 0.3327 - mse: 0.0291 - val\_loss: 2.4564 - val\_accuracy: 0.2979 - val\_mse: 0.0301  
Epoch 19/200  
- 0s - loss: 2.2820 - accuracy: 0.3562 - mse: 0.0290 - val\_loss: 2.4265 - val\_accuracy: 0.2978 - val\_mse: 0.0300  
Epoch 20/200  
- 0s - loss: 2.2667 - accuracy: 0.3562 - mse: 0.0290 - val\_loss: 2.3985 - val\_accuracy: 0.2978 - val\_mse: 0.0299  
Epoch 21/200  
- 0s - loss: 2.2403 - accuracy: 0.3562 - mse: 0.0289 - val\_loss: 2.3699 - val\_accuracy: 0.2978 - val\_mse: 0.0297  
Epoch 22/200  
- 0s - loss: 2.1999 - accuracy: 0.3562 - mse: 0.0286 - val\_loss: 2.3740 - val\_accuracy: 0.2987 - val\_mse: 0.0297  
Epoch 23/200  
- 0s - loss: 2.1910 - accuracy: 0.3562 - mse: 0.0285 - val\_loss: 2.3481 - val\_accuracy: 0.2978 - val\_mse: 0.0296  
Epoch 24/200  
- 0s - loss: 2.1687 - accuracy: 0.3562 - mse: 0.0285 - val\_loss: 2.3020 - val\_accuracy: 0.2978 - val\_mse: 0.0295  
Epoch 25/200  
- 0s - loss: 2.1393 - accuracy: 0.3562 - mse: 0.0284 - val\_loss: 2.2776 - val\_accuracy: 0.2978 - val\_mse: 0.0295  
Epoch 26/200  
- 0s - loss: 2.1288 - accuracy: 0.3562 - mse: 0.0285 - val\_loss: 2.2611 - val\_accuracy: 0.2978 - val\_mse: 0.0295  
Epoch 27/200  
- 0s - loss: 2.1143 - accuracy: 0.3562 - mse: 0.0285 - val\_loss: 2.2476 - val\_accuracy: 0.2978 - val\_mse: 0.0296  
Epoch 28/200  
- 0s - loss: 2.0919 - accuracy: 0.3562 - mse: 0.0284 - val\_loss: 2.2451 - val\_accuracy: 0.2978 - val\_mse: 0.0297  
Epoch 29/200  
- 0s - loss: 2.0801 - accuracy: 0.3562 - mse: 0.0284 - val\_loss: 2.2227 - val\_accuracy: 0.2978 - val\_mse: 0.0295  
Epoch 30/200  
- 0s - loss: 2.0650 - accuracy: 0.3547 - mse: 0.0283 - val\_loss: 2.1961 - val\_accuracy: 0.2948 - val\_mse: 0.0293  
Epoch 31/200  
- 0s - loss: 2.0517 - accuracy: 0.3509 - mse: 0.0283 - val\_loss: 2.1806 - val\_accuracy: 0.2975 - val\_mse: 0.0293  
Epoch 32/200  
- 0s - loss: 2.0366 - accuracy: 0.3543 - mse: 0.0282 - val\_loss: 2.1824 - val\_accuracy: 0.2978 - val\_mse: 0.0296  
Epoch 33/200  
- 0s - loss: 2.0251 - accuracy: 0.3562 - mse: 0.0283 - val\_loss: 2.1645 - val\_accuracy: 0.2978 - val\_mse: 0.0295  
Epoch 34/200  
- 0s - loss: 2.0125 - accuracy: 0.3562 - mse: 0.0282 - val\_loss: 2.1446 - val\_accuracy: 0.2978 - val\_mse: 0.0293  
Epoch 35/200  
- 0s - loss: 2.0021 - accuracy: 0.3562 - mse: 0.0281 - val\_loss: 2.1418 - val\_accuracy: 0.2978 - val\_mse: 0.0294  
Epoch 36/200  
- 0s - loss: 1.9884 - accuracy: 0.3562 - mse: 0.0281 - val\_loss: 2.1253 - val\_accuracy: 0.2978 - val\_mse: 0.0292  
Epoch 37/200  
- 0s - loss: 1.9768 - accuracy: 0.3556 - mse: 0.0280 - val\_loss: 2.1085 - val\_accuracy: 0.2982 - val\_mse: 0.0291  
Epoch 38/200  
- 0s - loss: 1.9676 - accuracy: 0.3538 - mse: 0.0280 - val\_loss: 2.1079 - val\_accuracy: 0.2978 - val\_mse: 0.0294

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Epoch 39/200
- 0s - loss: 1.9546 - accuracy: 0.3562 - mse: 0.0280 - val_loss: 2.0938 - val_accuracy: 0.2978 - val_mse: 0.0293
Epoch 40/200
- 0s - loss: 1.9438 - accuracy: 0.3562 - mse: 0.0279 - val_loss: 2.0789 - val_accuracy: 0.2978 - val_mse: 0.0292
Epoch 41/200
- 0s - loss: 1.9366 - accuracy: 0.3560 - mse: 0.0279 - val_loss: 2.0828 - val_accuracy: 0.2978 - val_mse: 0.0295
Epoch 42/200
- 0s - loss: 1.9276 - accuracy: 0.3562 - mse: 0.0279 - val_loss: 2.0551 - val_accuracy: 0.2979 - val_mse: 0.0290
Epoch 43/200
- 0s - loss: 1.9157 - accuracy: 0.3559 - mse: 0.0277 - val_loss: 2.0486 - val_accuracy: 0.2978 - val_mse: 0.0290
Epoch 44/200
- 0s - loss: 1.9067 - accuracy: 0.3562 - mse: 0.0277 - val_loss: 2.0446 - val_accuracy: 0.2978 - val_mse: 0.0291
Epoch 45/200
- 0s - loss: 1.8989 - accuracy: 0.3562 - mse: 0.0277 - val_loss: 2.0252 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 46/200
- 0s - loss: 1.8912 - accuracy: 0.3562 - mse: 0.0276 - val_loss: 2.0285 - val_accuracy: 0.2978 - val_mse: 0.0292
Epoch 47/200
