Problem Statement & Objectives

- ***Project Objectives***
- *Convert **any** contract (scanned or digital) documents into a structured CAD automatically*
- *Ensure all extracted information is **traceable**, correct, and easy to read*
- *Generate outputs in **JSON, DOCX, and PDF***
- *Provide additional tools like **compliance checking** and **conflict detection***
- *Reduce manual work while increasing speed and consistency*
- *Repo Link: https://github.com/Deepakc766/UGP2_CAD_Generation*

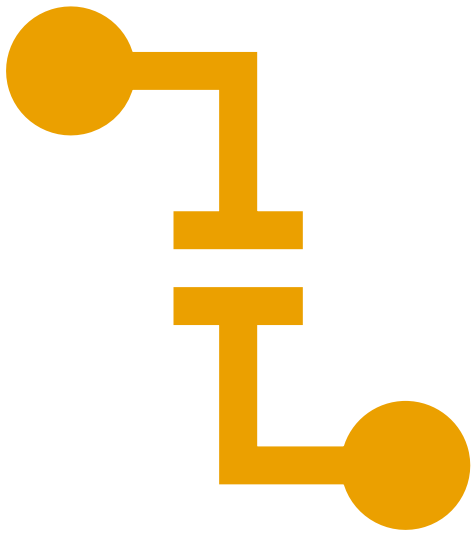
Overall System Architecture

- **How the System Works (High-Level Flow)**
- **PDF Extraction**
  - If text is available → extract directly using pdfplumber
  - If scanned → use OCR (Tesseract)
  - Maintain page markers for traceability
- **LLM Processing**
  - Approaches vary (RAG, Sliding JSON, One-Shot), but all aim to understand contract text
- **CAD Generation**
  - Output structured CAD in JSON
  - Convert JSON into **DOCX and PDF summary**
- **Additional Modules**
  - **Compliance check:** validates rules and requirements
  - **Conflict detection:** identifies contradictions

Approach-1: RAG (Retrieval-Augmented Generation)

