Identifying Sustainable Packaging Materials for Food Groups Through Clustering of Gas Permeability

Chair Group : Food Quality & Design

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Who am I ?

Final-year of my master degree in Food Technology in WUR

Specialization : sustainable processing engineering

Taiwan

Combine Data Science and Food Domain

Thesis topic : Identifying Sustainable Packaging Materials for Food Groups Through Clustering of Gas Permeability

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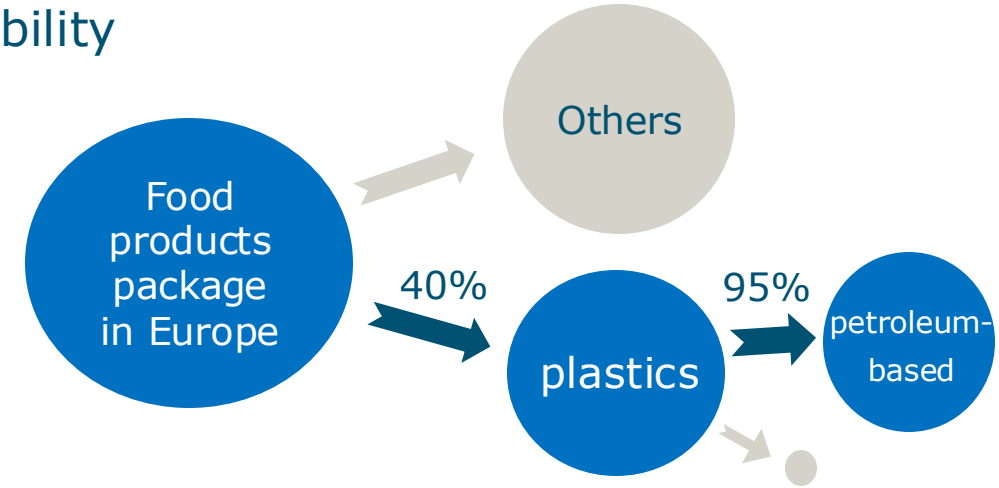
Background

Food packaging plays a crucial role in extending shelf life, preserving freshness, and maintaining quality cause it serves as a barrier.

- **Water vapor** permeability
- **Oxygen** permeability
- **Carbon Dioxide** permeability

shift towards **sustainable alternatives**



Knowledge Gap

specific packaging requirements

e.g. instant coffee / fresh fruits

inferior barrier properties of biodegradable materials

food waste

Current Research : isolated studies exploring specific materials for certain food types (e.g., chitosan-cellulose films for shredded lettuce)

Knowledge Gap: Lack a comprehensive, data-driven analysis, especially on gas permeability characteristics in different sustainable packaging materials.

Aim and Research Questions

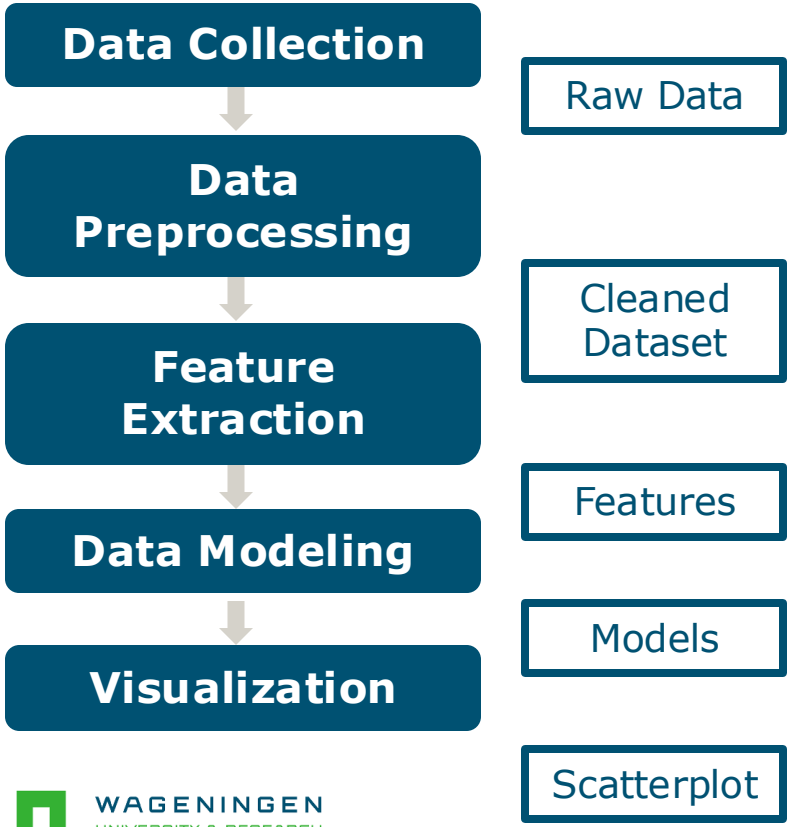
Aim: Developing **clustering algorithms** to group sustainable packaging materials according to their **gas permeability** characteristics— oxygen, water vapor, and carbon dioxide—and then **identify which materials** are best suited to the barrier needs of different food groups.

