



# Legacy Lift

Legacy Lift



Yesterday's Problem → Tomorrow's Solution

# Process

~~All Feasibility Elements - Justin~~

~~Development Tools - Justin~~

~~Development Model (e.g., Agile) - Spencer - done~~

~~Identification/Description of deliverables - Jordan Kemelhar~~

Identification of Technical Risks and Customer Risks

- ~~• Impact and probability - Spencer, Aaditya~~
- ~~• Mitigations - Spencer, Aaditya~~

~~Major Functional Components - Jordan Kemelhar~~

- ~~• Including COTS & Legacy Systems - Jordan Kemelhar~~

Technical Approach for software and hardware, including:

- ~~• Dataflow diagrams - Spencer~~
- Process flow diagrams - Caleb
- Database schemas - Caleb
- ~~• Data representation and management - Caleb~~

~~GUI Mockups and/or Rapid Prototypes - Spencer~~

~~Appendix - User Stories~~



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# Meet the Team

Spencer Peloquin - He is enrolled in the BSCS MS program at Old Dominion University. He has completed a technical internship at Tacoma Public Utilities. In addition, he has experience in Python, Java, Ruby, C++, C#, SQL and Fortran. He lives in Tacoma WA, where he enjoys running, reading and hiking.



Aaditya Ghimire(AG)- He is enrolled in Computer Science Program at ODU. He has experience in Java + Spring Boot and with main focus on Python deep learning computer vision.



Caleb Peterson - He is enrolled in the bachelors computer science program at ODU. He has experience in Java, JavaScript, C++, and SQL. His hobbies include video games and board games.



Justin Tendilla - CS Major. Loves playing guitar, video games, and movies. Experienced in C++ and Java.

Darius Itam - He is enrolled in the bachelors computer science program as a senior at ODU main campus in Norfolk, VA. He is proficient in Python, Java, JavaScript, and C#. He loves fitness, esports, and music.



Jordan Kemelhar - IT/Azure cloud professional and Senior CS student at Old Dominion University. Certified in CyberSecurity Has experience in Java and Azure user management. Hobbies video games, and, hiking, board games.



# Executive Summary

## AI Pipeline for Legacy Code Modernization



### Problem

Many critical enterprise systems still run on legacy software written in outdated languages such as COBOL. These systems are deeply embedded in industries such as finance, government, and enterprise infrastructure. 95% of ATM transactions in the U.S. are processed using COBOL-based systems, and over 60% of U.S. hospitals run critical applications on legacy software such as COBOL and Fortran (Pragmatic Coders, 1).

### Impact

The problem is that legacy systems introduce security risks, compatibility issues with modern technology, and large amounts of technical debt. Modernizing them is extremely difficult because these systems contain complex dependencies and decades of accumulated business logic. It is especially important to port code to modern platforms for use in cloud applications, which are primarily incompatible with legacy systems.

### Solution

Legacy Lift proposes an AI-driven pipeline that analyzes dependencies and incrementally converts legacy systems to modern infrastructure. It will maintain full compatibility with the infrastructure of the legacy code while enabling the security/performance benefits of modern programming languages.



# High Level Overview

## Purpose:

- Translate legacy code from COBOL to modern Python 3.11
- Solve technical debt with legacy codebases
- Resolve ongoing security and memory issues with legacy systems

## Mechanics:

- Uses Gemini AI to convert code
- Translates legacy plugin dependencies into modern package hooks
- Preserves class structure from original code

## Benefits:

- Functional equivalent code conversion
- Leverages both Generative AI and human review
- Provides an on-ramp to modern systems



# Development Tools

- Frontend
  - Python TK based widget
  - Electron wrapper
- Backend
  - Python 3.11
  - Gemini
- Database / Storage
  - MySQL Server
  - Vector Database for RAG retrieval
- Development / IDE
  - Visual Studio Code
- Version Control
  - GitHub + Git
- Environment / Infrastructure
  - Windows 11/Ubuntu 24.04
  - Miniconda
  - Docker

# Deliverables

Updated Python code with functional equivalence to the legacy code.

Changes documentation with a collection of log files and original COBOL functions.

RAG justification for python changes.

System tests to test for compatibility

Vector Database for Retrieval Augmented Generation

LegacyLift code update toolchain

Deployable self contained LegacyLift Docker environment for demo

# Work Breakdown Structure

## LegacyLift Full Development Breakdown

Everything to Build, Set Up, Design, or Test — AI-Assisted Fortran & COBOL Analysis Tool for Python Modernization

### Development Pipeline



■ Design
 ■ Build
 ■ Set Up
 ■ Test

# Code Comparison- Cobol

- 60+ lines for a single input validation task
- No OOP — paragraph-based procedural flow
- Fixed-width memory declarations (PIC X(10))

```
identification division_.
program-id is-numeric-test_.
data division_.
working-storage section_.
@1 ws-user-input pic x(10).
@1 ws-user-input-justified pic x(10) justified right.
procedure division_.
main-procedure_.
  perform process-plain
  perform process-zero-fill
  perform process-trim
  stop run.
process-plain_.
  display "(plain) Enter a value: " with no advancing
  accept ws-user-input
  if ws-user-input is numeric then
    display ws-user-input " is numeric!"
  else
    display ws-user-input " is not numeric!"
  end-if
  exit paragraph_.
process-zero-fill_.
  display "(right justify, zero fill) Enter another value: "
  with no advancing
  accept ws-user-input-justified
  inspect ws-user-input-justified
  replacing leading spaces by '0'
  if ws-user-input-justified is numeric then
    display ws-user-input-justified " is numeric!"
  else
    display ws-user-input-justified " is not numeric!"
  end-if
  exit paragraph_.
process-trim_.
  display "(trim) Enter a third value: " with no advancing
  accept ws-user-input
  if function trim(ws-user-input) is numeric then
    display function trim(ws-user-input) " is numeric!"
  else
    display function trim(ws-user-input) " is not
nameend-if
  exit paragraph_.
end program is-numeric-test_.
return go(f, seed, [])
}
```

