Notexio — CSE323 (Operating Systems Design) Project Report

Project name: Notexio Text Editor
Course: CSE323 — Operating Systems Design
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GitHub repository: https://github.com/nafisatabassum30/Notexio
GitHub Pages project page: https://nafisatabassum30.github.io/Notexio/
Demo video (2–5 min): https://youtu.be/5XnIDQdSf2A

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1) Executive Summary

Notexio is a lightweight, customizable text editor built with **Python + Tkinter** to demonstrate operating-system concepts through a practical GUI application. The project focuses on **file I/O**, **state consistency (unsaved changes)**, **crash recovery via recovery files**, **cross-platform behavior (Windows/Linux input + printing)**, and **safe user experience patterns** (warnings, recent files, settings persistence).

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2) Project Overview

2.1 Goals

bullet Build a usable text editor with core "Notepad-like" operations.

bullet Apply OS concepts in a real program: file handling, recovery, background work, resource management, and cross-platform compatibility.

bullet Provide a clean and modern UX: toolbar, status bar, themes, shortcuts.

2.2 Key Features Implemented (from the codebase)

- **File I/O:** New/Open/Save/Save As, recent files list, unsaved-changes warning.

- **Editing:** Undo/Redo, find/replace, go-to-line, clipboard operations.

- **View/UX:** Zoom, fullscreen, optional line numbers, status bar showing cursor position and counts.

- **Safety:** Recovery files + cleanup, optional auto-save loop.

- **Themes:** Light/dark mode and customizable colors.

- **Export:** Export document as **PDF** using ReportLab.

- **Platform support:** Windows drag-and-drop (optional `tkinterdnd2`), OS-specific printing (`win32print` on Windows, `lp/lpr` on Linux/macOS).

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3) Architecture & Module Responsibilities

Notexio is organized as a modular Tkinter application where UI events call into feature managers:

- `main.py`: App composition and menu/shortcut wiring.

- `src/editor.py`: Main text widget, modified-state tracking, and core UI container.

- `src/file_manager.py`: File open/save logic + recent files persistence.

- `src/safety_features.py`: Recovery file creation/cleanup + background auto-save loop.

- `src/theme_manager.py`: Theme application across widgets.

- `src/ui_components.py`: Toolbar, status bar, line numbers UI.

- `src/edit_operations.py`: Find/replace/go-to-line and clipboard operations.

- `src/misc_features.py`: Print / print preview / export as PDF / drag & drop.

- `src/settings_manager.py`: JSON config read/write (`config/settings.json`).

Design choice: This separation makes each feature set isolated and testable, and mirrors OS design thinking (clear responsibilities, controlled interaction points).

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4) Operating Systems Concepts Demonstrated

4.1 File I/O, Encoding, and Error Handling

Notexio reads and writes files using explicit encoding (`utf-8`). This touches OS-level concerns:

- **File descriptors / handles:** OS resources that must be opened/closed correctly (Python context managers handle this reliably).
- **Encoding correctness:** Prevents corrupted text and ensures consistent storage across machines.
- **Failure modes:** Permission errors, missing files, locked files — surfaced to the user as dialogs.

4.2 Concurrency and UI Thread Safety (Auto-save / Recovery)

Tkinter requires UI updates to happen on the **main thread**. Notexio's auto-save runs in a **background thread** (daemon), which periodically writes recovery files.

Theory: GUI toolkits generally are not thread-safe because widget state is shared; touching it from multiple threads can cause race conditions or crashes. A safe design is:

- Background thread does **file I/O only** and avoids mutating widgets directly.
- UI changes should be scheduled using the event loop (e.g., `root.after(...)`) if needed.

4.3 Crash Recovery and Data Durability

Recovery files are a simplified durability mechanism:

- Regular snapshots of unsaved content are stored in `recovery/`.
- On startup, the app scans for `.recovery` files and offers restore.
- Old recovery files are cleaned up to avoid disk growth.

Theory: This imitates OS/file-system reliability ideas (periodic checkpoints; reducing loss after abnormal termination).

4.4 Cross-platform Differences (Input + Printing)

- Mouse wheel events differ across OSs (`event.delta` vs `Button-4/5`).

- Printing pipelines differ: Windows typically uses Win32 APIs; Linux/macOS uses `lp/lpr`.

This is an OS-design reality: identical user features often require platform-specific implementations.