- 0s - loss: 1.8835 - accuracy: 0.3562 - mse: 0.0277 - val_loss: 2.0120 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 48/200
- 0s - loss: 1.8738 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 2.0060 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 49/200
- 0s - loss: 1.8661 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 2.0065 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 50/200
- 0s - loss: 1.8601 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 1.9908 - val_accuracy: 0.2978 - val_mse: 0.0287
Epoch 51/200
- 0s - loss: 1.8536 - accuracy: 0.3562 - mse: 0.0274 - val_loss: 2.0017 - val_accuracy: 0.2978 - val_mse: 0.0291
Epoch 52/200
- 0s - loss: 1.8496 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 1.9770 - val_accuracy: 0.2978 - val_mse: 0.0286
Epoch 53/200
- 0s - loss: 1.8451 - accuracy: 0.3563 - mse: 0.0273 - val_loss: 2.0042 - val_accuracy: 0.2978 - val_mse: 0.0292
Epoch 54/200
- 0s - loss: 1.8467 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 1.9622 - val_accuracy: 0.2982 - val_mse: 0.0284
Epoch 55/200
- 0s - loss: 1.8362 - accuracy: 0.3558 - mse: 0.0273 - val_loss: 1.9735 - val_accuracy: 0.2978 - val_mse: 0.0288
Epoch 56/200
- 0s - loss: 1.8275 - accuracy: 0.3562 - mse: 0.0273 - val_loss: 1.9530 - val_accuracy: 0.2978 - val_mse: 0.0285
Epoch 57/200
- 0s - loss: 1.8179 - accuracy: 0.3562 - mse: 0.0272 - val_loss: 1.9460 - val_accuracy: 0.2978 - val_mse: 0.0284
Epoch 58/200
- 0s - loss: 1.8167 - accuracy: 0.3563 - mse: 0.0271 - val_loss: 1.9784 - val_accuracy: 0.2978 - val_mse: 0.0290
Epoch 59/200
- 0s - loss: 1.8226 - accuracy: 0.3562 - mse: 0.0273 - val_loss: 1.9409 - val_accuracy: 0.2984 - val_mse: 0.0283
Epoch 60/200
- 0s - loss: 1.8153 - accuracy: 0.3557 - mse: 0.0271 - val_loss: 1.9682 - val_accuracy: 0.2978 - val_mse: 0.0287
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Epoch 61/200
- 0s - loss: 1.8125 - accuracy: 0.3562 - mse: 0.0271 - val_loss: 1.9350 - val_accuracy: 0.2979 - val_mse: 0.0283
Epoch 62/200
- 0s - loss: 1.7991 - accuracy: 0.3566 - mse: 0.0270 - val_loss: 1.9304 - val_accuracy: 0.2981 - val_mse: 0.0282
Epoch 63/200
- 0s - loss: 1.7958 - accuracy: 0.3564 - mse: 0.0270 - val_loss: 1.9598 - val_accuracy: 0.2978 - val_mse: 0.0287
Epoch 64/200
- 0s - loss: 1.8034 - accuracy: 0.3562 - mse: 0.0271 - val_loss: 1.9244 - val_accuracy: 0.2988 - val_mse: 0.0281
Epoch 65/200
- 0s - loss: 1.8008 - accuracy: 0.3563 - mse: 0.0270 - val_loss: 1.9597 - val_accuracy: 0.2978 - val_mse: 0.0286
Epoch 66/200
- 0s - loss: 1.8022 - accuracy: 0.3562 - mse: 0.0270 - val_loss: 1.9167 - val_accuracy: 0.2984 - val_mse: 0.0281
Epoch 67/200
- 0s - loss: 1.7850 - accuracy: 0.3577 - mse: 0.0269 - val_loss: 1.9112 - val_accuracy: 0.2979 - val_mse: 0.0280
Epoch 68/200
- 0s - loss: 1.7838 - accuracy: 0.3578 - mse: 0.0268 - val_loss: 1.9643 - val_accuracy: 0.2978 - val_mse: 0.0288
Epoch 69/200
- 0s - loss: 1.8010 - accuracy: 0.3562 - mse: 0.0270 - val_loss: 1.9090 - val_accuracy: 0.2991 - val_mse: 0.0279
Epoch 70/200
- 0s - loss: 1.7852 - accuracy: 0.3573 - mse: 0.0268 - val_loss: 1.9277 - val_accuracy: 0.2978 - val_mse: 0.0282
Epoch 71/200
- 0s - loss: 1.7751 - accuracy: 0.3562 - mse: 0.0267 - val_loss: 1.9089 - val_accuracy: 0.2987 - val_mse: 0.0279
Epoch 72/200
- 0s - loss: 1.7673 - accuracy: 0.3581 - mse: 0.0266 - val_loss: 1.9003 - val_accuracy: 0.2990 - val_mse: 0.0278
Epoch 73/200
- 0s - loss: 1.7654 - accuracy: 0.3587 - mse: 0.0266 - val_loss: 1.9468 - val_accuracy: 0.2978 - val_mse: 0.0286
Epoch 74/200
- 0s - loss: 1.7786 - accuracy: 0.3562 - mse: 0.0267 - val_loss: 1.9033 - val_accuracy: 0.3038 - val_mse: 0.0277
Epoch 75/200
- 0s - loss: 1.7852 - accuracy: 0.3631 - mse: 0.0266 - val_loss: 1.9814 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 76/200
- 0s - loss: 1.7994 - accuracy: 0.3562 - mse: 0.0268 - val_loss: 1.9021 - val_accuracy: 0.3074 - val_mse: 0.0277
Epoch 77/200
