A rapid machine-learning approach for detecting fish species and body parts

using rapid evaporative ionisation mass spectrometry

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GP [1, 2, 3] inspired by reproductive behaviour of animals

ECRG, VUW, New Zealand

Topics

1. Catfishing
2. Fish Oil
3. Mass Spectrometry
4. Classification
5. Transformer
6. Intepretable

Have you been catfished? [4]

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Popular restaurant accused of serving cheap Vietnamese catfish to customers who thought they were getting Australian dory

- **A Melbourne restaurant has been accused of serving catfish to customers**
- **Hunky Dory has allegedly been selling frozen fillets of basa as dory**
- **Owner Greg Robotis has denied allegations he is misleading customers**
- **The City of Port Phillip is investigating Hunky Dory's Port Melbourne store**

By HARRY PEARL FOR DAILY MAIL AUSTRALIA
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A Melbourne restaurant has been accused of serving a Vietnamese catfish to customers who believe they are ordering Dory.

A whistleblower has alleged that Hunky Dory outlets have been selling frozen fillets of basa, a species of catfish native to the Mekong basin, as fish-of-the-day dory, **The Age** reports.

Owner Greg Robotis has denied the claims and said inexperienced staff may have been calling the fish the wrong name.

Aussies! No surprises there...

Catfishing [4], Mislabelling [5], and Quality Assurance [6]

Nutrition Facts

6 servings per container

Serving size **4-5 ounces(187g)**

Amount per serving

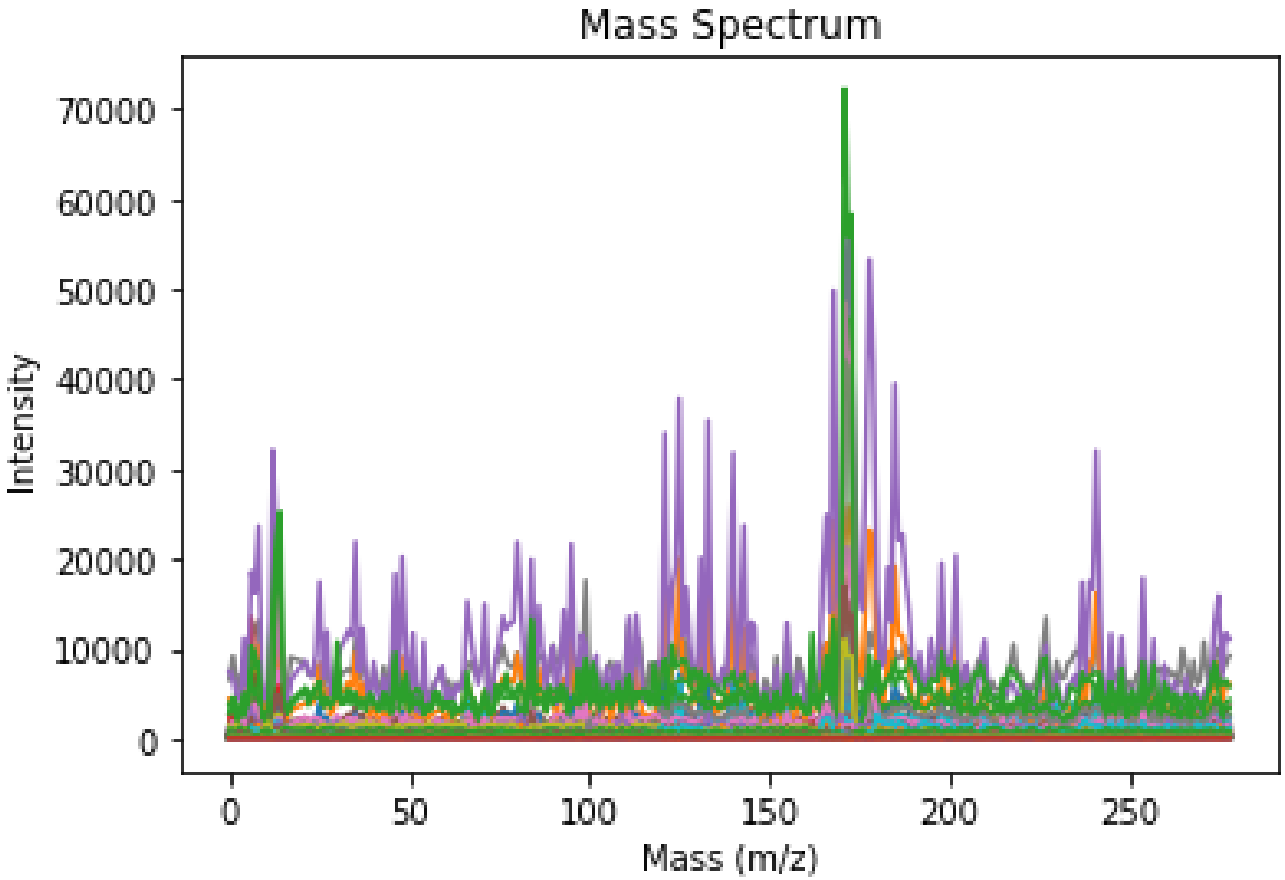
Calories **200**

	% Daily Value*
Total Fat 5g	**6%**
Saturated Fat 0.5g	**3%**
Trans Fat 0g	
Cholesterol 80mg	**27%**
Sodium 610mg	**27%**
Total Carbohydrate 10g	**4%**
Dietary Fiber 0g	**0%**
Total Sugars 3g	
Includes 0g Added Sugars	**0%**
Protein 27g	
Vitamin D 2mcg	10%
Calcium 79mg	6%
Iron 3mg	15%
Potassium 519mg	10%