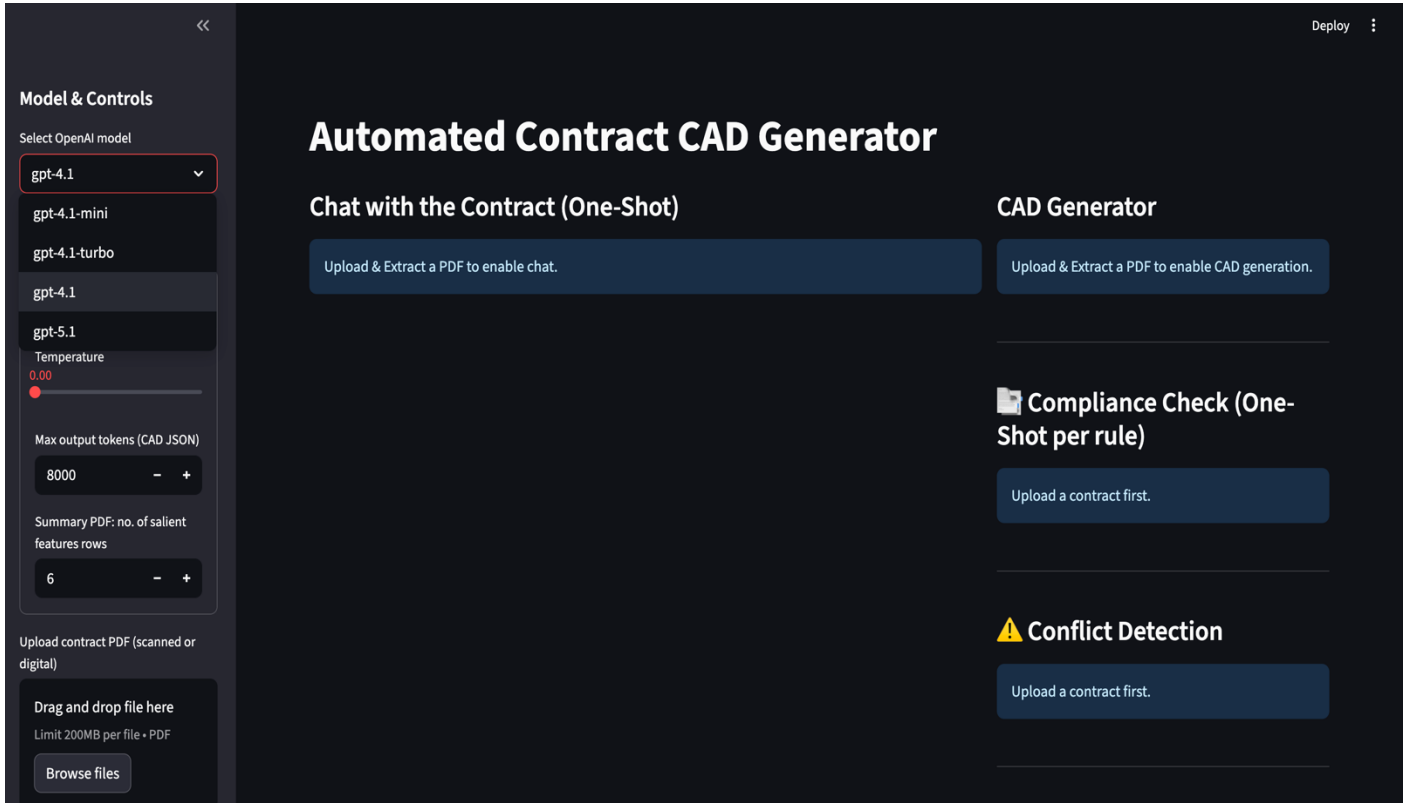
- **How it Works**
- Contract text is broken into small chunks of window size 1024 or 2048 and overlapping of 256/128 token.
- Chunks are converted into embeddings for similarity searching.
- Stored in Fiass(vector database) for efficient searching
- When asked a question, the system retrieves the most relevant chunks and return on console and hosted using local port and streamlit
- LLM (FLAN-T5) generates answers and CAD sections and better summarisation
- **Pros**
- Good for interactive Q&A
- Works well for smaller documents but not for large contract document like 150+ tokens because LLM(flant-t5) has maximum token limit of 1024.
- **Cons**
- CAD sections generated separately → inconsistent final output
- May miss cross-section linkages (global context missing and confusion in similarity)

Approach-2: Sliding Windows



- **How it Works**
- Entire contract is split into **overlapping token windows again into window size of 1024 and overlap of 128 tokens.**
- For each window, LLM outputs a **strict JSON block**
- All JSON blocks are merged into a final CAD
- Page references are added by searching for quotes in extracted pages
- **Advantages**
- More stable structure than RAG
- Works better for large documents but if LLM has large token size limit like GPT-4,5 or claude.
- **Limitations**
- Still not fully “global”—final consistency depends on merging and leads to bad results sometimes.
- Hard to manage if the contract is extremely long above 100 pages.

Approach-3: One-Shot ChatGPT API (Final Method)



- **How the Final Approach Works**
- The **entire contract** (after pdfplumber + OCR) is passed into a **large-context ChatGPT model** — no chunking, no retrieval, no merging.
- A **strict JSON CAD schema** (≈ 45+ fields across salient features, payment, notices, risks, disputes, etc.) ensures the model outputs a **complete and consistent CAD**.
- The model is forced to produce **valid JSON** using response_format="json_object" and rules such as: *unknown → null/false/[] if not found*
- Because the whole contract is read at once, the model understands:
  - cross-clause dependencies
  - temporal relationships
  - party roles, dates, and payment logic
- The output is a **single CAD JSON object**—no sliding windows or merging like Approach-2.
- **Post-Processing Pipeline**
- **JSON Validation & Repair** – fixes minor formatting issues.
- **DOCX Generation** – section headings + tables in Arial 11pt for professional readability.
- **PDF Summary** – clean 1-page report created using reportlab(although we can change the number of pages from left bar).