- 0s - loss: 1.7686 - accuracy: 0.3660 - mse: 0.0265 - val_loss: 1.8825 - val_accuracy: 0.2990 - val_mse: 0.0276
Epoch 78/200
- 0s - loss: 1.7534 - accuracy: 0.3586 - mse: 0.0263 - val_loss: 1.9849 - val_accuracy: 0.2978 - val_mse: 0.0292
Epoch 79/200
- 0s - loss: 1.8047 - accuracy: 0.3562 - mse: 0.0269 - val_loss: 1.9115 - val_accuracy: 0.3067 - val_mse: 0.0276
Epoch 80/200
- 0s - loss: 1.8144 - accuracy: 0.3561 - mse: 0.0267 - val_loss: 1.8868 - val_accuracy: 0.3003 - val_mse: 0.0276
Epoch 81/200
- 0s - loss: 1.7499 - accuracy: 0.3556 - mse: 0.0262 - val_loss: 2.0538 - val_accuracy: 0.2978 - val_mse: 0.0298
Epoch 82/200
- 0s - loss: 1.8310 - accuracy: 0.3562 - mse: 0.0271 - val_loss: 1.9038 - val_accuracy: 0.3121 - val_mse: 0.0277
```

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Epoch 83/200
- 0s - loss: 1.7864 - accuracy: 0.3512 - mse: 0.0267 - val_loss: 1.8836 - val_accuracy: 0.3073 - val_mse: 0.0276
Epoch 84/200
- 0s - loss: 1.7946 - accuracy: 0.3523 - mse: 0.0268 - val_loss: 1.8939 - val_accuracy: 0.2988 - val_mse: 0.0277
Epoch 85/200
- 0s - loss: 1.7863 - accuracy: 0.3565 - mse: 0.0265 - val_loss: 1.9468 - val_accuracy: 0.2979 - val_mse: 0.0286
Epoch 86/200
- 0s - loss: 1.7897 - accuracy: 0.3562 - mse: 0.0266 - val_loss: 1.9537 - val_accuracy: 0.2978 - val_mse: 0.0288
Epoch 87/200
- 0s - loss: 1.7735 - accuracy: 0.3562 - mse: 0.0266 - val_loss: 1.8911 - val_accuracy: 0.3126 - val_mse: 0.0276
Epoch 88/200
- 0s - loss: 1.7588 - accuracy: 0.3579 - mse: 0.0264 - val_loss: 1.9119 - val_accuracy: 0.3071 - val_mse: 0.0278
Epoch 89/200
- 0s - loss: 1.7805 - accuracy: 0.3475 - mse: 0.0267 - val_loss: 1.8995 - val_accuracy: 0.3006 - val_mse: 0.0278
Epoch 90/200
- 0s - loss: 1.7307 - accuracy: 0.3585 - mse: 0.0260 - val_loss: 1.9772 - val_accuracy: 0.2978 - val_mse: 0.0293
Epoch 91/200
- 0s - loss: 1.7772 - accuracy: 0.3562 - mse: 0.0269 - val_loss: 1.8823 - val_accuracy: 0.3053 - val_mse: 0.0274
Epoch 92/200
- 0s - loss: 1.7417 - accuracy: 0.3592 - mse: 0.0260 - val_loss: 1.8644 - val_accuracy: 0.3106 - val_mse: 0.0272
Epoch 93/200
- 0s - loss: 1.7400 - accuracy: 0.3651 - mse: 0.0260 - val_loss: 1.8877 - val_accuracy: 0.3037 - val_mse: 0.0275
Epoch 94/200
- 0s - loss: 1.7235 - accuracy: 0.3599 - mse: 0.0257 - val_loss: 1.9386 - val_accuracy: 0.2984 - val_mse: 0.0282
Epoch 95/200
- 0s - loss: 1.7512 - accuracy: 0.3562 - mse: 0.0259 - val_loss: 1.8556 - val_accuracy: 0.3120 - val_mse: 0.0272
Epoch 96/200
- 0s - loss: 1.7539 - accuracy: 0.3603 - mse: 0.0262 - val_loss: 1.8601 - val_accuracy: 0.3091 - val_mse: 0.0272
Epoch 97/200
- 0s - loss: 1.7635 - accuracy: 0.3559 - mse: 0.0262 - val_loss: 1.8784 - val_accuracy: 0.2991 - val_mse: 0.0276
Epoch 98/200
- 0s - loss: 1.7281 - accuracy: 0.3564 - mse: 0.0258 - val_loss: 1.9861 - val_accuracy: 0.2978 - val_mse: 0.0294
Epoch 99/200
- 0s - loss: 1.7787 - accuracy: 0.3562 - mse: 0.0267 - val_loss: 1.8523 - val_accuracy: 0.3106 - val_mse: 0.0271
Epoch 100/200
- 0s - loss: 1.7265 - accuracy: 0.3605 - mse: 0.0258 - val_loss: 1.8761 - val_accuracy: 0.3118 - val_mse: 0.0274
Epoch 101/200
- 0s - loss: 1.7699 - accuracy: 0.3478 - mse: 0.0265 - val_loss: 1.8576 - val_accuracy: 0.3132 - val_mse: 0.0272
Epoch 102/200
- 0s - loss: 1.7180 - accuracy: 0.3639 - mse: 0.0257 - val_loss: 1.9577 - val_accuracy: 0.2978 - val_mse: 0.0289
Epoch 103/200
- 0s - loss: 1.7510 - accuracy: 0.3562 - mse: 0.0264 - val_loss: 1.8791 - val_accuracy: 0.3005 - val_mse: 0.0276
Epoch 104/200
- 0s - loss: 1.7069 - accuracy: 0.3574 - mse: 0.0256 - val_loss: 1.8607 - val_accuracy: 0.3183 - val_mse: 0.0271
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Epoch 105/200
- 0s - loss: 1.7302 - accuracy: 0.3643 - mse: 0.0258 - val_loss: 1.8539 - val_accuracy: 0.3210 - val_mse: 0.0271
Epoch 106/200
- 0s - loss: 1.7196 - accuracy: 0.3653 - mse: 0.0257 - val_loss: 1.8773 - val_accuracy: 0.3025 - val_mse: 0.0275
Epoch 107/200