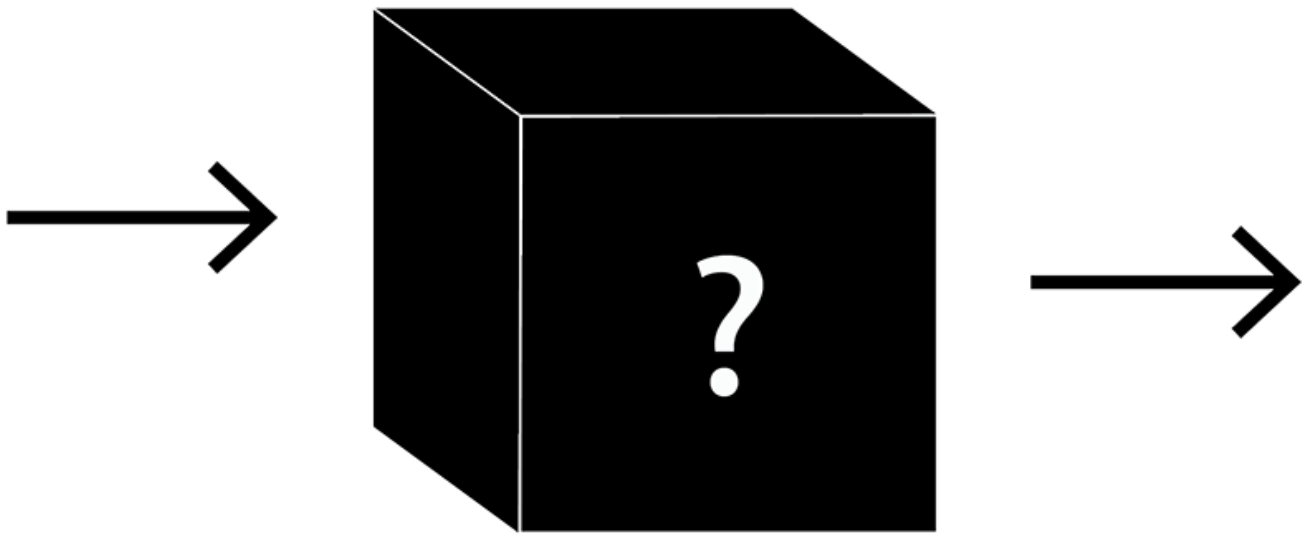
*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Fish oil is brain food! [7, 8]

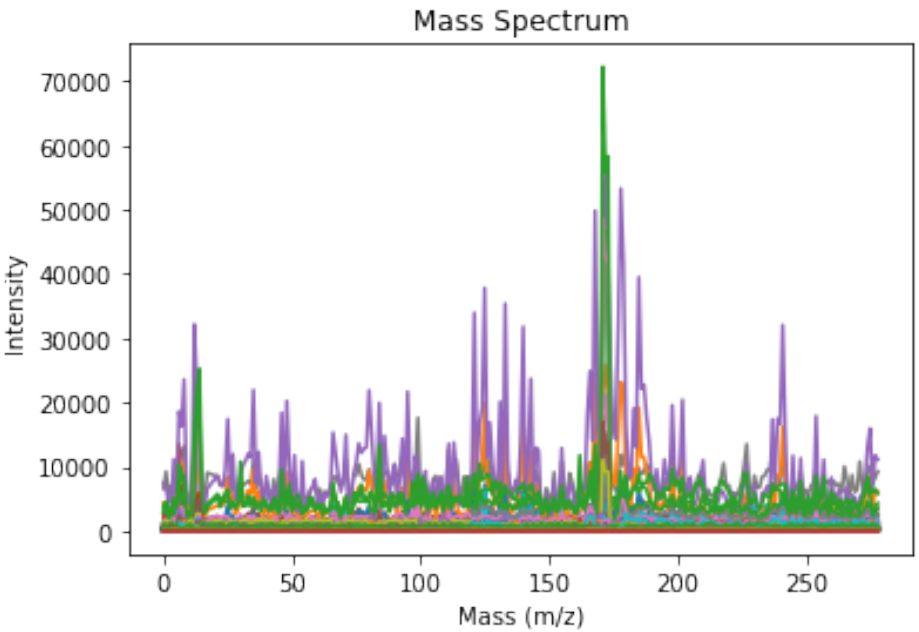
Fish oil analyzed with Mass Spectrometry! [6]



Fish oil analysis can't be blackbox! [9, 10]