# Code Comparison - Python

- 15 lines — 75% reduction
- Clean function-based OOP-ready structure
- Readable without COBOL-specific knowledge

```
def is_numeric(value):
    try:
        float(value)
        return True
    except (ValueError, TypeError):
        return False

user_input = input("Enter something: ").strip()
if is_numeric(user_input):
    print(f"'{user_input}' is numeric!")
    if user_input.isdigit():
        print("  It's an integer.")
    else:
        print("  It's a floating-point number.")
else:
    print(f"'{user_input}' is NOT numeric.")
```

# Infrastructure Comparison

Feature	Legacy Code (COBOL/Ada)	Modern Python Environment
Language	COBOL, Fortran, Ada	Python 3.11+
Developers	<b>Scarce</b>	<b>Millions:</b> Most taught globally
IDE / Tooling	Proprietary, limited debuggers	VSCode, linters, extensions
Testing	Manual, minimal frameworks	PyTest, Automated CI pipelines
Documentation	Often missing or non-standard	Docstrings, Auto-generated docs
Version Control	None or proprietary systems	Git + GitHub + GitHub Actions
Security	Slow patches, legacy vulnerabilities	Active community, rapid patching
Maintenance Cost	<b>High:</b> Specialist rates (\$150+/hr)	<b>Standard:</b> Competitive market

Feature	RWP	Legacy Lift
COBOL → Python 3.11 Translation	✓	✓
Fortran → Python Translation	✓	—
Ada → Python Translation	✓	—
Recreate Original Class Structure	✓	—
Modern Design Refactoring	✓	✓
Runs on Modern x86 Systems	✓	✓
Plugin / Framework Compatibility	✓	—
Preserve Comments & Documentation	✓	✓
Audit Logging	✓	—
Functional Equivalence	✓	✓
Dependency Analysis	✓	✓
Multi-file / Large Codebase Support	✓	—
CI/CD Integration (Enterprise Scale)	✓	✓
Security Vulnerability Scanning	✓	—

# Current Process Flow

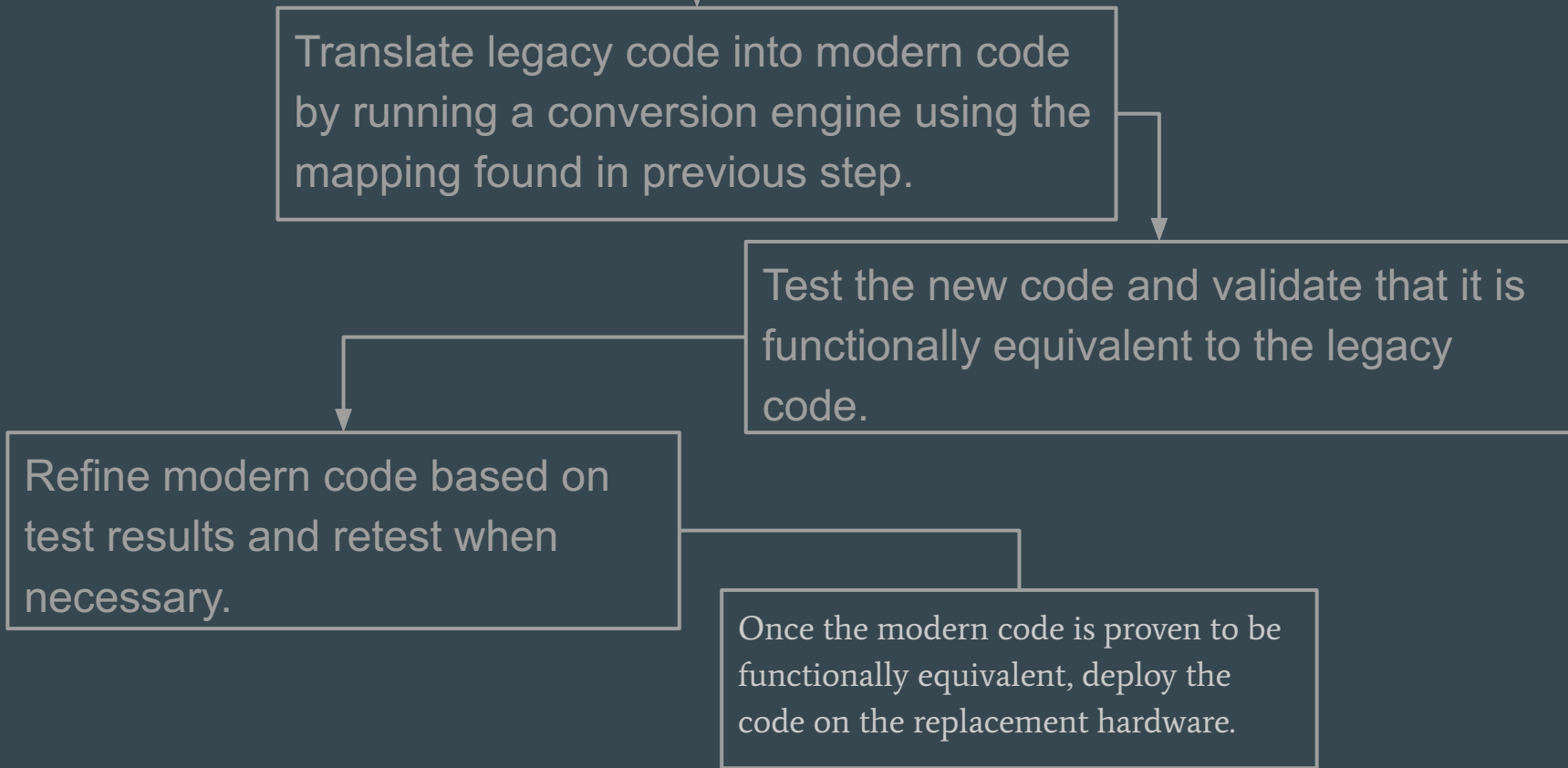
Create a specification document that outlines what the legacy code does and the requirements of the converted code.

