

Bank Statement Aggregation Following Cognitive Architecture

Proposal and AI System Explanation

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1. Problem Description

Very often, companies get financial records from clients that are not digital, mostly as scanned PDFs. There are big differences in the quality, style, and structure of these bank accounts, which makes entering and integrating data by hand a slow, error-prone, and time-consuming process. It's harder to quickly study and collect financial data when it isn't digitalized, which is important for consultant jobs like accounting, financial planning, and compliance reports. The goal is to make an AI system that can:

- Read bank statements from PDFs of different quality, such as scanned pictures and text-based papers.
- Getting the date, title, name, and transaction details from these papers.
- Putting the gathered data into an organized database so that it can be analyzed and put together in a better way.

This system will make it easier for business consulting firms to keep financial records by managing the digitization of bank bills. It will also significantly reduce mistakes and human work.

2. Challenges

- **Document Quality Variance:** Bank statements may be of varying quality, including poor scans, low resolution, noise, and handwritten annotations.
- **Layout Differences:** Different banks use unique layouts and formats, complicating template-based extraction.
- **Text Recognition:** Extracting accurate text from varying fonts, sizes, and orientations.
- **Data Validation:** Ensuring the extracted data is accurate and susceptible to OCR errors.
- **Security and Privacy:** Handling sensitive financial data securely.

3. Related Work

Several AI-powered solutions have been developed to address the challenges of extracting data from bank statements including research-oriented work such as:

- **Klipa DocHorizon:** Provides an Intelligent Document Processing platform that automates bank statement processing using OCR and AI technologies, enabling seamless data extraction and integration. [1]
- **Quantiphi's Virtual Assistant:** Automates the classification and extraction of content from scanned financial documents, eliminating manual dependency in business process outsourcing. [2]
- In academic research, Luo et al. (2021) proposed a method for automatic table detection and data extraction from financial PDF documents using a Faster R-CNN model with a Feature Pyramid Network (FPN), achieving superior detection performance on a customized dataset. [3]
- Similarly, Patel and Bhatt (2020) introduced an approach for extracting key information from scanned invoices by integrating visual and textual features through

a BiLSTM model, effectively automating data extraction from unstructured financial documents. [4]

These systems primarily focus on automating the extraction of data from bank statements using OCR and AI technologies, converting unstructured data into structured formats for easier analysis and integration.

4. Chosen Technology

We propose a **Hybrid Cognitive Architecture** that integrates symbolic and sub-symbolic approaches, closely aligned with the provided code structure:

- **Perception:** Using **pdfplumber** for text extraction from PDFs and **pytesseract** for OCR on scanned images.
- **Attention:** Utilizing **regular expressions (regex)** to filter and extract relevant transaction data.
- **Reasoning:** Applying **rule-based logic (regex)** for data validation and pattern matching.
- **Memory:** Implementing an **SQLite database** for structured storage of extracted transactions.
- **Python:** For implementing the entire pipeline.

5. Justification of Technology

- **Hybrid Cognitive Architecture:** Combines perception through OCR and text extraction with symbolic reasoning for data validation.
- **PDF Parsing:** pdfplumber for extracting text from PDFs
- **Pre-trained OCR Models:** Utilizing **pytesseract** reduces development time and effectively handles scanned documents.
- **SQLite Database:** Offers lightweight, reliable storage for extracted transactions.
- **Regex-based Extraction:** Provides flexible handling of varied bank statement layouts.
- **Python:** A versatile programming language with extensive libraries for text processing, OCR, and database management.

6. System Workflow & Methodology

The suggested AI system takes a cognitive architecture to process bank statements efficiently, borrowing from basic functional layers:

Data Ingestion

- Bank statements in PDF format are uploaded by users, which can be: digitally created PDFs (text-based) and scanned PDFs (image-based).
- Scanned documents are preprocessed, and preprocessing methods like binarization and noise removal are executed to achieve better OCR accuracy.

Perception Layer

- For machine-readable PDFs, the system utilizes **pdfplumber** for direct extraction of text.
- For scanned PDFs, pytesseract (Tesseract OCR) is used to extract text from images.
- Some basic validation tests are run to mark unreadable pages or corrupted files.