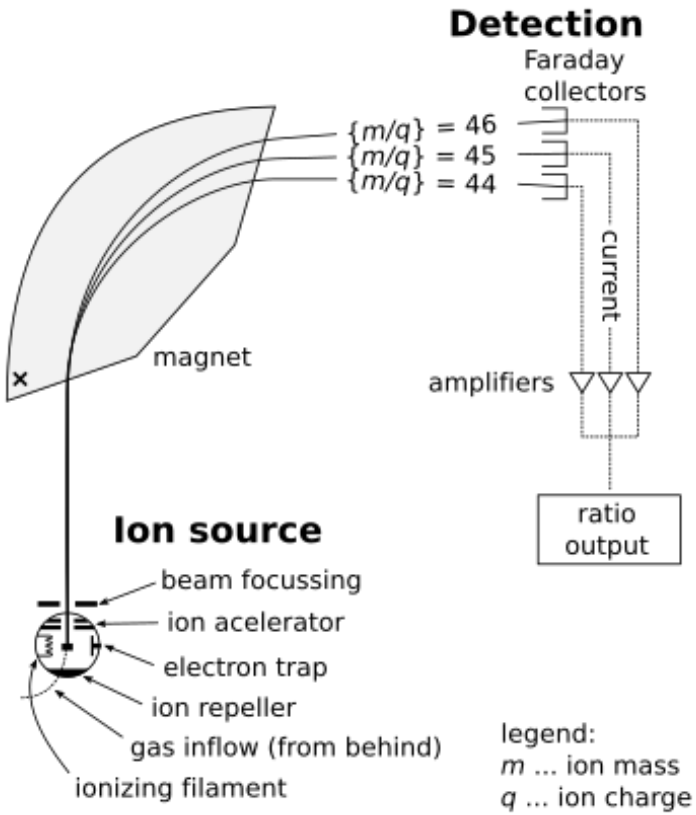


Mass Spectrometry [11, 6, 12] ≈ Chemical Fingerprint



Mass Spectrometry: Steps

1. Laser Pen
2. Vacuum
3. Electromagnetic Field (EMF)
4. Detector



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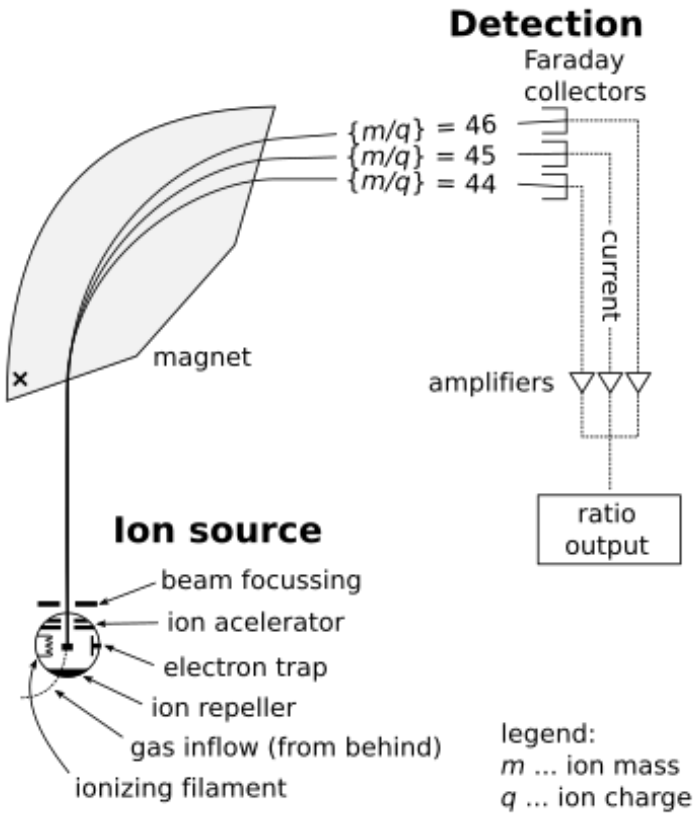

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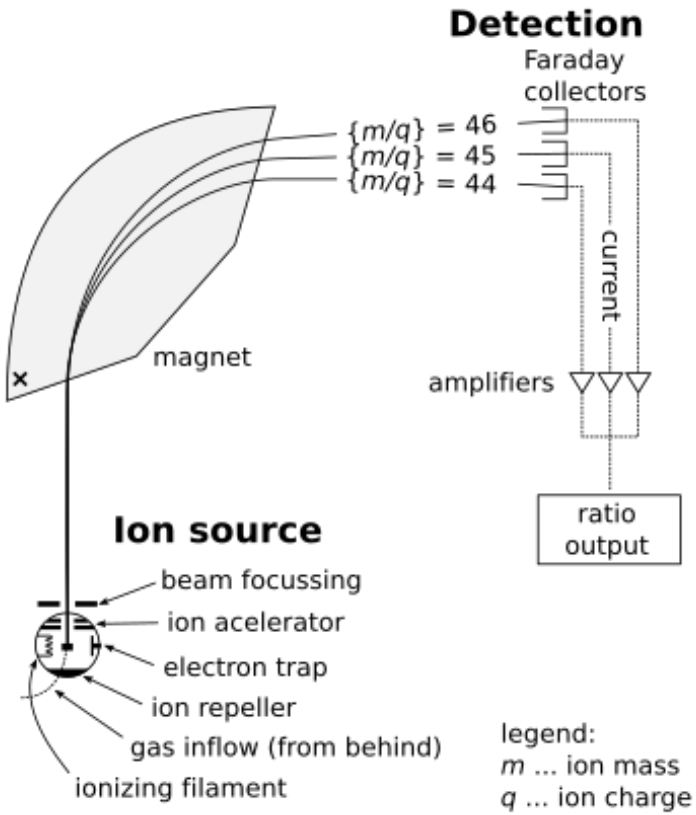