- 0s - loss: 1.7039 - accuracy: 0.3593 - mse: 0.0255 - val_loss: 1.9091 - val_accuracy: 0.3000 - val_mse: 0.0280
Epoch 108/200
- 0s - loss: 1.7210 - accuracy: 0.3576 - mse: 0.0258 - val_loss: 1.8445 - val_accuracy: 0.3175 - val_mse: 0.0270
Epoch 109/200
- 0s - loss: 1.6987 - accuracy: 0.3697 - mse: 0.0254 - val_loss: 1.8406 - val_accuracy: 0.3195 - val_mse: 0.0269
Epoch 110/200
- 0s - loss: 1.7115 - accuracy: 0.3670 - mse: 0.0256 - val_loss: 1.8392 - val_accuracy: 0.3097 - val_mse: 0.0270
Epoch 111/200
- 0s - loss: 1.6871 - accuracy: 0.3640 - mse: 0.0253 - val_loss: 1.9019 - val_accuracy: 0.2984 - val_mse: 0.0282
Epoch 112/200
- 0s - loss: 1.7121 - accuracy: 0.3564 - mse: 0.0258 - val_loss: 1.8348 - val_accuracy: 0.3197 - val_mse: 0.0269
Epoch 113/200
- 0s - loss: 1.6840 - accuracy: 0.3673 - mse: 0.0252 - val_loss: 1.8362 - val_accuracy: 0.3213 - val_mse: 0.0268
Epoch 114/200
- 0s - loss: 1.6942 - accuracy: 0.3736 - mse: 0.0253 - val_loss: 1.8561 - val_accuracy: 0.3092 - val_mse: 0.0272
Epoch 115/200
- 0s - loss: 1.6772 - accuracy: 0.3619 - mse: 0.0251 - val_loss: 1.8655 - val_accuracy: 0.3091 - val_mse: 0.0274
Epoch 116/200
- 0s - loss: 1.6809 - accuracy: 0.3606 - mse: 0.0252 - val_loss: 1.8478 - val_accuracy: 0.3272 - val_mse: 0.0269
Epoch 117/200
- 0s - loss: 1.7094 - accuracy: 0.3679 - mse: 0.0254 - val_loss: 1.8338 - val_accuracy: 0.3198 - val_mse: 0.0268
Epoch 118/200
- 0s - loss: 1.6710 - accuracy: 0.3694 - mse: 0.0250 - val_loss: 1.9612 - val_accuracy: 0.2982 - val_mse: 0.0290
Epoch 119/200
- 0s - loss: 1.7637 - accuracy: 0.3567 - mse: 0.0266 - val_loss: 1.9226 - val_accuracy: 0.3017 - val_mse: 0.0276
Epoch 120/200
- 0s - loss: 1.8366 - accuracy: 0.3208 - mse: 0.0267 - val_loss: 1.9432 - val_accuracy: 0.2747 - val_mse: 0.0282
Epoch 121/200
- 0s - loss: 1.8778 - accuracy: 0.2843 - mse: 0.0276 - val_loss: 1.8787 - val_accuracy: 0.3068 - val_mse: 0.0277
Epoch 122/200
- 0s - loss: 1.8051 - accuracy: 0.3258 - mse: 0.0271 - val_loss: 1.8698 - val_accuracy: 0.3070 - val_mse: 0.0274
Epoch 123/200
- 0s - loss: 1.7618 - accuracy: 0.3560 - mse: 0.0261 - val_loss: 1.9628 - val_accuracy: 0.2979 - val_mse: 0.0288
Epoch 124/200
- 0s - loss: 1.8158 - accuracy: 0.3562 - mse: 0.0268 - val_loss: 2.0187 - val_accuracy: 0.2976 - val_mse: 0.0297
Epoch 125/200
- 0s - loss: 1.8565 - accuracy: 0.3562 - mse: 0.0275 - val_loss: 1.9251 - val_accuracy: 0.2979 - val_mse: 0.0283
Epoch 126/200
- 0s - loss: 1.7775 - accuracy: 0.3562 - mse: 0.0264 - val_loss: 1.8513 - val_accuracy: 0.3049 - val_mse: 0.0273
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Epoch 127/200
- 0s - loss: 1.7316 - accuracy: 0.3568 - mse: 0.0260 - val_loss: 1.8572 - val_accuracy: 0.3206 - val_mse: 0.0273
Epoch 128/200
- 0s - loss: 1.7545 - accuracy: 0.3422 - mse: 0.0263 - val_loss: 1.8782 - val_accuracy: 0.3225 - val_mse: 0.0273
Epoch 129/200
- 0s - loss: 1.7690 - accuracy: 0.3432 - mse: 0.0263 - val_loss: 1.8568 - val_accuracy: 0.3249 - val_mse: 0.0271
Epoch 130/200
- 0s - loss: 1.7182 - accuracy: 0.3624 - mse: 0.0257 - val_loss: 1.9256 - val_accuracy: 0.2994 - val_mse: 0.0282
Epoch 131/200
- 0s - loss: 1.7487 - accuracy: 0.3567 - mse: 0.0264 - val_loss: 1.8854 - val_accuracy: 0.3047 - val_mse: 0.0275
Epoch 132/200
- 0s - loss: 1.7130 - accuracy: 0.3569 - mse: 0.0257 - val_loss: 1.8330 - val_accuracy: 0.3242 - val_mse: 0.0269
Epoch 133/200
- 0s - loss: 1.6952 - accuracy: 0.3667 - mse: 0.0255 - val_loss: 1.8337 - val_accuracy: 0.3243 - val_mse: 0.0270
Epoch 134/200
- 0s - loss: 1.7156 - accuracy: 0.3580 - mse: 0.0258 - val_loss: 1.8263 - val_accuracy: 0.3195 - val_mse: 0.0268
Epoch 135/200
- 0s - loss: 1.7043 - accuracy: 0.3614 - mse: 0.0255 - val_loss: 1.8383 - val_accuracy: 0.3094 - val_mse: 0.0271
Epoch 136/200
- 0s - loss: 1.6878 - accuracy: 0.3586 - mse: 0.0253 - val_loss: 1.8905 - val_accuracy: 0.2972 - val_mse: 0.0279
Epoch 137/200
- 0s - loss: 1.7132 - accuracy: 0.3564 - mse: 0.0257 - val_loss: 1.8235 - val_accuracy: 0.3154 - val_mse: 0.0268