Why Approach-3 Is the Best

- **1. Highest Accuracy**
- No missing clauses because the **whole contract** is seen at once.
- Eliminates window mismatch, overlap drifting, and retrieval errors from earlier approaches.
- Ensures dates, parties, payment terms, and DLP are all **globally consistent**.
- **2. Most Consistent Output**
- CAD fields stay synchronized across the JSON schema.
- Employer/Contractor information does not conflict.
- All payment sections (advance, retention, final settlement) align perfectly.
- **3. Simplest & Most Reliable Pipeline**
- Compared to earlier methods:
- No embeddings
- No Chroma DB
- No token windows or merging
- No post-LLM recomposition

Easy Readability: CAD Generation

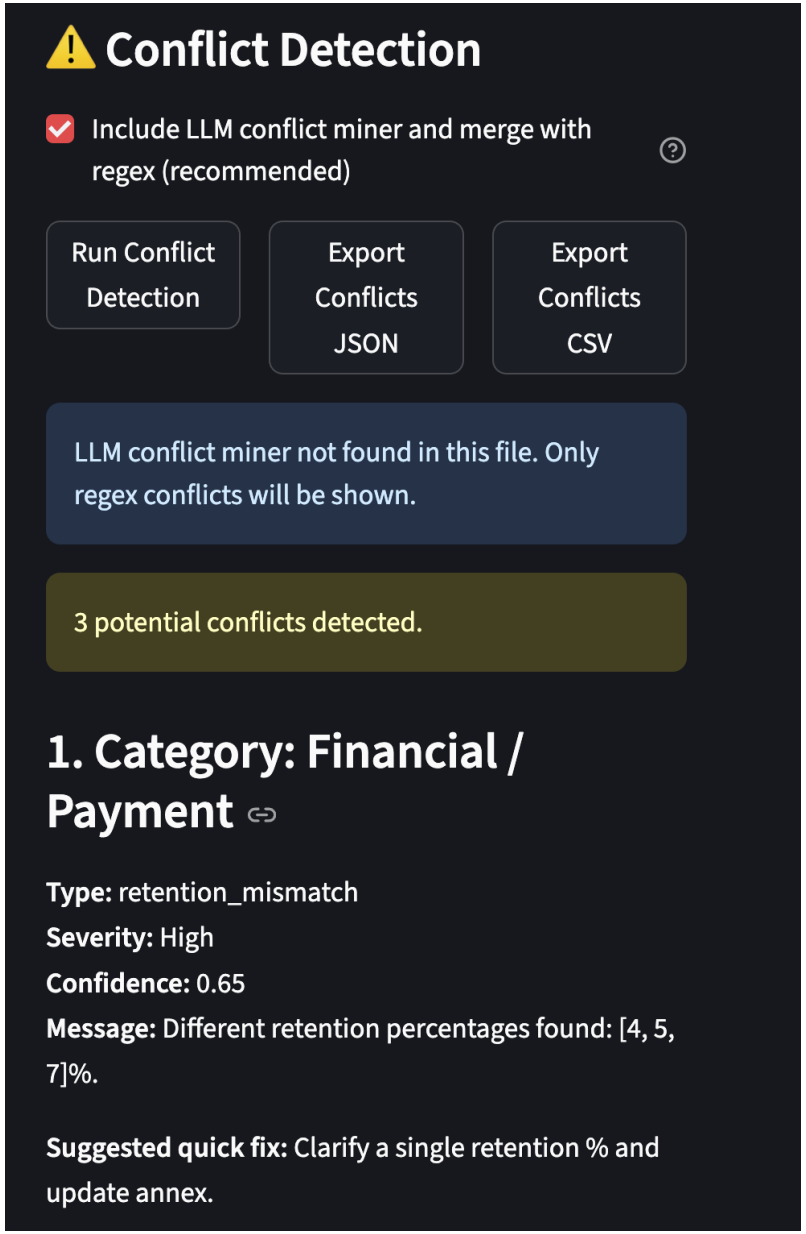
- **What Makes the CAD Easy to Read?**
- One-shot JSON ensures each section of the CAD is well-structured
- DOCX contains neat tables for each major part
- PDF summary presents all key information on one page
- Eliminates unnecessary text and extracts only meaningful details
- Sample Example on Right side of Notice Clause.