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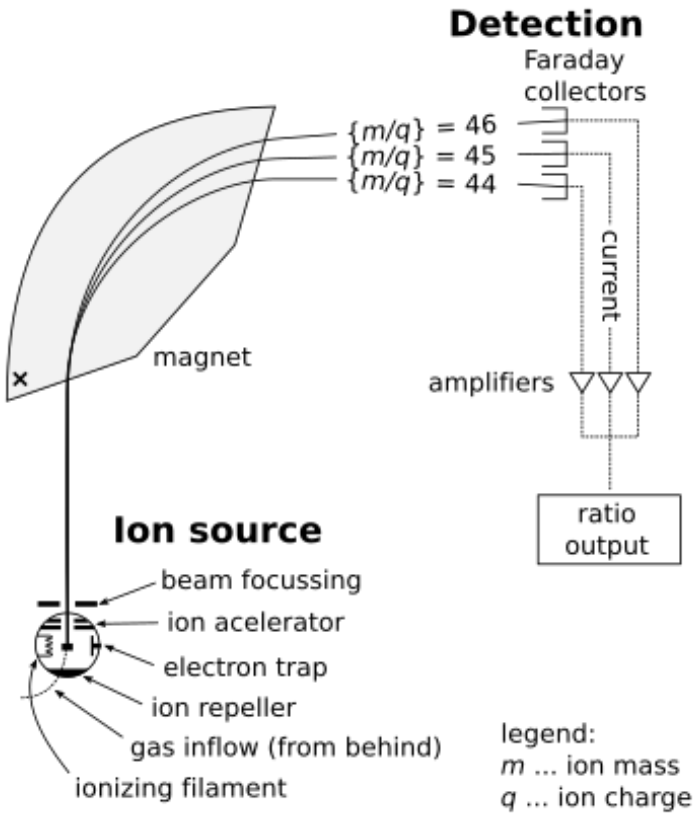