Epoch 138/200
- 0s - loss: 1.6735 - accuracy: 0.3634 - mse: 0.0251 - val_loss: 1.8159 - val_accuracy: 0.3242 - val_mse: 0.0267
Epoch 139/200
- 0s - loss: 1.6882 - accuracy: 0.3695 - mse: 0.0253 - val_loss: 1.8191 - val_accuracy: 0.3283 - val_mse: 0.0267
Epoch 140/200
- 0s - loss: 1.6810 - accuracy: 0.3728 - mse: 0.0252 - val_loss: 1.8463 - val_accuracy: 0.3157 - val_mse: 0.0271
Epoch 141/200
- 0s - loss: 1.6647 - accuracy: 0.3620 - mse: 0.0250 - val_loss: 1.8859 - val_accuracy: 0.3052 - val_mse: 0.0277
Epoch 142/200
- 0s - loss: 1.6829 - accuracy: 0.3584 - mse: 0.0253 - val_loss: 1.8463 - val_accuracy: 0.3323 - val_mse: 0.0268
Epoch 143/200
- 0s - loss: 1.6912 - accuracy: 0.3758 - mse: 0.0251 - val_loss: 1.8346 - val_accuracy: 0.3275 - val_mse: 0.0267
Epoch 144/200
- 0s - loss: 1.6837 - accuracy: 0.3689 - mse: 0.0251 - val_loss: 1.8741 - val_accuracy: 0.3144 - val_mse: 0.0275
Epoch 145/200
- 0s - loss: 1.6754 - accuracy: 0.3627 - mse: 0.0251 - val_loss: 1.8299 - val_accuracy: 0.3210 - val_mse: 0.0269
Epoch 146/200
- 0s - loss: 1.6586 - accuracy: 0.3711 - mse: 0.0249 - val_loss: 1.8156 - val_accuracy: 0.3230 - val_mse: 0.0267
Epoch 147/200
- 0s - loss: 1.6618 - accuracy: 0.3735 - mse: 0.0249 - val_loss: 1.8240 - val_accuracy: 0.3191 - val_mse: 0.0269
Epoch 148/200
- 0s - loss: 1.6540 - accuracy: 0.3696 - mse: 0.0249 - val_loss: 1.8534 - val_accuracy: 0.3109 - val_mse: 0.0274
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Epoch 149/200
- 0s - loss: 1.6648 - accuracy: 0.3596 - mse: 0.0251 - val_loss: 1.8171 - val_accuracy: 0.3177 - val_mse: 0.0268
Epoch 150/200
- 0s - loss: 1.6571 - accuracy: 0.3739 - mse: 0.0249 - val_loss: 1.8117 - val_accuracy: 0.3224 - val_mse: 0.0267
Epoch 151/200
- 0s - loss: 1.6580 - accuracy: 0.3752 - mse: 0.0249 - val_loss: 1.8281 - val_accuracy: 0.3197 - val_mse: 0.0269
Epoch 152/200
- 0s - loss: 1.6526 - accuracy: 0.3735 - mse: 0.0248 - val_loss: 1.8538 - val_accuracy: 0.3166 - val_mse: 0.0272
Epoch 153/200
- 0s - loss: 1.6607 - accuracy: 0.3665 - mse: 0.0249 - val_loss: 1.8174 - val_accuracy: 0.3267 - val_mse: 0.0267
Epoch 154/200
- 0s - loss: 1.6539 - accuracy: 0.3767 - mse: 0.0248 - val_loss: 1.8189 - val_accuracy: 0.3273 - val_mse: 0.0267
Epoch 155/200
- 0s - loss: 1.6582 - accuracy: 0.3775 - mse: 0.0249 - val_loss: 1.8370 - val_accuracy: 0.3162 - val_mse: 0.0270
Epoch 156/200
- 0s - loss: 1.6516 - accuracy: 0.3652 - mse: 0.0249 - val_loss: 1.8466 - val_accuracy: 0.3172 - val_mse: 0.0272
Epoch 157/200
- 0s - loss: 1.6546 - accuracy: 0.3620 - mse: 0.0249 - val_loss: 1.8140 - val_accuracy: 0.3239 - val_mse: 0.0266
Epoch 158/200
- 0s - loss: 1.6528 - accuracy: 0.3752 - mse: 0.0248 - val_loss: 1.8116 - val_accuracy: 0.3234 - val_mse: 0.0266
Epoch 159/200
- 0s - loss: 1.6548 - accuracy: 0.3745 - mse: 0.0249 - val_loss: 1.8282 - val_accuracy: 0.3180 - val_mse: 0.0269
Epoch 160/200
- 0s - loss: 1.6469 - accuracy: 0.3678 - mse: 0.0248 - val_loss: 1.8366 - val_accuracy: 0.3160 - val_mse: 0.0271
Epoch 161/200
- 0s - loss: 1.6511 - accuracy: 0.3628 - mse: 0.0249 - val_loss: 1.8069 - val_accuracy: 0.3231 - val_mse: 0.0265
Epoch 162/200
- 0s - loss: 1.6598 - accuracy: 0.3751 - mse: 0.0249 - val_loss: 1.8045 - val_accuracy: 0.3230 - val_mse: 0.0265
Epoch 163/200
- 0s - loss: 1.6535 - accuracy: 0.3759 - mse: 0.0248 - val_loss: 1.8385 - val_accuracy: 0.3160 - val_mse: 0.0271
Epoch 164/200
- 0s - loss: 1.6544 - accuracy: 0.3619 - mse: 0.0249 - val_loss: 1.8082 - val_accuracy: 0.3245 - val_mse: 0.0266
Epoch 165/200
- 0s - loss: 1.6453 - accuracy: 0.3742 - mse: 0.0248 - val_loss: 1.8038 - val_accuracy: 0.3261 - val_mse: 0.0265
Epoch 166/200
- 0s - loss: 1.6495 - accuracy: 0.3770 - mse: 0.0248 - val_loss: 1.8117 - val_accuracy: 0.3254 - val_mse: 0.0267
Epoch 167/200
- 0s - loss: 1.6432 - accuracy: 0.3708 - mse: 0.0248 - val_loss: 1.8285 - val_accuracy: 0.3177 - val_mse: 0.0269
