Prediction Of Flares In RA Patient

Leveraging Machine Learning on Flow Cytometry Data

Introduction

Overview of Rheumatoid Arthritis (RA)

- Chronic autoimmune disorder
- Characterized by inflammation, pain, and joint damage
- Relapsing and remitting nature

Hypothesis

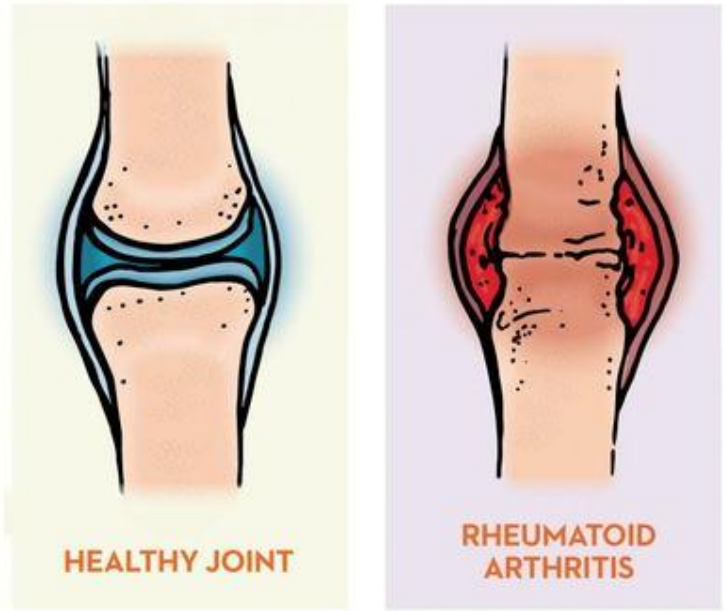
- RA comprises distinct pathotypes with varied flare mechanisms

Challenges in Understanding RA Flares

- Mechanisms remain elusive despite advances
- Unpredictable nature complicates treatment planning

Importance of Personalized Treatment Strategies

- Tailoring treatments to individual patients
- Enhancing efficacy and minimizing side effects



https://www.baptisthealth.com/-/media/images/migrated/blog-images/content-images/bh-rhuematoid-arthritis-1024x616.jpg?rev=82260ed4c7a74996b6a8a61c7d440802&hash=76A94C0AC5399F885D5F4F4ED16135D4

Background

Overview of Bioflare Project

- 6-month observational study
- Collaboration between Newcastle University, University of Birmingham, and University of Glasgow

Research Focus

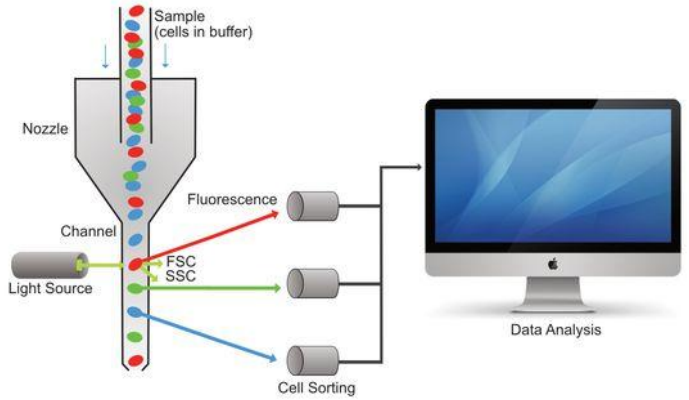
Addressing the lack of understanding in the pathogenesis of RA flares

Utilizing Advanced Techniques

Emphasis on flow cytometry for studying immune cell populations

Challenges and Solutions

- Manual analysis limitations
- Introduction of automated methods like OPTICS for improved analysis efficiency



