Automatic Classification of Human Granulosa Cells in Assisted Reproductive Technology using vibrational spectroscopy imaging

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Introduction

In medical fields, reproductive technologies are gaining broadening importance. Each year, 10-15% of couples face problems related to infertility, an increasing number of whom are referred to assistive reproductive technology (ART) laboratories.

The main goal of ART is the ability to obtain and select a large number of competent oocytes. Oocytes are specialised cells formed in the ovary during oogenesis, and and have the capacity to be fertilized and to evolve like a viable embryo. Oogenesis is regulated and characterized by a complex molecular cross-talk among the oocyte and the somatic cells that are around.

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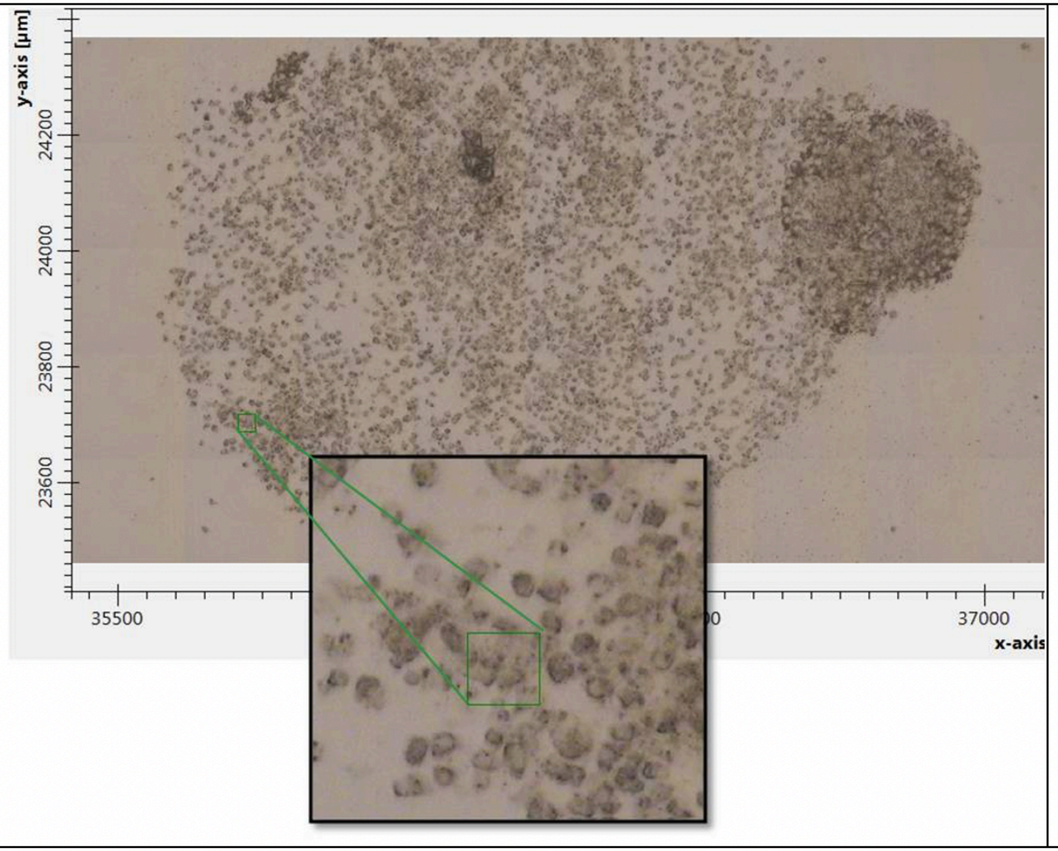
The idea and Motivations



Microphotograph of a living GC sample inside the microfluidic device.
The green square represents a selected area (30x30 µm) on which the IR acquisition was performed.

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User Generated & Environment data collection

Input data

Spectral biomarkers
Biological Reference Dataset (BRD)

Cloud data aggregation

Data Storage
Data Transformation
Data Filtering
Data Integration

Machine Learning Processor

Multivariate Statistical Analysis

Probabilistic Modelling

Machine Learning for Supervised Classification

Advanced Analytics

Insight & Evaluation

System Performance Perspective

Clinical Perspective

Assisted Reproductive Predictions

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Biological Reference Dataset and Feature Set

Band area ratios	Biological significance
Lipids/Cell	Total cellular lipids
Proteins/Cell	Total cellular proteins
AmideI/AmideII	Protein pattern
Lipids/Proteins	Lipids related to protein content
Phosphate1/Cell	Total cellular phosphate groups
Phosphate1/Proteins	Phosphate groups related to protein content
Phosphate1/Lipids	Phosphate groups related to lipid content
Carbonyl ester of fatty acids/Cell	Total cellular fatty acids
Carbonyl ester of fatty acids/Lipids	Ester moieties in lipids
1400/Proteins	Methyl groups related to protein content
1400/Lipids	Methyl groups related to lipid content
1460/Proteins	Methyl and methylene groups related to protein content
1400/1460	Methyl and methylene proportion in aliphatic chains
1460/Lipids	Methyl and methylene groups related to lipid content
Unsaturated alkyl chains of lipids/Cell	Unsaturation levels in lipid chains
Unsaturated alkyl chains of lipids/Lipids	Unsaturation levels in lipid chains
Unsaturated alkyl chains of lipids/Methyl groups of cellular lipids	Unsaturation levels in lipid chains
Methylene groups of cellular lipids/Lipids	Branching of lipid chains
Methylene groups of cellular lipids/Methyl groups of cellular lipids	Branching of lipid chains

