1. Problem Definition

- ***Goal**: Classify text messages (emails, SMS, etc.) as **spam** or **ham (not spam)**.*

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2. Data Collection

- *Use datasets like the **SMS Spam Collection** dataset from UCI Machine Learning Repository or any relevant labeled dataset.*
- *Format: Typically has two columns: `label` (`spam` or `ham`) and `message` (the actual text).*

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3. Data Preprocessing

- *Convert labels to binary (e.g., `spam` → 1, `ham` → 0).*
- ***Clean the text**:*
    - *Lowercasing*
    - *Remove punctuation, numbers, and special characters*
    - *Remove stopwords (like "the", "is", "in")*
    - *Tokenization (splitting text into words)*
    - *(Optional) Lemmatization or stemming*
    - ***Explanation***

1. Tokenization

Meaning: Breaking a sentence or paragraph into smaller parts like words or punctuation.

Example:
Text: `"I love playing football."`
Tokens: `['I', 'love', 'playing', 'football', '.']`

This helps machines understand and process each word separately.

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2. Stemming

Meaning: Cutting the word to its root form by removing prefixes or suffixes, even if the result is not a valid word.

Example:

- `"playing"`, `"played"`, `"plays"` → `"play"`
- `"running"` → `"runn"` ***(not a real word, but stemmed)***

It's fast but sometimes gives rough or inaccurate root words.

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3. Lemmatization

Meaning: Converting a word to its proper dictionary root form, considering grammar and context.

Example:

- `"playing"` → `"play"`
- `"better"` → `"good"`
- `"studies"` → `"study"`

More accurate than stemming, but a bit slower.

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4. Feature Extraction (Text Vectorization)

- *Convert text into numerical format using:*
  - ***Bag of Words (CountVectorizer)***

- ***TF-IDF (TfidfVectorizer)***
- *(Optional) Word embeddings like Word2Vec, BERT for advanced models*

5 Split Your Data

*Divide your dataset into **training** and **testing** sets:*

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6 Model Selection

- *Choose a classification model:*
  - ***Naive Bayes (MultinomialNB)** — best for text classification*
  - *Logistic Regression*
  - *Support Vector Machine (SVM)*
  - *Random Forest / XGBoost*
  - *(Advanced) Deep Learning: LSTM, BERT*

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7. Model Evaluation

- *Use metrics:*
  - *Accuracy*
  - *Precision, Recall, F1-Score (important for imbalanced datasets)*

    - *Confusion Matrix*

- *Validate with cross-validation if needed*

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8. Prediction and Testing

- *Use the trained model to classify new messages.*
- *Evaluate its real-world performance.*

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9. Save the Model

- *Use `joblib` or `pickle` to save the trained model and vectorizer:*

python
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```
import joblib
joblib.dump(model, 'spam_classifier.pkl')
joblib.dump(vectorizer, 'vectorizer.pkl')
```

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10. Deployment(local in vs_code)

- *Build a web or mobile app using Flask, Django, or Streamlit to input new messages and show classification results.*