Parse and analyse the legacy code to gain insight on the code's logic, structure, patterns, and dependencies.

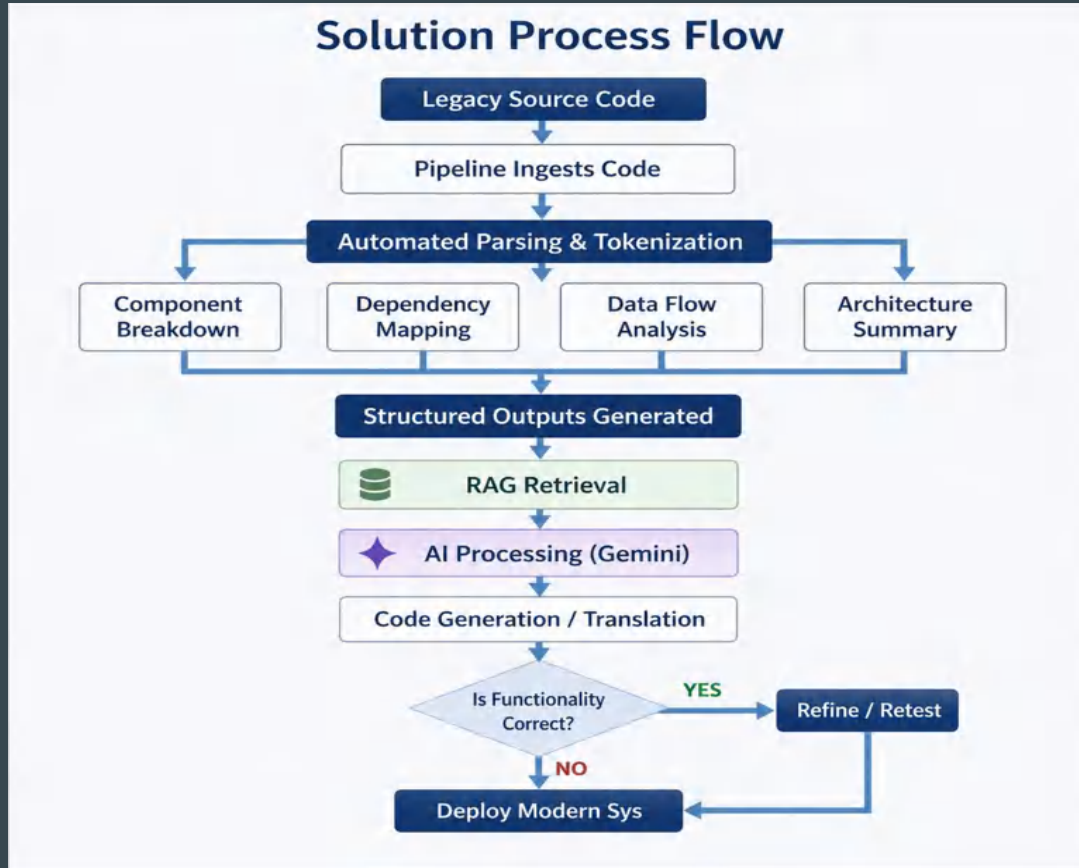
Map legacy patterns to corresponding modern language structures.



# Current Process Flow



# Solution Process Flow





# Solution Statement

This project will produce a prototype software pipeline that analyzes legacy source code and generates structured outputs describing the code's components and relationships, demonstrating the feasibility of using AI-assisted techniques to support legacy system modernization.

## Software Type

- AI-assisted legacy code analysis tool

## Purpose

- AI-assisted analysis of legacy source code
- Marketed for Consultants.