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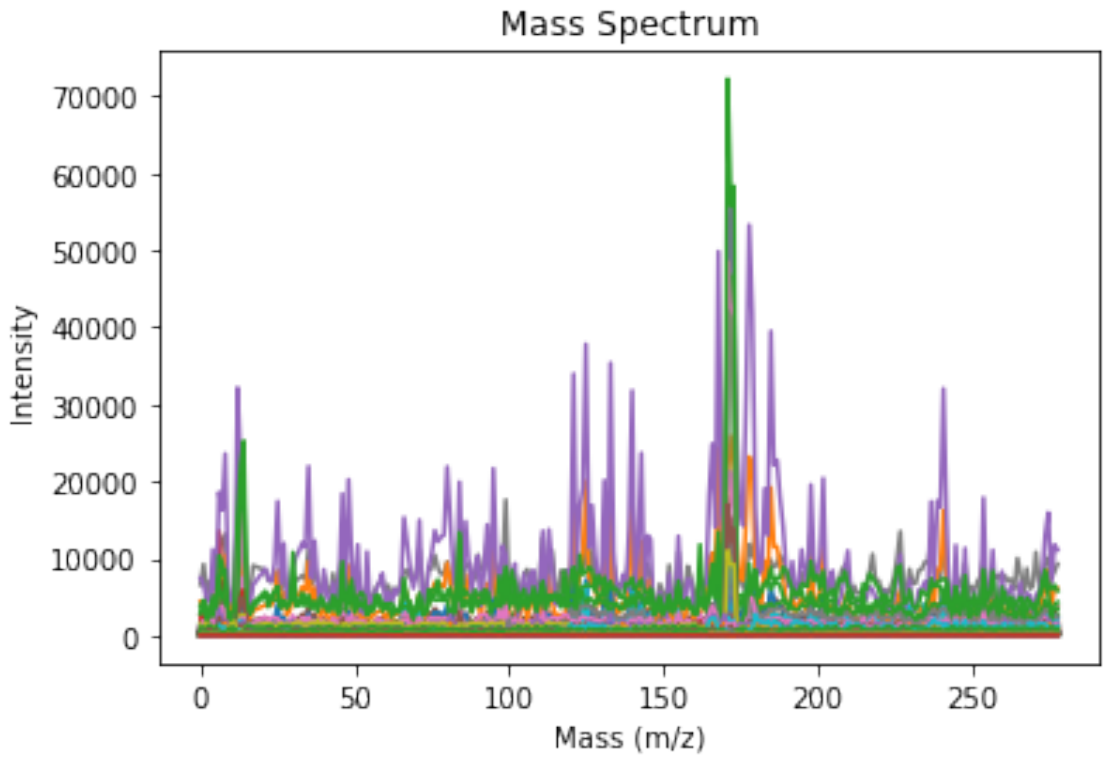
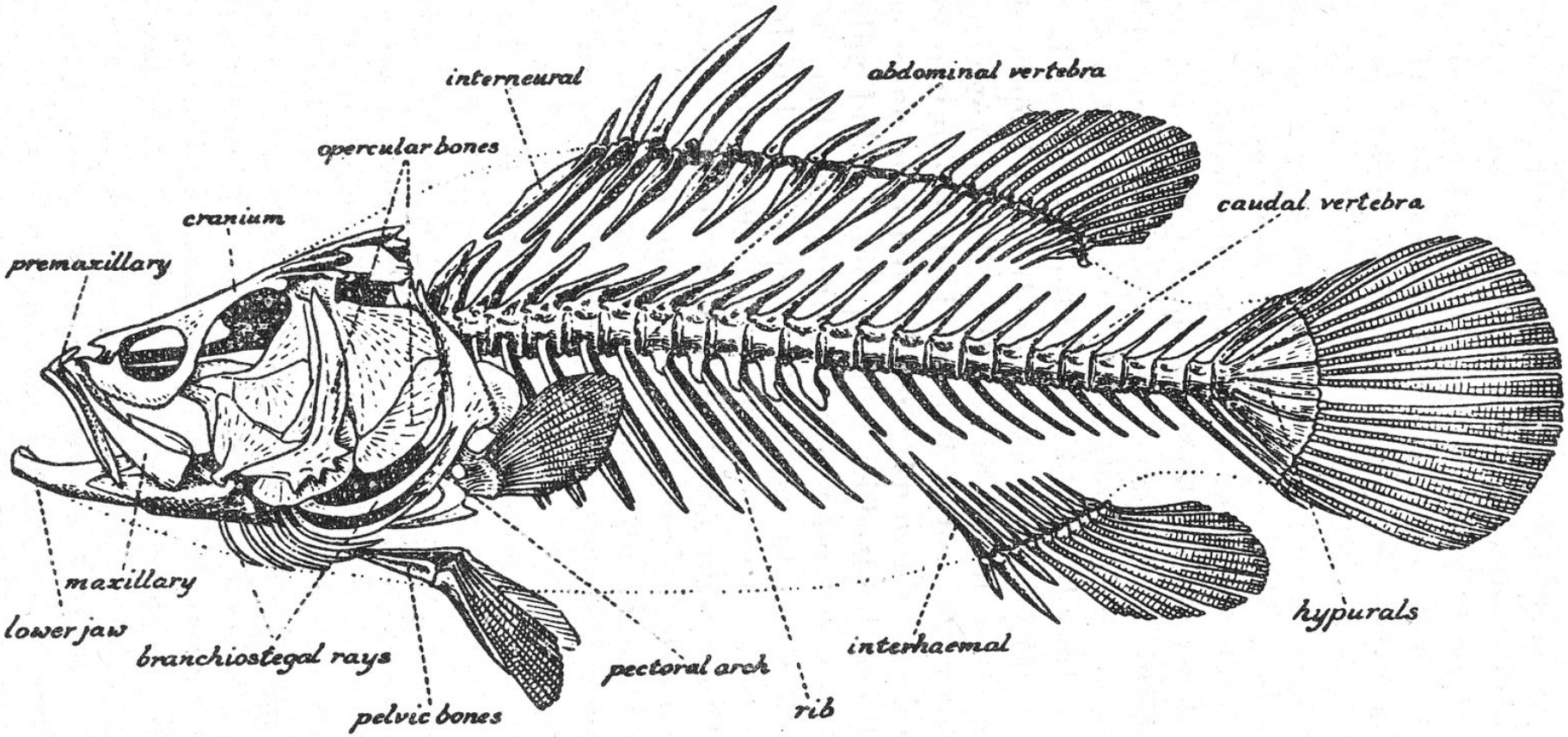


Fish Species

Hoki

Mackerel

Fish Body Parts



Body parts  : fillets, heads, livers, skins, guts and frames

Classification: Datasets

Dataset

Species 

Parts 

Classification: Methods

Dataset	**Method**
Species  Parts 	RF [13]
	KNN [14]
	DT [15]
	NB [16]
	LR [17]
	SVM [18]
	LDA [19]
	Ensemble [20]
	Transformer [21, 22]
	MCIFC [2, 3]