Research Questions

1. Which **clustering algorithms** most accurately classify sustainable packaging materials based on their gas permeability?

2. Which **sustainable materials** are best suited for packaging **different food categories**?

Approach



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Approach

Data Collection

Raw Data

Data Preprocessing

- Text-mined dataset from study of Lentschat (2021) from 50 scientific articles
- published between 2000 to 2016

Variable	Explanation	Values
Doc	the article title	Barrier and surface properties of chitosan-coated greaseproof paper
DOI	Digital Object Identifier	https://doi.org/10.1016/j.carbpol.2006.02.005
Target	generic concept represented	Permeability
Type	the ontology concept category, symbolic, quantitative or addimensional	QUANTITY
Original_Value	a list of annotated tokens for symbolic data, two lists of annotated tokens for quantitative data	(['3400'],['cm','^','3','mm','/','(','m','^',2', 'atm','day',')'])
Attached_Value	the list of annotated tokens to disambiguate a measure unit when necessary for quantitative data. None for symbolic data.	['carbon', 'dioxide']
Annotator	annotator id	1

Scatterplot

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Approach

Expected Features

Materials	Based Material	Type	Secondary Material	Composition	OP	OTR	WVP	WVTR	Pco2	co2TR	temp	RH
chitosan-coated greaseproof paper	greaseproof paper	coated	chitosan	['CS','2.4',' %']	0.01	0.001	nan	nan	0.001	0.0001	25	95
poly (lactic acid) nanocomposites	polylactic acid	nanocomposite	montmorillonite	['MMT', '0.15', '%']	nan	nan	$1.160 * 10^{-10}$	$1.160 * 10^{-8}$	nan	nan	38	52
Carrot puree films	Carrot puree	individual	nan	nan	20.20	4.80	nan	nan	nan	nan	25	83