## High-level Function

- Accept legacy code as input
- Analyze structure and dependencies
- Produce structured outputs describing the system



# Features

- Translate legacy code from COBOL (initially) to Python
- Preserve program structure and translate it into modern Python modules
- Refactor code to match modern design protocols
- Enable translated code to run on a modern x86 PC Operating System
- Contain full compatibility with any existing plugins or frameworks
- Translated code will be fully equivalent in function to the original code
- All comments and documentation will be intact
- Contain an audit log of all changes made to the original code



# Limitations

- Be able to run unmodified on legacy hardware
- Run its own code
- Translate or decompile binary modules
- Retain any or all technical debt
- Assume missing functionality
- Access the network or external/cloud drives
- Guarantee the absence of bugs or security issues
- Convert legacy code into code of a completely different nature
- Function as a chatbot, game engine or “swiss army knife tool”

# Competition Matrix



FEATURES	Our Product	ChatGPT	IBM Watsonx Code Assistant	Azure Migrate
Legacy Code Conversion	✓	✓	✓	✓
Dependency Analysis	✓			✓
Full Compatibility with Plugins or Frameworks	✓			
AI Incremental Translation Pipeline	✓			
New Code has Functional Equivalence with old code	✓		✓	✓
Audit log of changes	✓			✓
Modern OS/x86 Compatibility	✓		✓	✓



# Competition Analysis

- Current competition includes IBM and Microsoft.
- These models use in house AI conversion tools based on Copilot models.
- They also come with enterprise support and are open source.
- The key difference between our model (Legacy Lift) and theirs is that our model uses the Gemini model.
- It is fully backed by a University CS department and does not collect data for sale.
- Other research projects from universities like Stanford and MIT hold this model, and should provide proper benefits for a company.



# Legal Risks

- **Primary Risk** : Users over-trust AI in the COBOL-to-Python translator, assuming consistent accuracy despite frequent hallucinations in code logic, data handling, or refactoring.
- **Real-World Evidence** : Numerous lawsuits and sanctions against AI users (e.g., lawyers fined \$1,500–\$86,000 for hallucinated legal citations); enterprise hallucination losses estimated at **\$67.4 billion** in 2024.
- **Probability** : High — AI confidently wrong outputs are common (e.g., 17–34% hallucination rates even in specialized legal AI tools).
- **Impact Rating** : 4/5 — Heavy financial (fines, rework, lost revenue) and reputational costs for a small modernization startup.
- **Specific Relevance** : Critical for legacy migrations where errors in translated COBOL business rules or Fortran numerical code can cause production failures or compliance issues.
- **Key Recommendation** : Strong disclaimers, mandatory human review, and clear limitation disclosures in all client engagements to reduce liability.



# Risk Analysis

- Incompatibility & Technical Debt
- Compatibility between legacy and modern Python
- Gemini produces hallucinated Python logic
- Migration Failure Risks
- AI Over-Trust Amplification
- Deployed code behaves differently in production

## Mitigations:

- Disclaimers
- human review
- Audit trail of model version
- Runtime compatibility
- Full audit logging and documentation



# Major Functional Components

Tech stack:

L - Container - Docker

A - Cloud - Google GCP

M - DB - MySQL

P - Language - Python

Python CLI -> Provides the Conda shell to run the code

Program runs -> The Legacy Lift Software is initialized on the cloud PC

Code Parsing -> The Legacy Lift Software takes tokens and classes and sends them to Gemini

Sends to Gemini -> Gemini parses these tokens and generates compatible classes

Dependency analysis -> The tokens are analyzed for possible dependencies and compatible classes

Converts Code to target language -> These classes are rebuilt for Python with a focus of creating modern code over preserving legacy quirks

Verify integrity -> check for corruption and verify all classes are valid

Makes sure it can run -> run the first 10,000 tokens on the bare metal for stress testing

Validates one to one functionality -> A series of unit, system and integration tests are run to ensure 1:1 compatibility

Deploys new code -> create a Conda Environment to deploy new code

# COTS and Legacy Systems

COTS:

LegacyLift will use Gemini as the primary translation backbone. Retrieval Augmented Generation will be accomplished by using Gemini in a vector database.

MySQL will be the primary database implementation.

Uses GCP with docker so LegacyLift can be run anywhere with any code size

Legacy Systems:

Uses GnuCOBOL as an interpreter for COBOL

# Agile Development Model

Agile development method

Chosen because LegacyLift works like a startup

Organized using a scrum

Waterfall and RUP are not suitable because LegacyLift is not enterprise

# Algorithms

Parsing & Abstract Syntax Tree (AST) Construction

Component Detection & Inventory

Dependency & Relationship Analysis

AI-Assisted Analysis Layer

Graph & Visualization Algorithms

Supporting / Utility Algorithms

# Libraries and Frameworks

- FastAPI - API Framework
- Psycopg2 - PostgreSQL driver
- ANTLR4 Python runtime - COBOL/Fortran Parsing
- NetworkX - Network Graphing
- LangChain - Gemini Integration
- Python-dotenv - Environment Management
- React - Frontend
- Pytest - Unit testing
- f2py / numpy / scipy - Data Manipulation