Classification: Fish Species

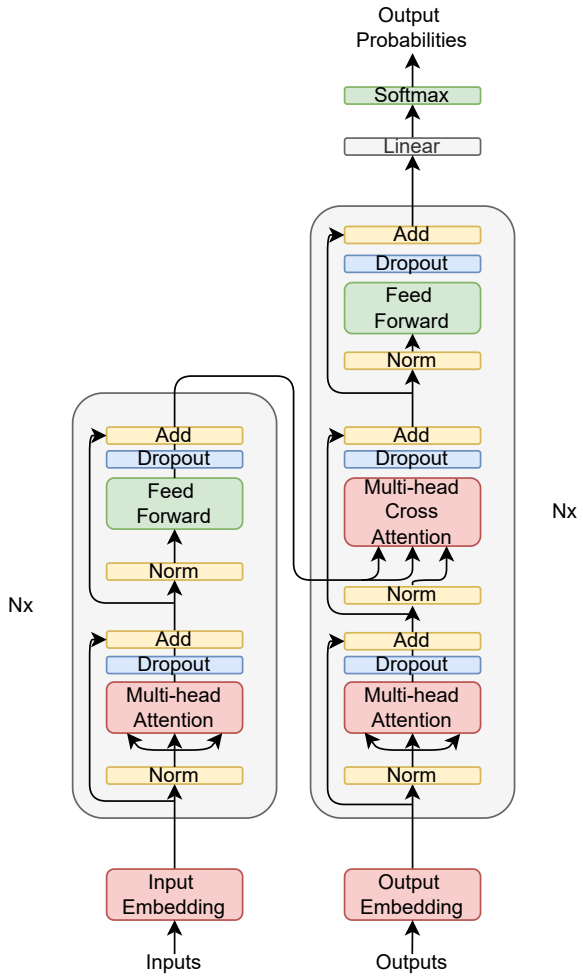
Dataset	Method	**Train**	**Test**
Species 	RF [13]	100.0% ± 0.00%	95.88% ± 4.47%
	KNN [14]	93.24% ± 2.43%	83.69% ± 6.91%
	DT [15]	*100.0% ± 0.00%*	*99.13% ± 1.72%*
	NB [16]	100.0% ± 0.00%	87.97% ± 9.57%
	LR [17]	100.0% ± 0.00%	96.72% ± 4.75%
	SVM [18]	100.0% ± 0.00%	95.97% ± 5.06%
	LDA [19]	98.67% ± 0.77%	96.47% ± 3.67%
	Ensemble [20]	100.0% ± 0.00%	98.16% ± 3.00%
	Transformer [21, 22]	**100.0% ± 0.00%**	**99.58% ± 1.31%**
	MCIFC [2, 3]	99.97% ± 0.15%	94.72% ± 10.25%

Classification: Fish Body Parts

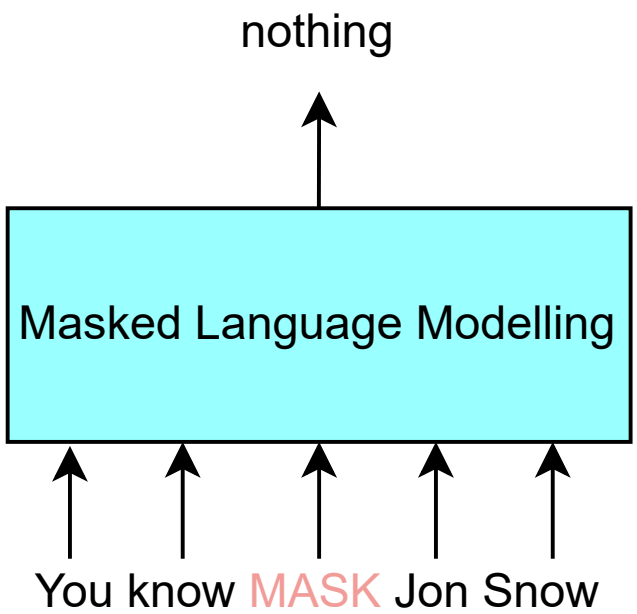
Dataset	Method	**Train**	**Test**
Parts 	RF [13]	100.0% ± 0.00%	40.00% ± 15.27%
	KNN [14]	42.88% ± 5.37%	31.66% ± 14.49%
	DT [15]	100.0% ± 0.00%	27.22% ± 13.25%
	NB [16]	100.0% ± 0.00%	45.00% ± 15.60%
	LR [17]	*100.0% ± 0.00%*	*56.66% ± 15.27%*
	SVM [18]	100.0%± 0.00%	56.11% ± 14.58%
	LDA [19]	75.61% ± 3.20%	45.55% ± 16.06%
	Ensemble [20]	100.0% ± 0.00%	51.66% ± 15.72%
	Transformer [21, 22]	**100.0% ± 0.00%**	**63.33% ± 24.59%**
	MCIFC [2, 3]	97.93% ± 1.59%	55.83% ± 18.97%

Classification: Avoid Catfishing [4] & Mislabelling [5]

Transformer Architecture [21]



Pre-Training: Masked Spectra Modelling [22]