Epoch 168/200
- 0s - loss: 1.6484 - accuracy: 0.3622 - mse: 0.0248 - val_loss: 1.8088 - val_accuracy: 0.3251 - val_mse: 0.0266
Epoch 169/200
- 0s - loss: 1.6439 - accuracy: 0.3737 - mse: 0.0247 - val_loss: 1.8066 - val_accuracy: 0.3254 - val_mse: 0.0266
Epoch 170/200
- 0s - loss: 1.6445 - accuracy: 0.3760 - mse: 0.0248 - val_loss: 1.8213 - val_accuracy: 0.3243 - val_mse: 0.0268
```

```
Epoch 171/200
- 0s - loss: 1.6423 - accuracy: 0.3702 - mse: 0.0247 - val_loss: 1.8153 - val_accuracy: 0.3236 - val_mse: 0.0267
Epoch 172/200
- 0s - loss: 1.6403 - accuracy: 0.3731 - mse: 0.0247 - val_loss: 1.8063 - val_accuracy: 0.3228 - val_mse: 0.0266
Epoch 173/200
- 0s - loss: 1.6418 - accuracy: 0.3767 - mse: 0.0247 - val_loss: 1.8166 - val_accuracy: 0.3209 - val_mse: 0.0268
Epoch 174/200
- 0s - loss: 1.6392 - accuracy: 0.3727 - mse: 0.0247 - val_loss: 1.8121 - val_accuracy: 0.3225 - val_mse: 0.0267
Epoch 175/200
- 0s - loss: 1.6384 - accuracy: 0.3736 - mse: 0.0247 - val_loss: 1.8111 - val_accuracy: 0.3224 - val_mse: 0.0267
Epoch 176/200
- 0s - loss: 1.6379 - accuracy: 0.3742 - mse: 0.0247 - val_loss: 1.8158 - val_accuracy: 0.3227 - val_mse: 0.0267
Epoch 177/200
- 0s - loss: 1.6379 - accuracy: 0.3729 - mse: 0.0247 - val_loss: 1.8072 - val_accuracy: 0.3218 - val_mse: 0.0266
Epoch 178/200
- 0s - loss: 1.6388 - accuracy: 0.3778 - mse: 0.0247 - val_loss: 1.8166 - val_accuracy: 0.3261 - val_mse: 0.0267
Epoch 179/200
- 0s - loss: 1.6381 - accuracy: 0.3725 - mse: 0.0247 - val_loss: 1.8081 - val_accuracy: 0.3242 - val_mse: 0.0266
Epoch 180/200
- 0s - loss: 1.6371 - accuracy: 0.3761 - mse: 0.0247 - val_loss: 1.8134 - val_accuracy: 0.3258 - val_mse: 0.0267
Epoch 181/200
- 0s - loss: 1.6363 - accuracy: 0.3711 - mse: 0.0247 - val_loss: 1.8095 - val_accuracy: 0.3246 - val_mse: 0.0266
Epoch 182/200
- 0s - loss: 1.6358 - accuracy: 0.3737 - mse: 0.0246 - val_loss: 1.8095 - val_accuracy: 0.3243 - val_mse: 0.0266
Epoch 183/200
- 0s - loss: 1.6352 - accuracy: 0.3731 - mse: 0.0246 - val_loss: 1.8073 - val_accuracy: 0.3228 - val_mse: 0.0266
Epoch 184/200
- 0s - loss: 1.6347 - accuracy: 0.3745 - mse: 0.0246 - val_loss: 1.8064 - val_accuracy: 0.3234 - val_mse: 0.0266
Epoch 185/200
- 0s - loss: 1.6345 - accuracy: 0.3745 - mse: 0.0246 - val_loss: 1.8065 - val_accuracy: 0.3239 - val_mse: 0.0266
Epoch 186/200
- 0s - loss: 1.6341 - accuracy: 0.3737 - mse: 0.0246 - val_loss: 1.8055 - val_accuracy: 0.3249 - val_mse: 0.0266
Epoch 187/200
- 0s - loss: 1.6337 - accuracy: 0.3730 - mse: 0.0246 - val_loss: 1.8072 - val_accuracy: 0.3248 - val_mse: 0.0266
Epoch 188/200
- 0s - loss: 1.6336 - accuracy: 0.3711 - mse: 0.0246 - val_loss: 1.8049 - val_accuracy: 0.3249 - val_mse: 0.0266
Epoch 189/200
- 0s - loss: 1.6333 - accuracy: 0.3722 - mse: 0.0246 - val_loss: 1.8077 - val_accuracy: 0.3231 - val_mse: 0.0266
Epoch 190/200
- 0s - loss: 1.6330 - accuracy: 0.3711 - mse: 0.0246 - val_loss: 1.8032 - val_accuracy: 0.3242 - val_mse: 0.0266
Epoch 191/200
- 0s - loss: 1.6329 - accuracy: 0.3760 - mse: 0.0246 - val_loss: 1.8095 - val_accuracy: 0.3243 - val_mse: 0.0267
Epoch 192/200
- 0s - loss: 1.6329 - accuracy: 0.3722 - mse: 0.0246 - val_loss: 1.8013 - val_accuracy: 0.3243 - val_mse: 0.0265
```

```
Epoch 193/200
- 0s - loss: 1.6340 - accuracy: 0.3778 - mse: 0.0246 - val_loss: 1.8150 - val_accuracy: 0.3224 - val_mse: 0.0267
Epoch 194/200
- 0s - loss: 1.6345 - accuracy: 0.3701 - mse: 0.0247 - val_loss: 1.7993 - val_accuracy: 0.3239 - val_mse: 0.0265
Epoch 195/200
- 0s - loss: 1.6404 - accuracy: 0.3774 - mse: 0.0247 - val_loss: 1.8094 - val_accuracy: 0.3246 - val_mse: 0.0267
Epoch 196/200
- 0s - loss: 1.6315 - accuracy: 0.3706 - mse: 0.0246 - val_loss: 1.8160 - val_accuracy: 0.3221 - val_mse: 0.0268
Epoch 197/200
- 0s - loss: 1.6344 - accuracy: 0.3703 - mse: 0.0247 - val_loss: 1.7957 - val_accuracy: 0.3270 - val_mse: 0.0264
Epoch 198/200
```

In [192...]