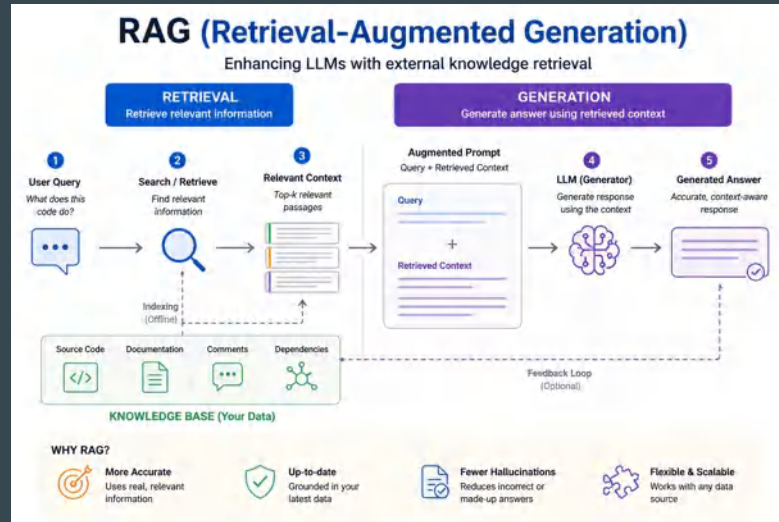
# RAG - What It Is

## Retrieval-Augmented Generation

- Combines data retrieval + AI generation
- Retrieves relevant code, documentation, and dependencies before AI processing
- Provides context to the model instead of relying on memory alone

# RAG - How It Works

- Legacy code and documentation are split into searchable chunks
- Relevant context is retrieved based on the current task
- Retrieved data is added to the prompt
- Gemini generates analysis or translated code utilizing that context



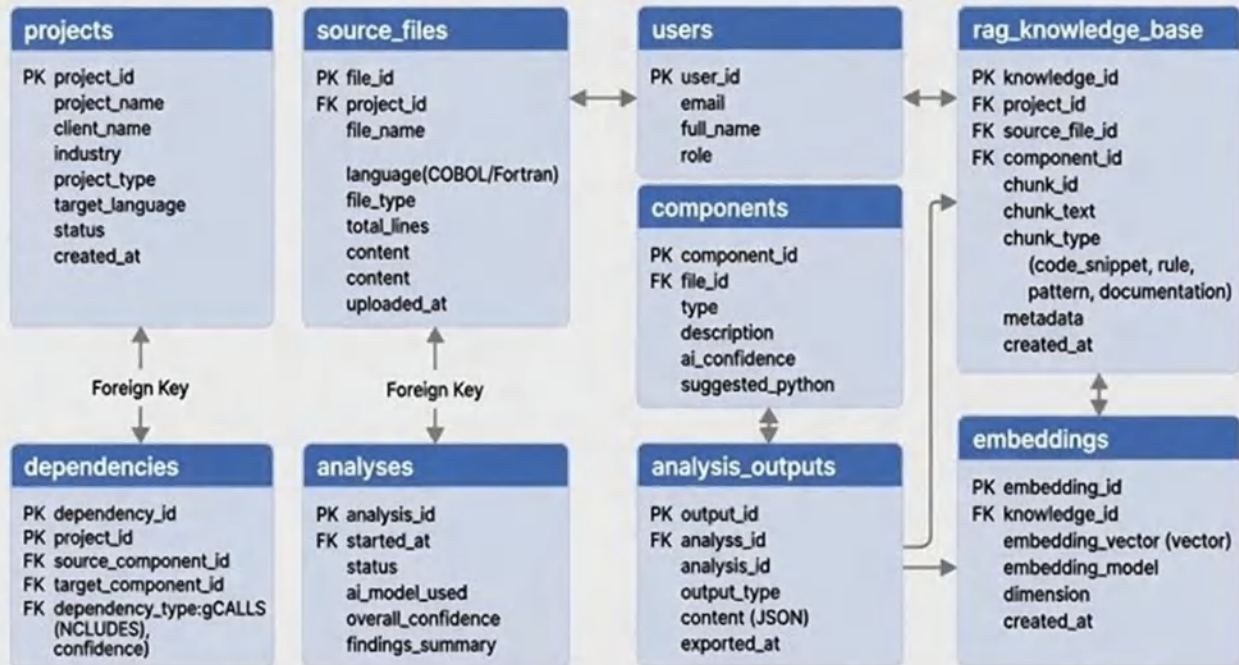
# RAG - Why It Matters for Legacy Lift

- Reduce AI errors
  - Prevents the model from guessing or making up logic
  - Uses real code and context
- Preserves Business Logic
  - Legacy systems contain critical rules spread across multiple files
  - RAG ensures the AI sees related code, dependencies, and comments
- Improves Consistency
  - The framework pulls from the same dataset every time as opposed to what is uploaded at each instance.
- Enables Safer Modernization
  - Reduces risk of breaking critical system behavior during conversion

# Database Schema

## LegacyLift ER Diagram - AI-Assisted Fortran & COBOL Analysis for Python Modernization (with RAG)

AI-Assisted Fortran & COBOL Analysis for Python Modernization with Retrieval Augmented Generation





# Project Monetization

## Discovery and Assessment

Initial evaluation costs range from \$2,000 to \$10,000, providing tailored project insights for clients.

## Framework Implementation

Implementation services are priced \$5,000 to \$20,000, reflecting increased complexity and customization.