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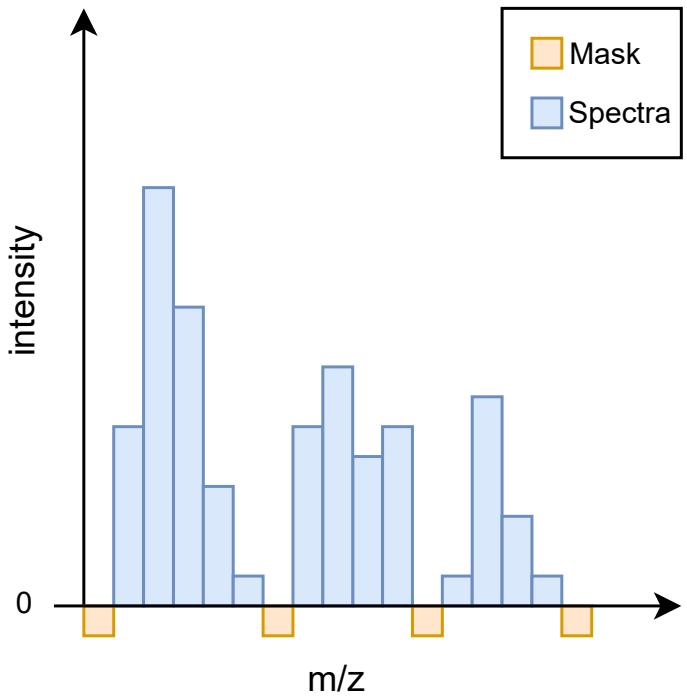
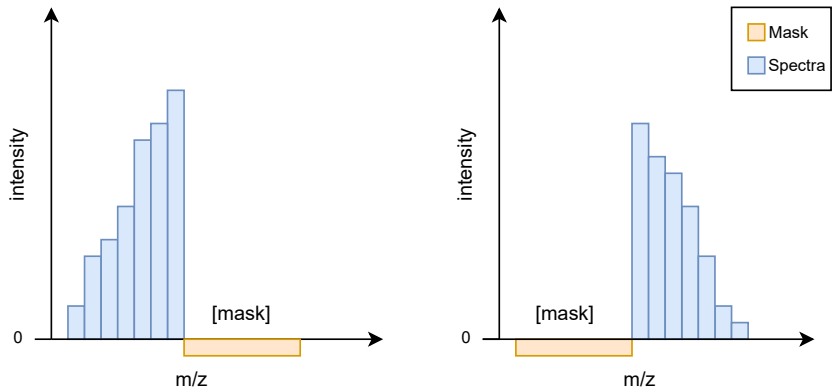


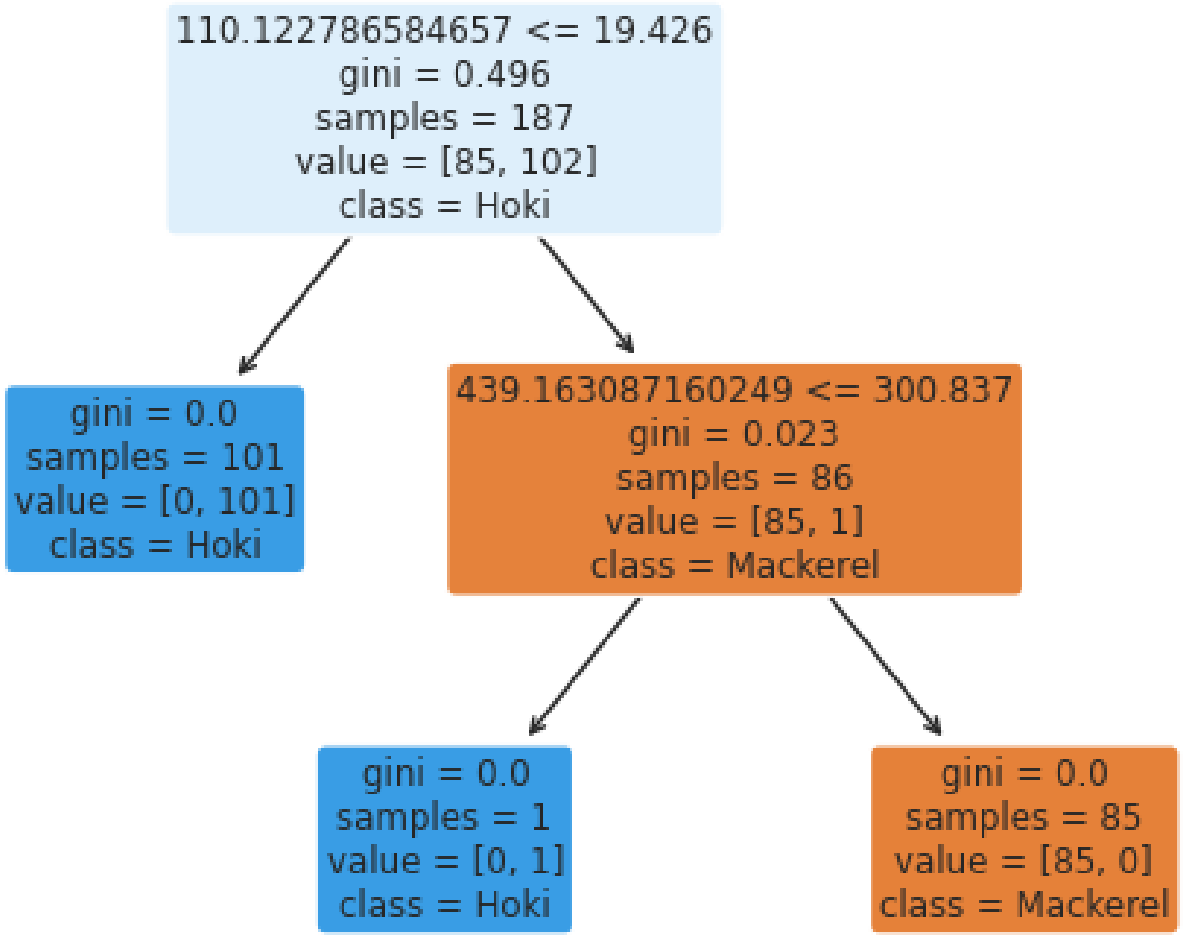
Pre-Training: Next Spectra Prediction [22]