4. Important clauses pertaining to project progress - EOT, Escalation, Variation, Suspension, etc.

Sl. No.	Topic	Clause No.	Summary
1	Extension of Time (EOT)	3.5, 7.4, 26.3	EOT may be granted for force majeure, delays in drawings/approvals, or suspension >30 days; claims must be notified within 14 days
2	Escalation	Annexure B	Price escalation applicable beyond 180 days from commencement; formula based on indices for cement, steel, fuel, labour, misc.
3	Variation	7.1-7.3	Employer may instruct variations; Contractor to submit quotation within 7 days; Engineer's determination binding until arbitration
4	Suspension	26.1-26.4	Employer may instruct suspension; EOT if >30 days; payment for idle resources by mutual agreement
5	Liquidated Damages (LD)	19.2, Annexure B	Delay in mobilization beyond 15 days from site possession: LD 0.05%/day; cap 10% of Contract Price

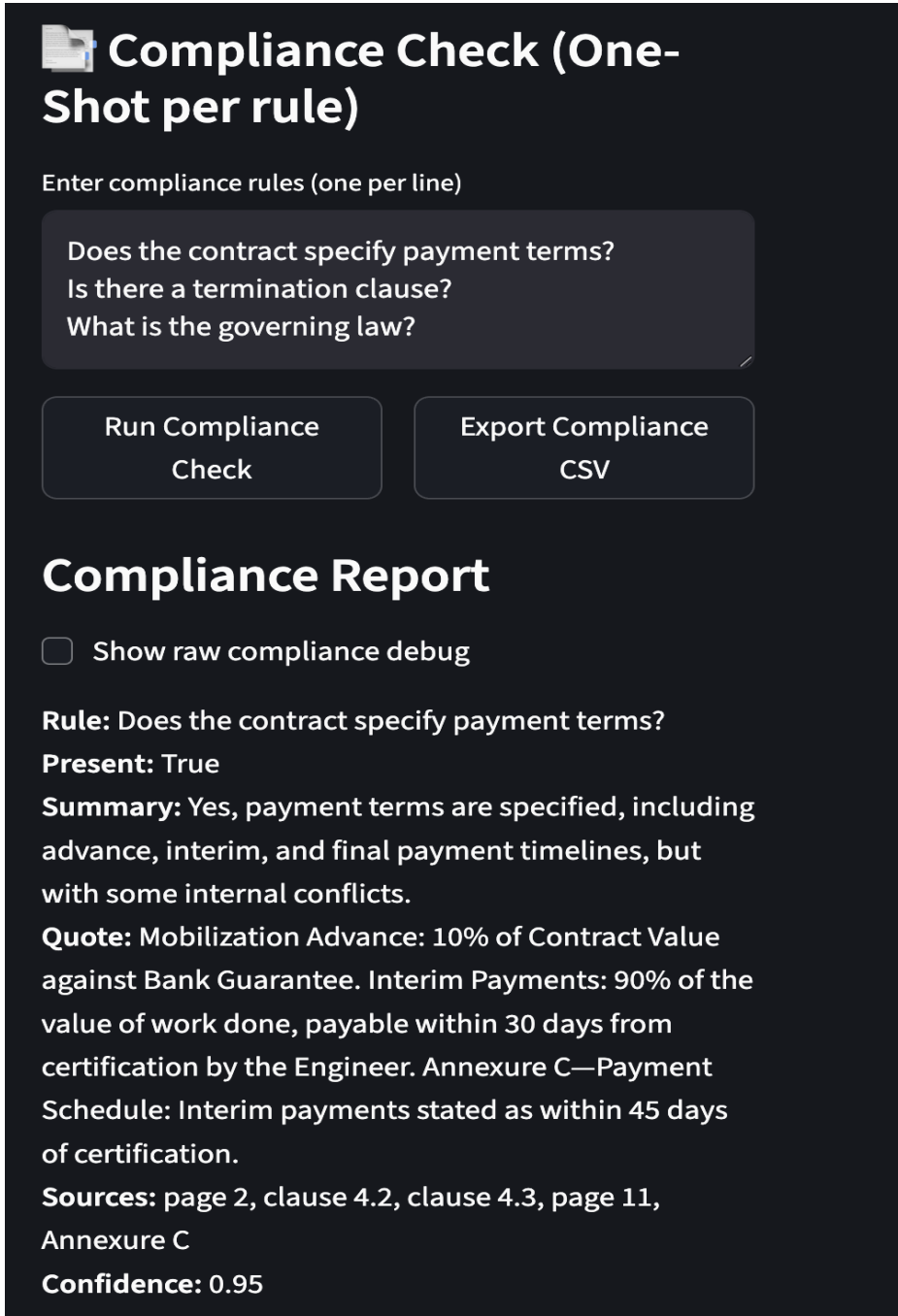
Accuracy: Conflict Detection

- **Implemented Conflict Checks**
- Your system automatically detects contract inconsistencies such as:
- Commencement date vs site possession date
- Payment term mismatch
- Retention percentage mismatch
- Arbitration vs court contradiction
- Security/performance guarantee inconsistencies
- Other 10 checks are there in code .
- **Why This Matters :**
- Conflicts cause disputes during project execution
- Automated detection helps contract reviewers catch issues early