## Full Migration

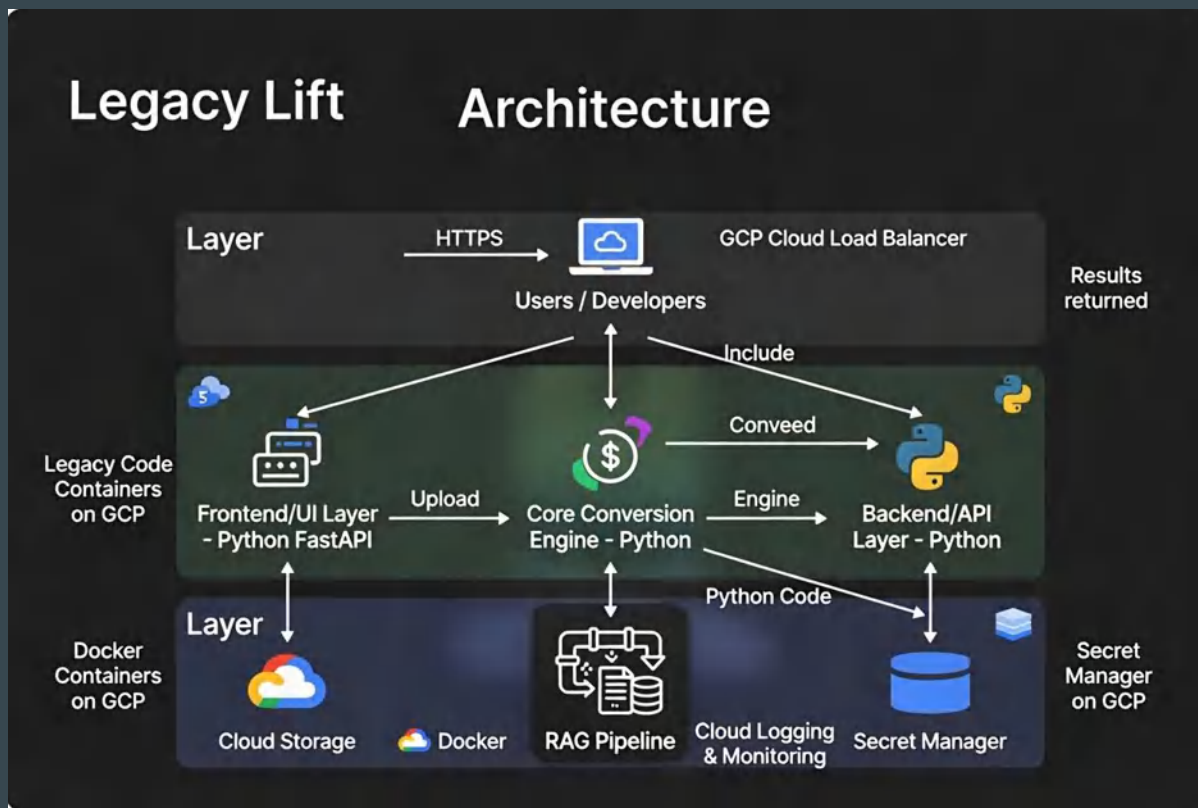
Comprehensive migration services cost \$20,000 to \$80,000, covering extensive technical work and support.

## Annual Maintenance

Ongoing maintenance is \$2,000 per year, ensuring continued performance and reliability for clients.



# Major Functional Components Diagram



# Driver

The image shows a VS Code editor window with a file explorer on the left and a code editor on the right. The file explorer shows a project structure for 'COBOL\_OOP\_MODERNIZATION' with files like 'run\_demo.py' and 'output\_refactored\_account.py'. The code editor displays the content of 'run\_demo.py', which is a Python script that uses the 'OORefactorer' class to refactor a COBOL file. The terminal at the bottom shows the output of running the script, including a confirmation message and the path to the generated Python code.

```
run_demo.py > ...
1 # run_demo.py - Quick test for the COBOL to OOP modernization mockup
2 from src.refactorer import OORefactorer
3
4 print("🚀 ML-Driven Legacy Code Modernization - Quick Demo\n")
5
6 refactorer = OORefactorer()
7
8 # Test on the main example
9 python_code = refactorer.refactor('data/simple_account.cbl')
10
11 print("=== GENERATED PYTHON OOP CODE ===\n")
12 print(python_code)
13
14 # Save with proper UTF-8 encoding
15 with open('output/output_refactored_account.py', 'w', encoding='utf-8') as f:
16     f.write(python_code)
17
18 print("\n✅ Successfully saved to: output/output_refactored_account.py")
19 print("You can now open this file in any editor (VS Code recommended).")
```

```
PROBLEMS OUTPUT TERMINAL PORTS QUERY RESULTS DEBUG CONSOLE
# Business logic preserved and modernized from original COBOL

✅ Successfully saved to: output/output_refactored_account.py
You can now open this file in any editor (VS Code recommended).
PS C:\Users\misap\OneDrive\Documents\ODU University\01Spring 2026\CS 522\Course Project\New-Files\cobol_oop_modernization> (C:\ProgramData\miniconda3\shell\condabin\conda-hook.ps1) ; (conda activate cs422)
(cs422) PS C:\Users\misap\OneDrive\Documents\ODU University\01Spring 2026\CS 522\Course Project\New-Files\cobol_oop_modernization>
```

main Indexing completed.