Sentence 1	Sentence 2	Next Sentence?
The quick brown fox	jumped over the lazy dog.	Yes
The quick brown fox	You know nothing Jon Snow.	No

Pre-Training: Next Spectra Prediction [22]

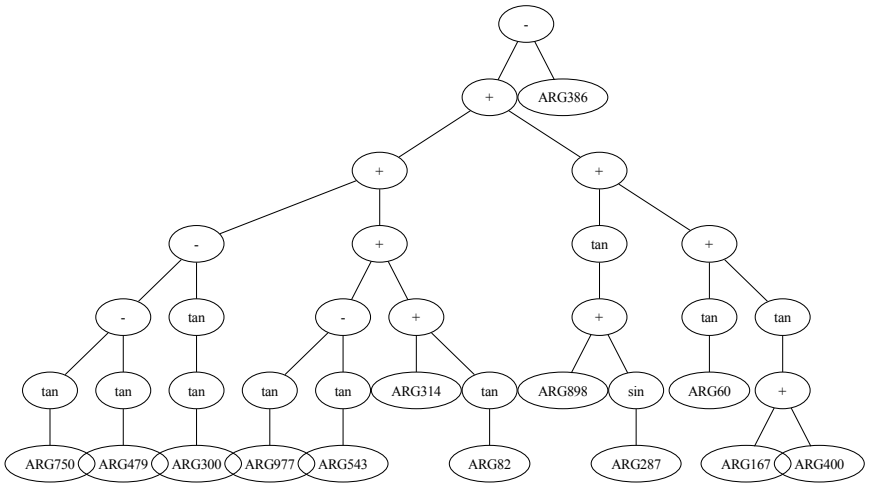


Decision Tree



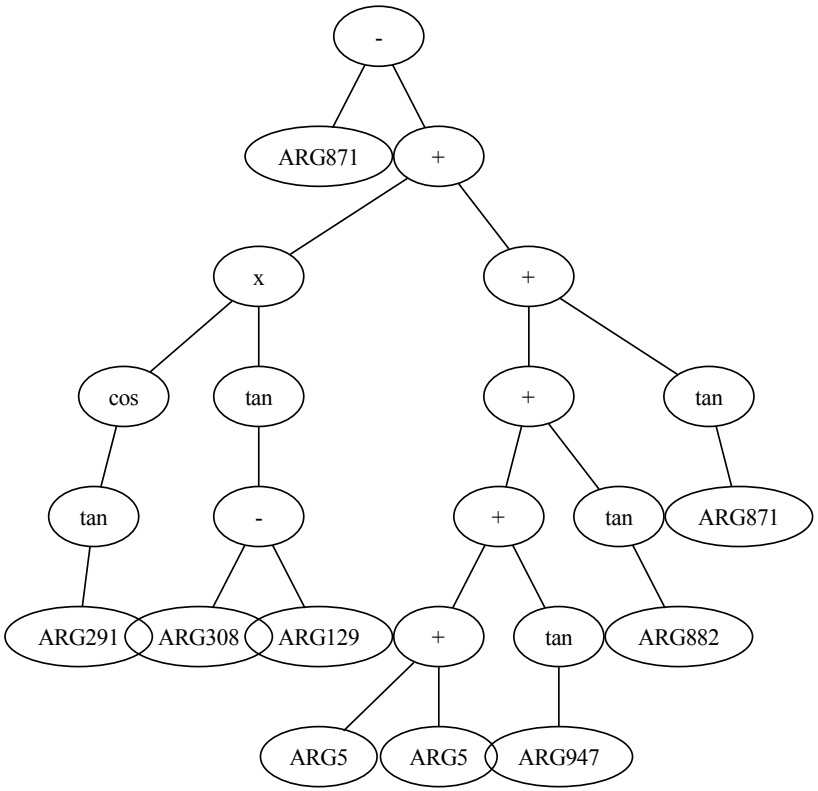
Decision tree for fish species

Genetic Programming Tree - Hoki



Genetic Programming Tree - Fish Species Hoki

Genetic Programming Tree - Mackerel



Genetic Programming Tree - Fish Species Hoki

TLDR;

Transformer can predict fish species with near-perfect accuracy, **DT** and **GP** provide **accurate**, **interpretable** and **efficient** models for **Rapid Evaporative Ionisation Mass Spectrometry**.

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