Attention Layer

- Regex is utilized for parsing and extracting transaction details (date, description, amount) from raw text.
- The extracted information is transformed into a structured format (i.e. a table with columns for date, description, and amount).
- Anomalies (i.e. missing fields or invalid formats) are flagged for manual review.

Reasoning Layer

- Rule-based reasoning provides data integrity and consistency (for instance, duplicate transaction checking or invalid date checking).
- Common OCR errors (e.x. misrecognized characters) are corrected according to predefined rules.
- Inconsistencies or mistakes that cannot be fixed automatically are marked for manual checking.
- Validated and cleaned transactions are prepared to be inserted into the database.

Memory Layer

- Once validated and cleaned, the transaction data is inserted into an SQLite database.
- The database facilitates effective querying and extraction of financial information for additional analysis.

Output

- The system presents the formatted data in readily readable formats like Excel or CSV.
- Integration with current fiscal systems is also provided.

7. Flow Diagram

The following flow diagram illustrates the cognitive architecture of the proposed AI system:

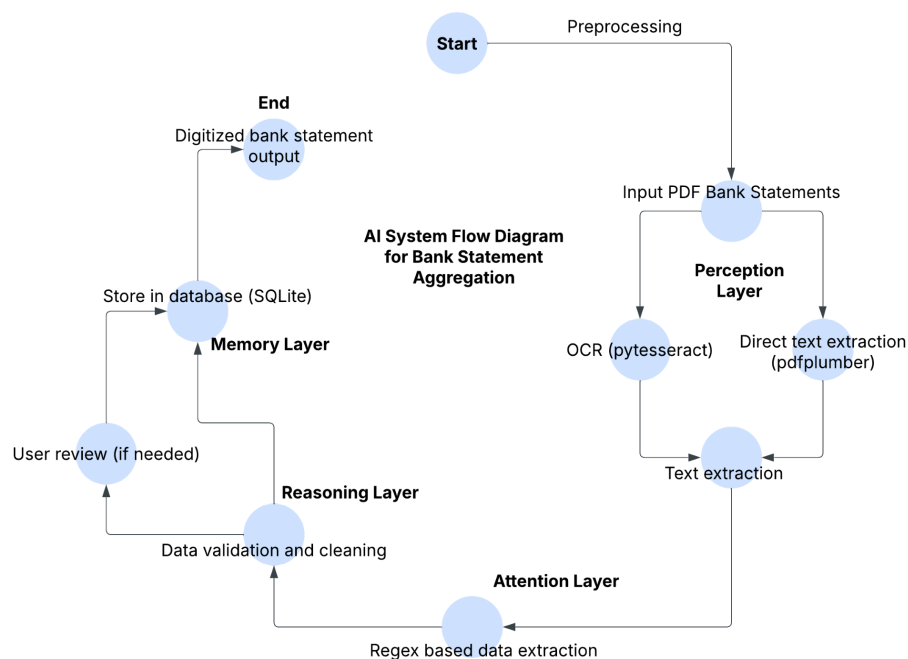


Fig: AI System Flow Diagram For Bank Statement Aggregation

8. Limitations

- **OCR Errors:** Low-quality scans may still result in incorrect extractions.
- **Regex Limitations:** Complex or unusual statement layouts may require manual regex updates.
- **Processing Time:** Large PDF files may slow down the extraction process.
- **Data Security:** Handling sensitive financial data requires strict privacy measures.
- **Scalability:** SQLite is suitable for small to medium datasets but may not scale for enterprise-level data.
- **Human Oversight:** Complex cases or anomalies still require manual review

9. Conclusion

In conclusion, the proposed AI system offers an efficient solution for automating bank statement aggregation using a hybrid cognitive architecture. By combining OCR technology, regular expressions, and rule-based reasoning, the system effectively extracts structured data from unstructured sources, streamlining financial data processing for corporate consulting companies. While challenges such as OCR accuracy and data privacy remain, the system provides a strong foundation for future enhancements.

10. References

- [1] Klippa DocHorizon. (n.d.). *Intelligent Document Processing*. Retrieved from <https://www.klippa.com>
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- [4] Patel, R., & Bhatt, P. (2020). *Information Extraction from Scanned Invoices Using BiLSTM*. Retrieved from <https://arxiv.org/abs/2009.05728>