Spencer Peloquin (2 days ago) Ln 15, Col 44 Spaces: 4 UTF-8

# Implementation

```
src > cobol_parser.py > parse_cobol
1 import re
2 from typing import Dict, List
3
4 def parse_cobol(file_path: str) -> Dict:
5     with open(file_path, 'r', encoding='utf-8', errors='ignore') as f:
6         content = f.read().upper()
7
8         data = {
9             'program_id': re.search(r'PROGRAM-ID\.\s*(\w+)', content),
10            'data_items': re.findall(r'[0-9]\s+\w+.*PIC\s+(\w{1,4})+', content),
11            'paragraphs': re.findall(r'(\w+)-?\w*\.\s*(.*)?(=\w+)?\w*\.\|STOP RUN', content, re.DOTALL)
12        }
13
14        # Extract potential class fields from DATA DIVISION
15        fields = []
16        for item in data['data_items']:
17            match = re.search(r'(\w+)\s+\w+PIC\s+(.+)', item)
18            if match:
19                fields.append({'name': match.group(1), 'pic': match.group(2)})
20
21        # Paragraphs as potential methods
22        methods = [p[0] for p in data['paragraphs'] if p[0] not in ['MAIN-LOGIC', 'STOP']]
23
24        return {
25            'program_name': data['program_id'].group(1) if data['program_id'] else 'UNKNOWN',
26            'potential_attributes': fields,
27            'potential_methods': methods,
28            'raw_paragraphs': data['paragraphs']
29        }
```

PROBLEMS OUTPUT TERMINAL PORTS QUERY RESULTS DEBUG CONSOLE

```
# Business logic preserved and modernized from original COBOL
```

```
✓ Successfully saved to: output/output_refactored_account .py
```

```
You can now open this file in any editor (VS Code recommended).
```

```
PS C:\Users\misap\OneDrive\Documents\ODU University\01Spring 2026\CS 522\Course Project\New-Files\cobol_oop_modernization> (C:\ProgramData\miniconda3\shell\condabin\conda-hook.ps1) ; (conda activate cs422)
```

```
(cs422) PS C:\Users\misap\OneDrive\Documents\ODU University\01Spring 2026\CS 522\Course Project\New-Files\cobol_oop_modernization>
```

# Output

The image shows a Visual Studio Code editor window with the following components:

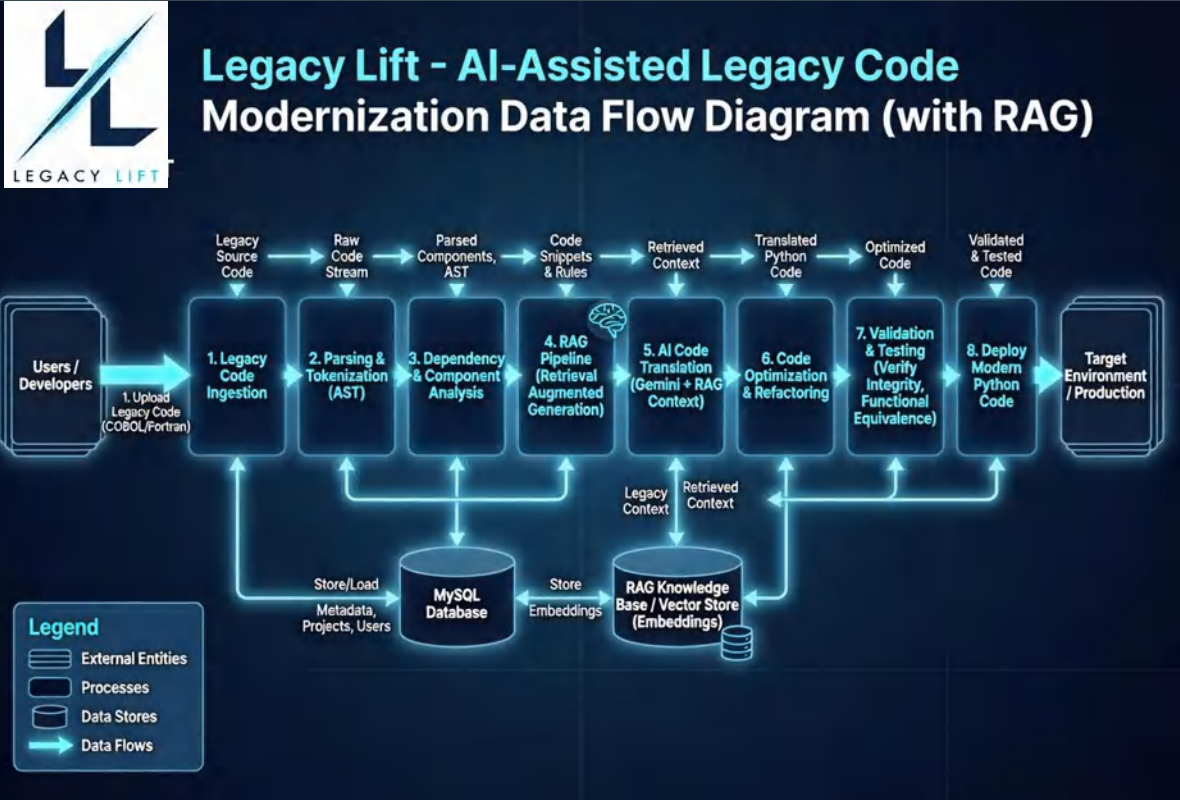
- Explorer:** Shows the project structure for 'COBOL\_OOP\_MODERNIZATION'. The file 'output\_refactored\_account.py' is selected in the 'output' folder.
- Code Editor:** Displays the Python code for 'output\_refactored\_account.py'. The code is as follows:

```
1 from decimal import Decimal
2 from typing import Any
3
4 class AccountClass:
5     """
6     Modern OOP version of COBOL program: ACCOUNT
7     Generated by ML-Driven Legacy Code Modernization framework
8     """
9
10    def __init__(self, account_number: int = 0, owner: str = ''):
11        """
12        # Data Division - Class Attributes
13        self.number: int = None # from PIC 9(18)
14        self.balance: Decimal = None # from PIC 99(18)V99
15        self.owner: str = None # from PIC X(58)
16        self.amount: Decimal = None # from PIC 99(8)V99
17        self.number = account_number
18        self.owner = owner
19        self.amount: Decimal = Decimal('0.00')
20        self.balance: Decimal = Decimal('0.00')
21
22        # == Business Logic Methods (Procedural Patterns Grouped via Clustering) ==
23
24    def division(self):
25        """
26        Implements clustered logic from COBOL paragraphs: DIVISION, PROGRAM, ACCOUNT
27        """
28        # From paragraph: DIVISION
29        # TODO: Translate remaining COBOL logic here
30        pass
31
32        # From paragraph: PROGRAM
```
- Terminal:** Shows a notification: "Successfully saved to: output/output\_refactored\_account .py" and a PowerShell prompt: "PS C:\Users\misap\OneDrive\Documents\ODU University\01Spring 2026\CS 522\Course Project\New-Files\cobol\_oop\_modernization>".