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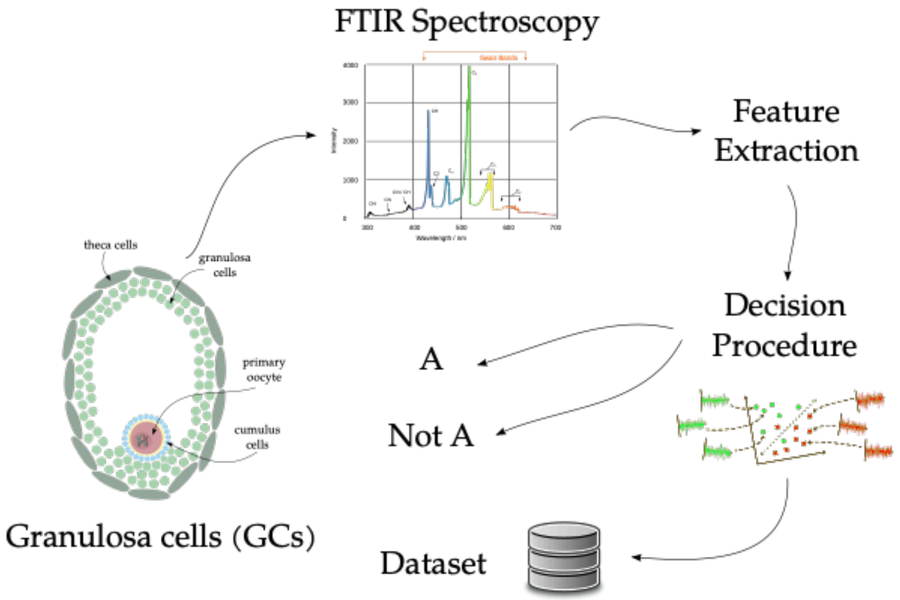
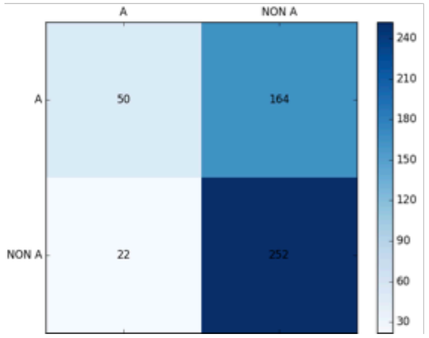
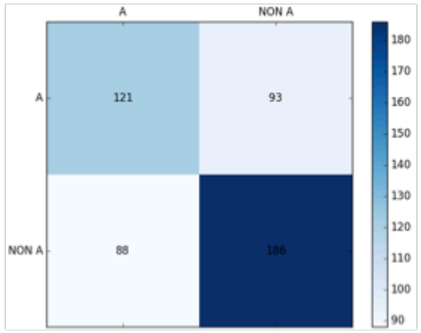
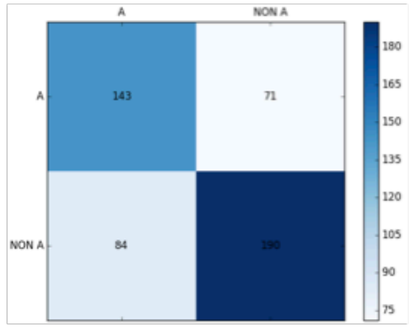
Results

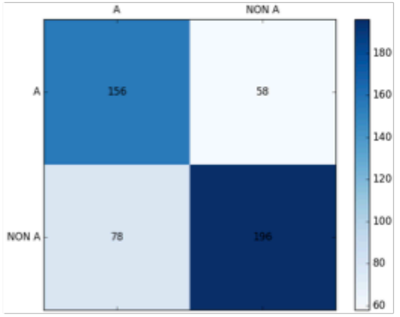


SVM	Precision	Recall	F1-score	Support
A	0.69	0.23	0.35	214
NOT A	0.61	0.92	0.73	214
AVG/Total	0.64	0.62	0.56	488
kNN	**Precision**	**Recall**	**F1-score**	**Support**
A	0.58	0.57	0.57	214
NOT A	0.67	0.68	0.67	214
AVG/Total	0.63	0.63	0.63	488
Decision Tree	**Precision**	**Recall**	**F1-score**	**Support**
A	0.64	0.66	0.65	214
NOT A	0.73	0.71	0.72	214
AVG/Total	0.69	0.69	0.69	488
Random Forest	**Precision**	**Recall**	**F1-score**	**Support**
A	0.67	0.73	0.70	214
NOT A	0.77	0.72	0.74	214
AVG/Total	**0.73**	**0.72**	**0.72**	**488**









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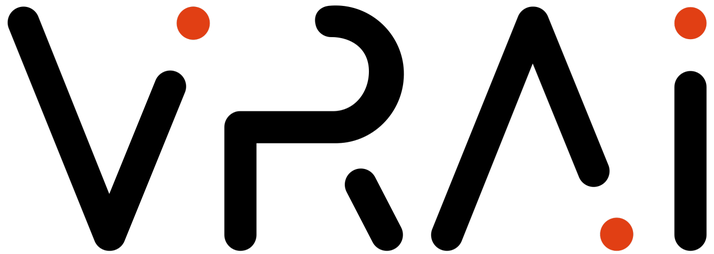

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