Approach

Data Collection → Raw Data

Data Preprocessing → Cleaned Dataset

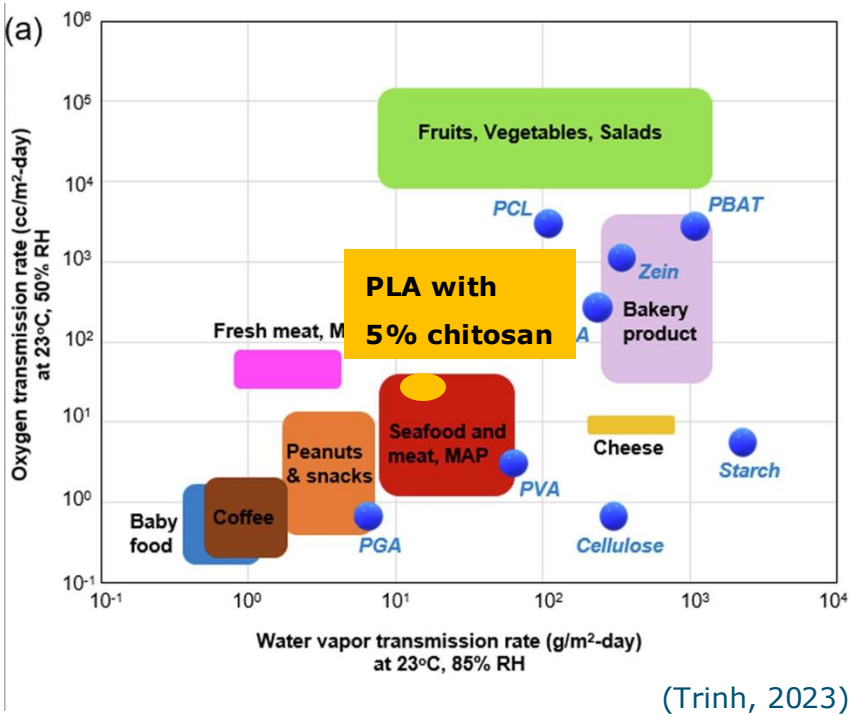
Feature Extraction → Features

Data Modeling → Models

Visualization → Scatterplot

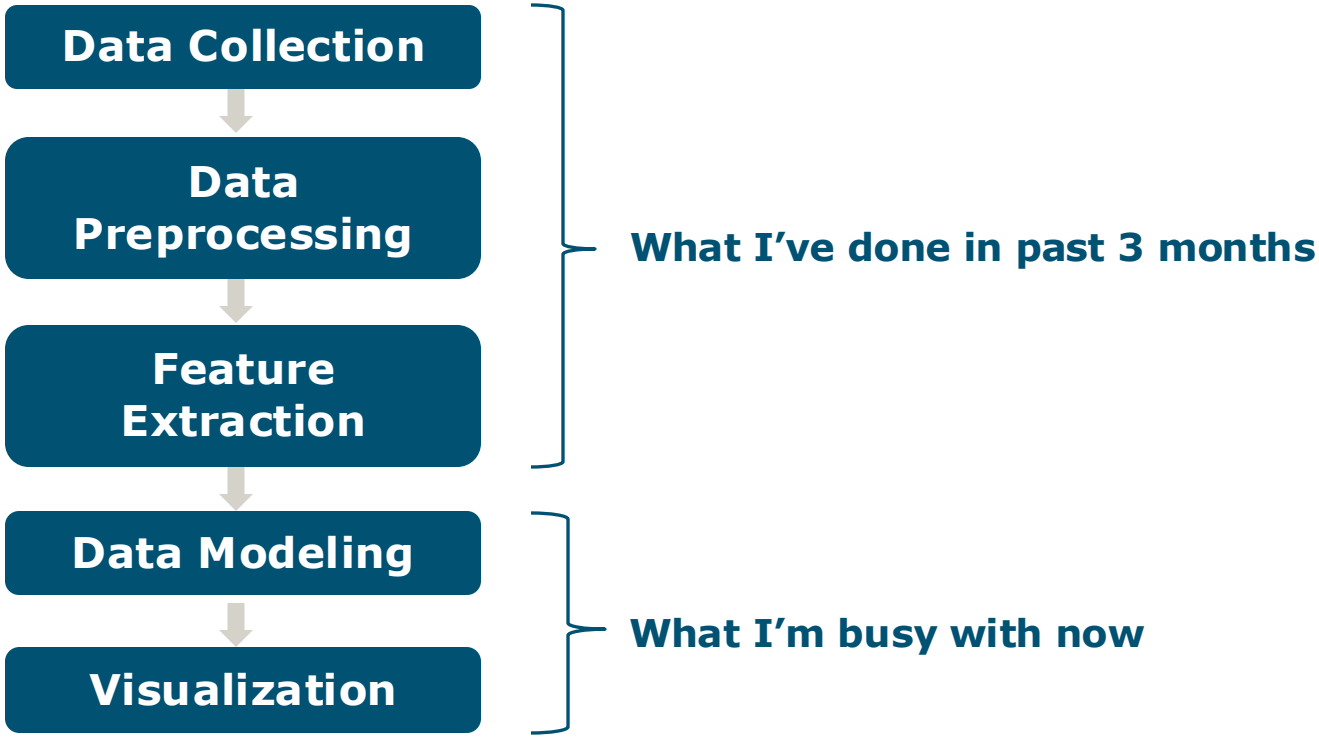
Clustering models:

1. K-means
2. DBSCAN
3. Gaussian Mixed Matrix



(Trinh, 2023)

Approach


Data Collection
Data Preprocessing
Feature Extraction
Data Modeling
Visualization
What I've done in past 3 months
What I'm busy with now