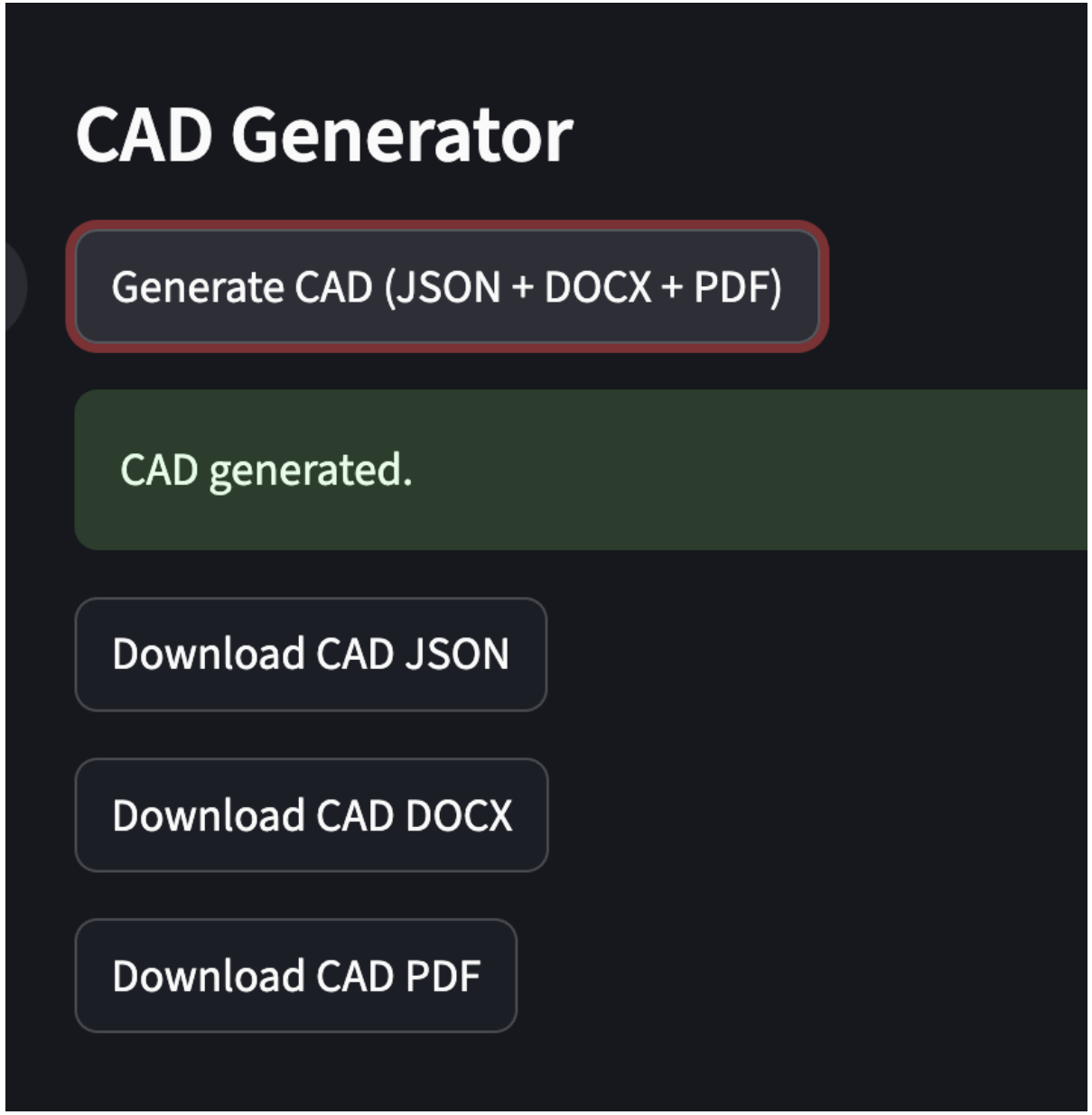
Completeness: Compliance Check

- **What It Does**
- Validates whether the contract contains specific rules or required sections
- Each rule produces a small JSON output with:
  - Is the rule present?
  - Summary of text
  - A direct quote
  - Page or clause number
  - Confidence score
- **Why It Helps**
- Ensures contract meets legal/technical standards
- Helps users identify missing or incomplete clauses
- We can also download compliance report as well.



Results & Comparison

- **Overall Comparison of Approaches**
- **Approach-1 (RAG)**
- Works but limited because of separate chunks
- Good for basic Q&A, weak for full CAD
- **Approach-2 (Sliding JSON Windows)**
- More robust than RAG
- Better structure but merging is complex
- **Approach-3 (One-Shot ChatGPT)**
- Best performance overall
- Highest accuracy, consistency, readability
- Required for production-level CAD generation



Limitations & Future Work

- **Current Limitations**
- **Privacy Concern for Legal Documents:**
  Sending confidential contracts to cloud-based models may violate company or legal policies.
  Solution: Use an **Enterprise API key** or private deployment with strict data-retention controls.
- **Token Size Limitations:**
  Very long contracts can exceed the model's maximum context window, causing incomplete processing.
  Solution: Use models with **larger context sizes** or apply adaptive chunking only when needed.
- **OCR Errors in Scanned PDFs:**
  Low-quality scans lead to incorrect text extraction, affecting accuracy of CAD, compliance, and conflicts.
- **Conflict Detection Coverage:**
  Not all possible legal inconsistencies are detected; current system implements only selected major rules.
- **Formatting Variations:**
  Contracts differ in structure (tables, annexures, multi-column layouts), causing extraction inconsistencies.

Solution :

API(enterprise) Key might work ,They won't train model on private data and large token size model like gpt-5