# Automated Fish Classification Using Unprocessed Fatty Acid Chromatographic Data: A Machine Learning Approach

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**INTRO**

- **Gas Chromatography** is an analytical chemistry method that produces high-dimensional low-sample data.
- **This study** compares classification and feature selection when applied to gas chromatagraphy measurements from fish oil data.
- **Classification** to predict Fish Species and Body Parts, two datasets that share the same features.
- **Feature selection** to reduce the dimensionality, improve computation efficiency, and (even) improve classification performance.

**METHODS**

- **Evaluation:** average balanced classification accuracy using 10-fold cross validation.
- 30 independent runs for each classification method.
- Each feature selection method for number of features in { 50, 100, ..., 4800 }. PSO evaluated on 30 independent runs.

**RESULTS**

- Classification: Linear SVM performed best, with 98.33% accuracy for fish species, 79.86% accuracy for body parts.
- Feature Selection: mRMR and PSO have 99.17% accuracy for fish species, 86.94% accuracy for body parts.

**DISCUSSION**

- **Linear SVM** provides an **interpretable** and **accurate** model.
- **PSO/mRMR** feature selection improve the model further with greater **efficient** and **accuracy**.
- Body Parts is more difficult to classify than Fish Species

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**Linear SVM** can accurately predict fish species, **PSO** makes that process 4 times faster, producing an **accurate**, **interpretable** and **efficient** model for **Gas Chromatography**.

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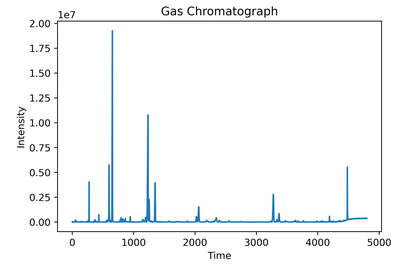
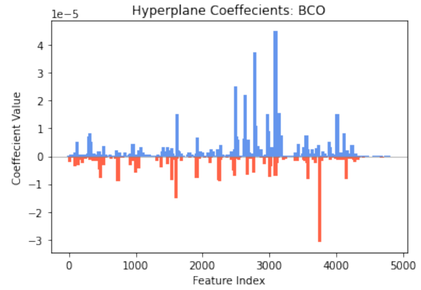
**Gas chromatogram** where x-axis measures time, the y-axis measure intensity.




**Linear SVM** hyperplane coefficients for **Fish Species** for the Blue cod class:




A table with **classification** results:

| Dataset | Method | Train | Test |
|---|---|---|---|
| Species | KNN | 83.57 | 74.88 |
| | RF | 100.0 | 85.65 |
| | DT | 100.0 | 76.98 |
| | NB | 79.54 | 75.27 |
| | **SVM** | **100.0** | **98.33** |
| Parts | KNN | 68.95 | 43.61 |
| | RF | 100.00 | 72.60 |
| | DT | 100.00 | 60.14 |
| | NB | 65.54 | 48.61 |
| | **SVM** | **100.00** | **79.86** |

Best accuracy for **feature selection** for **Fish Species**

| Method | # Features | Train | Test |
|---|---|---|---|
| ReliefF | 359 | 100.0 | 98.33 |
| **mRMR** | **1500** | **100.0** | **99.17** |
| $\chi^2$ | 3250 | 100.0 | 98.33 |
| **PSO** | **1192** | **100.0** | **99.17** |
| Full | 4800 | 100.0 | 98.33 |

Best accuracy for **feature Selection** for **Body Parts**

| Method | # Features | Train | Test |
|---|---|---|---|
| ReliefF | 1650 | 100.0 | 84.44 |
| **mRMR** | **1500** | **100.0** | **86.94** |
| $\chi^2$ | 1550 | 100.0 | 82.50 |
| PSO | 1223 | 100.0 | 84.31 |
| Full | 4800 | 100.0 | 79.86 |