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5) Challenges & Fixes (STAR Format)

The course requirement asks for challenges described using **STAR**:

- **Situation** (context)
- **Task** (what needed to be done)
- **Action** (what I did)
- **Result** (outcome)

Challenge 1 — Recent Files menu opened the wrong file (late-binding lambda bug)

- **Situation:** I added an "Open Recent" submenu. Clicking a recent file sometimes opened the *last* file in the list, not the one clicked.
- **Task:** Fix the menu so every item opens its correct path.
- **Action:** I fixed the classic Python late-binding closure issue by capturing the current filepath in the lambda default argument:

  - `command=lambda fp=filepath: open_file(fp)` instead of `command=lambda: open_file(filepath)`
- **Result:** Each menu entry consistently opens the correct file, improving usability and correctness.

Theory (why it happens): In Python, closures capture variables by reference. When the callback runs, `filepath` has already changed to the last loop value unless you bind it at definition time.

Challenge 2 — PDF export crashed on special characters like `&` or `<`

- **Situation:** Exporting to PDF failed on some documents; ReportLab raised parsing errors when the text had special characters.
- **Task:** Make "Export as PDF" robust for real text content.

- **Action:** I escaped reserved XML/HTML characters before feeding text into `reportlab.platypus.Paragraph`:

  - `&` → `&`, `<` → `<`, `>` → `>`

- **Result:** PDF export became stable for normal programming text and notes that include symbols.

Theory: ReportLab's `Paragraph` expects XML-like markup; unescaped characters can break parsing.

Challenge 3 — Auto-save could freeze or behave unpredictably (UI thread-safety)

- **Situation:** I added auto-save / recovery to protect user work. Early versions risked touching UI state from a background thread.
- **Task:** Keep auto-save reliable without breaking Tkinter's single-thread UI rules.
- **Action:** I designed auto-save as a background loop that performs **file writes only**, keeping UI rendering and widget updates inside the main event loop.
- **Result:** Auto-save runs without UI freezes, and recovery snapshots are produced in the background.

Theory: Tkinter widgets are not thread-safe; UI changes must happen on the main thread to avoid race conditions and crashes.

Challenge 4 — Mouse wheel scrolling didn't work consistently across Windows/Linux

- **Situation:** Scrolling worked on Windows but failed on Linux (or scrolled in the wrong direction).
- **Task:** Support scrolling across platforms with consistent behavior.
- **Action:** I implemented dual handling:

  - Windows/macOS: `event.delta` - Linux: `Button-4` and `Button-5`

- **Result:** Scrolling works across platforms and improves the "feels like Notepad" UX.

Challenge 5 — Recovery files could grow unbounded and waste disk space

- **Situation:** Recovery snapshots are valuable, but frequent snapshots can flood disk storage over time.
- **Task:** Keep recovery useful while avoiding uncontrolled disk growth.
- **Action:** I implemented cleanup logic to keep only the newest N recovery files (default 10), deleting older ones based on modification time.

- **Result:** Recovery stays effective without filling storage, matching responsible OS resource management.

Theory: Storage is a finite OS resource. Good applications apply retention policies and clean up old artifacts.

Challenge 6 — Modified/unsaved state management (false positives and UX correctness)

- **Situation:** In text editors, "unsaved changes" must be accurate; false warnings annoy users, and missing warnings can cause data loss.
- **Task:** Track modified state correctly and integrate it with window title and exit prompts.
- **Action:** I used Tkinter's `<<Modified>>` virtual event and maintained an `is_modified` flag to:

  - add `*` to the title when content changes - prompt on exit or before opening a new file
- **Result:** Users get correct warnings and visual indicators, reducing accidental data loss.

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6) Testing & Validation (What I Verified)

- Open/Save/Save As for `.txt` and arbitrary extensions.
- Recent files list updates and opens correct file.
- Unsaved-changes prompt appears when expected.
- Recovery files are created and older ones are cleaned up.
- Theme toggles apply to major UI components.
- Export as PDF works for normal text and text containing `<`, `>`, `&`.
- Mouse wheel works on Windows/Linux event models.

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7) Limitations & Future Work

- Add atomic-save strategy (write to temp + rename) to avoid partial writes if the app crashes mid-save.
- Add unit tests for file operations and settings persistence.
- Improve print preview to render like a real page layout.
- Package for distribution (PyInstaller) with icon + assets bundled.

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8) Submission Checklist (What included on GitHub)

- `docs/index.md` (GitHub Pages landing page)
- `docs/Notexio_CSE323_Report.pdf` (the report PDF)
- `docs/report.md` (same report in Markdown for quick reading)
- A demo video link (YouTube/Drive) embedded/linked on `docs/index.md`

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9) References

- Tkinter documentation (event loop and `<<Modified>>` usage)
- ReportLab documentation (`SimpleDocTemplate`, `Paragraph`)
- OS printing concepts (`lp/lpr`, Win32 print pipeline)