```
model_neuronal.summary()
```

Model: "sequential\_5"

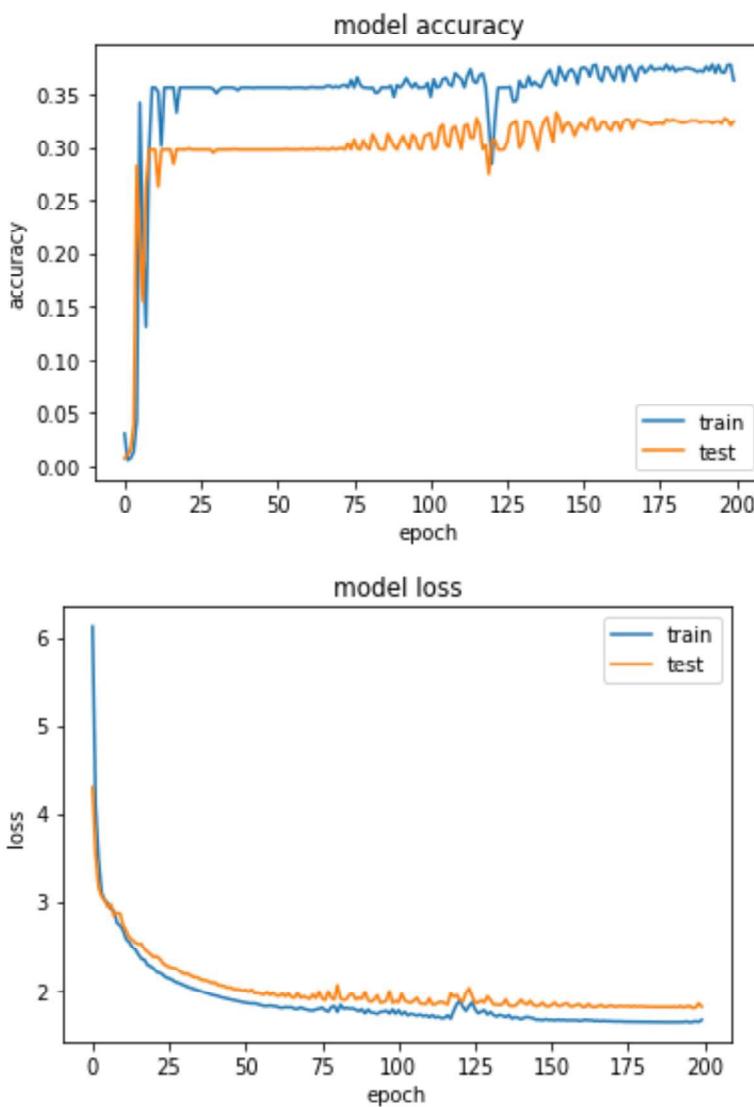
Layer (type)	Output Shape	Param #
<hr/>		
dense_21 (Dense)	(None, 64)	2880
dense_22 (Dense)	(None, 32)	2080
dense_23 (Dense)	(None, 10)	330
dense_24 (Dense)	(None, 8)	88
dense_25 (Dense)	(None, 28)	252
<hr/>		
Total params: 5,630		
Trainable params: 5,630		
Non-trainable params: 0		

In [193...]

```
%matplotlib inline
```

```
# Visualizamos la evolución de la accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='lower right')
plt.show()

# Visualizamos la evolución del error cometido por la red
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper right')
plt.show()
```



In [194...]

```
# Predicciones sobre conjunto train y test
y_predict_train_NN = model_neuronal.predict(x_train)
y_predict_test_NN = model_neuronal.predict(x_test)
```

In [195...]

```
y_predict_train_NN = pd.DataFrame(y_predict_train_NN)
y_predict_train_NN = round(y_predict_train_NN).astype('int')

y_predict_test_NN = pd.DataFrame(y_predict_test_NN)
y_predict_test_NN = round(y_predict_test_NN).astype('int')
```

In [196...]

```
# Precisión sobre train y test
score_train = accuracy_score(y_train_transf, y_predict_train_NN)
print('El grado de precisión del modelo para el conjunto train es {}.'.
      format(round(score_train,4)))
score_test = accuracy_score(y_test_transf, y_predict_test_NN)
print('El grado de precisión del modelo para el conjunto test es {}.'.
      format(round(score_test,4)))
# accuracy_score(y_train_transf2, y_predict_train_NN2)
```

El grado de precisión del modelo para el conjunto train es 0.153.  
El grado de precisión del modelo para el conjunto test es 0.1421.

In [197...]