# Major Functional Components Diagram



# Data Flow Diagram



# Project GUI Mockup

**</> LegacyLift** AI-Assisted Fortran & COBOL Analysis for Python Modernization Consulting Mode Consultant

Dashboard **New Analysis** Projects Dependency Explorer Reports Consulting Mode

**Upload Vn**

Project Type  
Project Type  
Project wittren  
**Analyze with AI**

**COBOL / Fortran**

COBOL **29.80 m** Fortran **15.00 m**

**Live Analysis** 68%

**Summary**

Foler Cojeccct Mowry  
Scteran

Summary  
4.556 43.65b 6.41  
3% 20% 1%

**Coed Type** Strucing Results

Analyze	Mome	Wommary	Demmary	Fosut	Projyze	Negute
422P15	Component	63010	411,000	12,000	13,000	🟢
422915	Component	65010	43,000	12,000	14,000	🟢

Note: All AI-generated analysis requires human validation before deployment.



# Conclusion

Legacy Lift is a viable solution for small businesses seeking a stable, cost effective means for updating and modernizing their legacy code infrastructure.

Questions?



# References

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# Appendix User Stories - Small Business

As a small business owner, I want to make sure that this transition is seamless and the business can keep running even through the code conversion.

As a small business owner, I want to make sure the conversion happens silently without disruption of day to day operation.

As a small business owner, I want to make sure my employees are just as familiar with the new system as they were with the old system, and there is minimal onboarding.

As a small business owner, I want the implementation time to be as short as possible to avoid disrupting production.

As a small business owner, I want the finished product to be compatible with the same GUI elements as the original product.

As a small business owner, I want to be able to run the existing code during the implementation of the product so that production is not disrupted.

As a small business owner, I want to be able to cancel the implementation and roll back if I no longer want to work with it.

As a small business owner, I want the option for the conversion to be done on premises instead of in the cloud, as I may have hardware or data quirks that would make an upload infeasible.

As a small business, I want the new code to be implemented on day one of completion, as any downtime is costly.

As a customer of this business, I want assurance that my data will be kept secure and not be corrupted.



# Appendix User Stories - Production Engineer

As a production engineer, I want the Legacy Lift Python code to have identical functionality to the original COBOL code in system tests.

As a production engineer, I want the legacy Lift to log any changes made during translation process.

As a production engineer, I want the finished product to be able to run on modern hardware.

As a cybersecurity admin, I want the finished product to have no new zero day vulnerabilities.

As a cybersecurity admin, I want the finished product to fix all security flaws known and unpatched in the original product.

As a production engineer, I want the finished product to use fewer resources than the original product.

As a production engineer, I want the finished product to have as few redundancies in production as possible to improve performance.

As a production engineer, I want the framework to have enough tokens purchased so that it does not stall mid-conversion.

As a production engineer, I want there to be an API to embed existing frameworks into LegacyLift.



# Appendix User Stories - Enterprise

As a banking firm, I want to make sure that I do not need to rip out and reinstall all of my ATMs just to accommodate the new system.

As an enterprise, I want to make sure that there is some sort of fallback option in case the conversion fails catastrophically.

As a potential enterprise client, I want to make sure that the framework is completely scalable, from a sole accountant's work to a local or regional bank.

As an enterprise, I want the finished product to be compatible with the existing enterprise toolchain so all plugins are compatible.

As an enterprise, I want the finished product to be fully compatible with the existing SQL workflows.

As an enterprise, I want the finished product to integrate with the company's website and backend to avoid a larger conversion.

As an enterprise, I want the conversion to occur in a sandbox to avoid disrupting existing systems.

As an enterprise, I want the AI code to be sanitized to avoid corruption or copyright violations.

As an enterprise, I want existing filesystem hooks to be preserved in order to maintain compatibility.

As an enterprise, I do not want the finished product to sanitize the existing codebase just to make it look prettier, as poorly written code enables functionality that could break if altered.

As an enterprise, I want all of the data sanitized so that no PII is leaked.