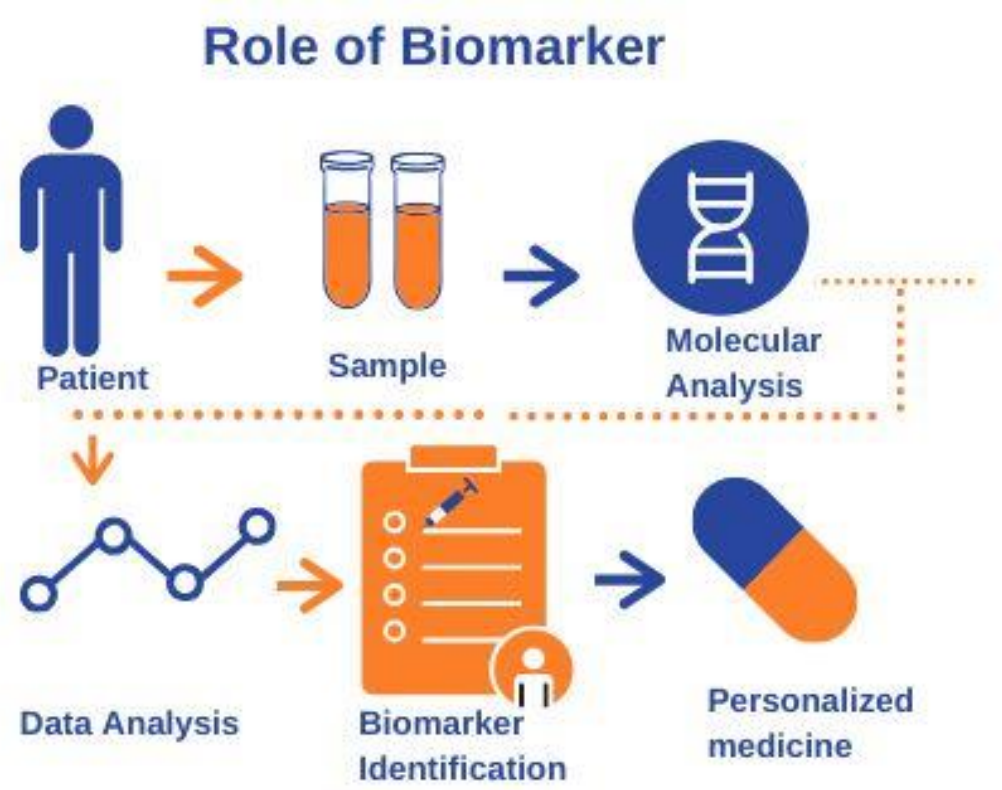
Flow Cytometry

https://jaxmecfs.files.wordpress.com/2018/01/flow_figure.png

Research Question

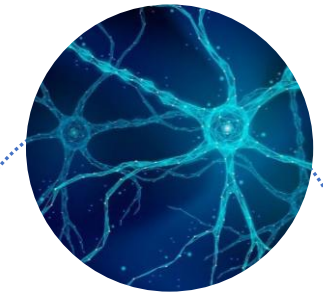
Which subsets of biomarkers predict RA flares?

Tailoring treatments with biomarker subsets enhances efficacy, controls disease, and minimizes side effects, while gaining flare pathogenesis insights



https://www.proxzar.ai/wp-content/uploads/2019/11/Biomarker.png

Objectives



Assessing Immune Cell Populations

- Measure the similarity or dissimilarity between immune cell populations
- Utilize distance metrics to quantify differences in immune cell profiles.

Identifying Distinct Subsets of RA Patients

- Utilizing Clustering to Distinguish Flare and Non-Flare RA Groups
- Examining Immune Cell Variations for RA Subgroup Identification

Comparing Immune Cell Profiles between Flare and Remission States

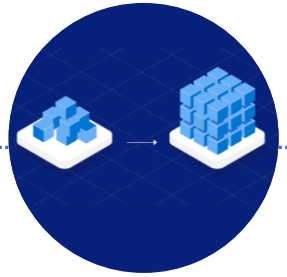
- Compare immune profiles of RA patients in flare vs. remission
- Identify significant biomarkers between RA flare and remission

https://www.technologynetworks.com/immunology/news/possible-role-for-newly-discovered-immune-cell-population-in-ms-341971
https://www.usfhealthonline.com/resources/health-informatics/why-is-patient-centered-care-important/
https://naturenews.africa/habits-that-negatively-affect-the-immune-system/

Methodology

Data Transformation

Preprocessing flow cytometry data



Clustering Analysis

Utilizing clustering algorithms to identify distinct subsets within immune cell populations

Differential Analysis

Comparing immune cell profiles to identify significant differences between flare and remission states

https://www.fivetran.com/blog/why-does-my-business-need-to-transform-data
https://online.keele.ac.uk/wp-content/uploads/2023/07/data-clustering.jpg
https://www.simplilearn.com/data-analysis-methods-process-types-article

Data Transformation

1 Data Collection

Collect flow cytometry data targeting immune cell populations from biological samples such as blood or synovial fluid

2 Data Preprocessing

Remove errors or inconsistencies

3 Normalization

Standardize data across samples

4 Scaling

Adjust range of values

5 Feature Extraction

- Selecting relevant parameters such as fluorescence intensity
- Extract meaningful features - cell surface markers or intracellular cytokines.

6 Dimensionality Reduction

Reduce number of features while preserving information

7 Quality Control

- Ensure data quality and reliability
- Address anomalies or artifacts

8 Data Formatting

Format data into structured format

Clustering Analysis

Apply OPTICS Algorithm	• Use OPTICS clustering algorithm • Analyze flow cytometry data
Reachability Plot	• Generate reachability plot • Visualize data ordering based on reachability distance
Cluster Extraction	• Identify clusters from reachability plot • Select points with low reachability distances
Cluster Analysis	• Analyze cluster characteristics • Assess immune cell population composition
Interpretation and Validation	• Interpret clustering results • Validate clusters using independent datasets or experiments

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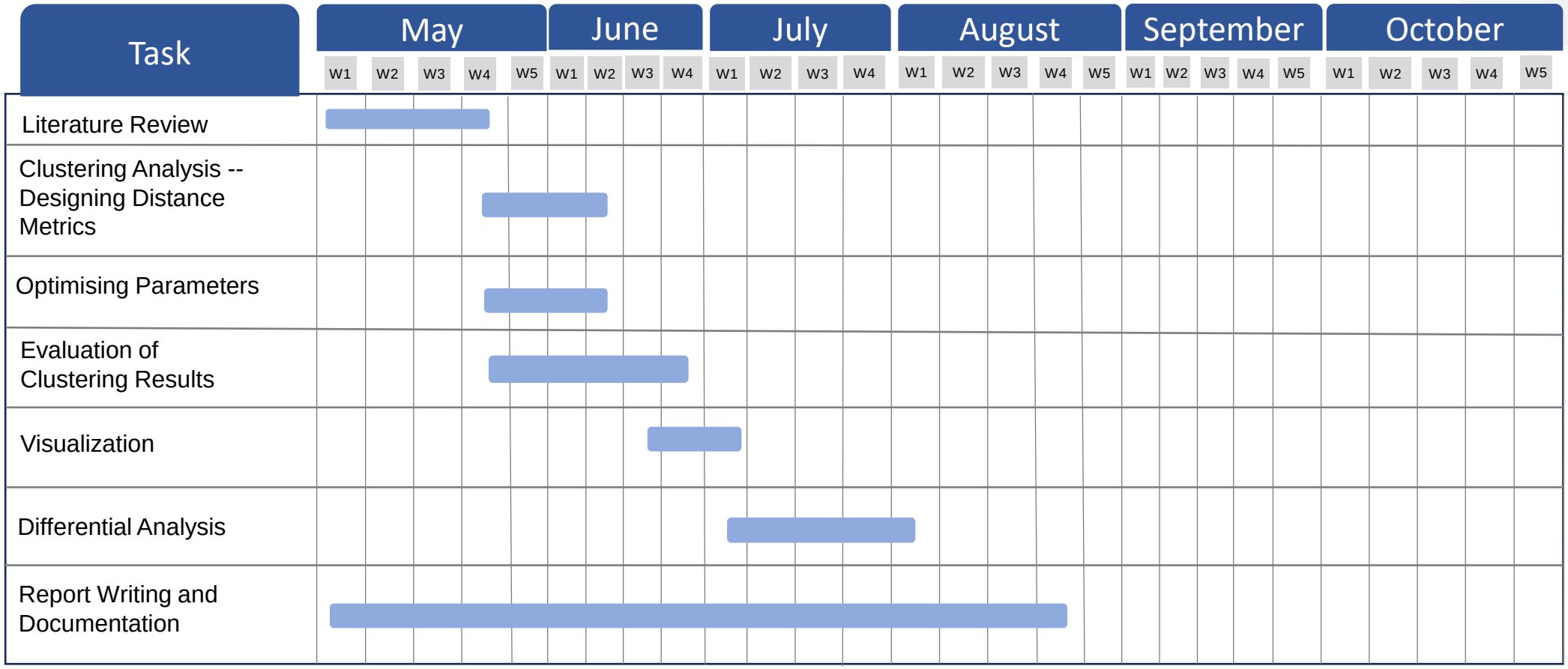
https://www.questionpro.com/blog/data-analytics-vs-data-analysis/

Differential Analysis

1. **Statistical Analysis**
   - Use appropriate statistical tests to compare immune cell profiles between disease states
   - Identify features showing significant differential expression
2. **Prioritization of Biomarkers**
   - Focus on markers indicative of disease activity
   - Prioritize biomarkers known to play a role in RA pathogenesis
3. **Validation**
   Validate identified biomarkers using independent datasets or experimental validation techniques
4. **Functional Analysis**
   Investigate biological functions and pathways associated with identified biomarkers
5. **Integration with Clinical Data**
   Integrate biomarker data with clinical data to assess clinical relevance and predictive value

Timeline



Expected results:

- Identification of distinct immune cell populations with annotations indicating cell types.
- A list of biomarkers that are significantly different between flare and non-flare conditions within each identified cell population, providing insights into flare pathogenesis.

Summary

- Collaborative effort to understand and predict rheumatoid arthritis (RA) flares.
- Advanced methodologies like Optics and clustering analysis employed for data analysis.
- Focus on identifying predictive biomarkers for RA flare prediction.
- Expected outcomes include development of prediction models for RA flares and personalized treatment strategies.
- Detailed timeline outlines project phases from literature review to result validation.
- Future directions may involve further validation studies and clinical applications to improve RA management.