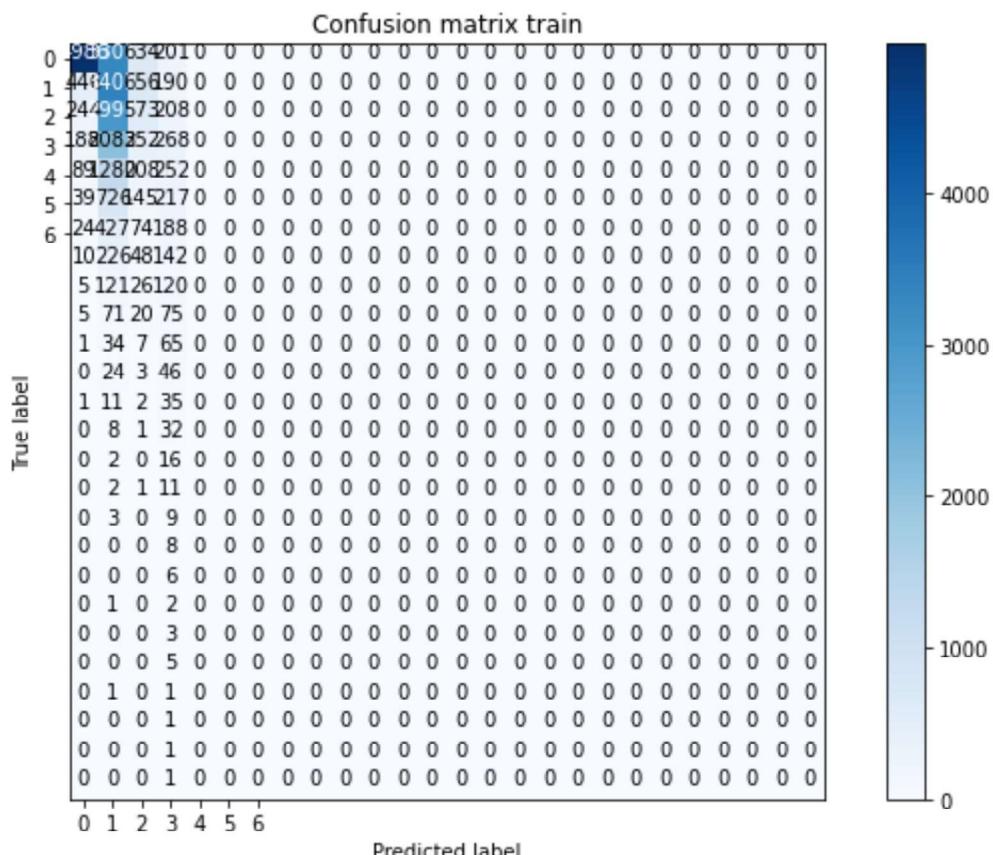
```
#Vemos el error del algoritmo a la hora de predecir, para comprobar si a ajustado
print('MAE in train:', mean_absolute_error(y_predict_train_NN, y_train_transf))
print('RMSE in train:', np.sqrt(mean_squared_error(y_predict_train_NN, y_train_transf)))
print('MAE in test:', mean_absolute_error(y_predict_test_NN, y_test_transf))
print('RMSE in test:', np.sqrt(mean_squared_error(y_predict_test_NN, y_test_transf)))
```

```
MAE in train: 0.030565024072658698
RMSE in train: 0.1748285562276904
MAE in test: 0.03151735879145745
RMSE in test: 0.17753128961244397
```

In [198...]

```
# Convertir dataframe a array
x = model_neuronal.predict(x_train)
y = y_train_transf.to_numpy()

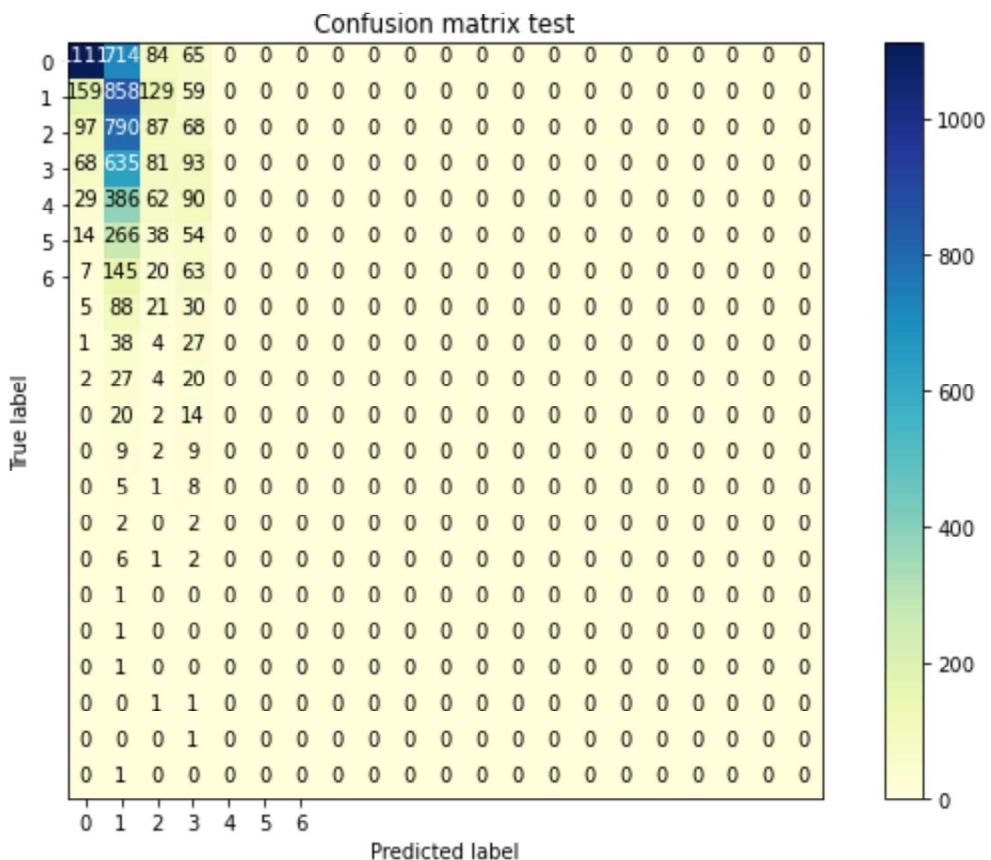
# Matriz de confusión train
cm = confusion_matrix(y.argmax(axis=1),
                      x.argmax(axis=1))
np.set_printoptions(precision=2)
class_names = ['0', '1', '2', '3', '4', '5', '6']
plt.figure(1, figsize=(9, 6))
plot_confusion_matrix(cm, classes=class_names,
                      title='Confusion matrix train')
plt.savefig('graph/matriz_confusion_NNtrain_3.jpg')
plt.show()
```



In [199]:

```
# Convertir dataframe a array
x = model_neuronal.predict(x_test)
y = y_test_transf.to_numpy()

# Matriz de confusión test
cm = confusion_matrix(y.argmax(axis=1),
                      x.argmax(axis=1))
np.set_printoptions(precision=2)
class_names = ['0', '1', '2', '3', '4', '5', '6']
plt.figure(1, figsize=(9, 6))
plot_confusion_matrix(cm, classes=class_names,
                      title='Confusion matrix test',
                      cmap="YlGnBu")
plt.savefig('graph/matriz_confusion_NNtest_3.jpg')
plt.show()
```



In [ ]: