COMP 8505
Assignment 1

Design

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Jan 26th, 2026

What it does

Goal

Accept command line input that specifies the PNG image, a file to hide or extract and an encryption key. The program will then securely encrypt the data and embeds it into a PNG image using the Least Significant Bit (LSB) steganography or reverses the process to recover the original file.

Success condition (observable outcome)

The message is printed to standard output the correct number of times, and the program exits normally without displaying an error message.

- In encode mode: a visually indistinguishable PNG image that has the encrypted data embedded.
- In decode mode: the original hidden file is successfully recovered and matches the original byte to byte.

Invariant (one checkable rule)

The program never embeds, extracts, or decrypts data unless all inputs are valid and the carrier image has sufficient capacity.

How I will test it

Valid Encoding

The program is invoked with a valid PNG image, an input file that will be embedded and a valid encryption key.

Steps:

1. Run the program in encode mode with a PNG image, a data file and a key
2. Observe output stego image.
3. Compare the stego image visually with the original.

Expected result:

- A new PNG image is produced that appears visually identical to the original.

What it proves:

- Valid inputs transition the system from argument handling to encryption and embedding and then to clean termination.

Valid Decoding

The program is invoked with a stego PNG image and a correct encryption key.

Steps:

1. Run the program in decode mode with a stego PNG image and a key
2. Observe output file creation.
3. Compare the recovered file with the original.

Expected result:

- The decoded file matches the original.

What it proves:

- Correct extraction and decryption restore the original data without corruption.

Invalid Image File

The program is invoked with a non-PNG or unreadable image file.

Steps:

1. Run the program in encode mode with an invalid image file.
2. Observe standard error output.

Expected result:

- A clear error message is displayed and not processing occurs.

Insufficient Image Capacity

The program is invoked with a message file that exceeds the image's embedding capacity.

Steps:

1. Attempt to encode a large file into a small PNG.
2. Observe standard error output.

Expected result:

- An error message is displayed and no output image is created.

Help Option

The program is invoked with a help option.

Steps:

1. Run the program with the help flag.

2. Observe standard output.
3. Observe program termination.

Expected result:

- Usage information is displayed, and the program exits without attempting to process or display messages.

What it proves:

- Explicit user requests for help bypass normal execution and terminate cleanly.

FSM

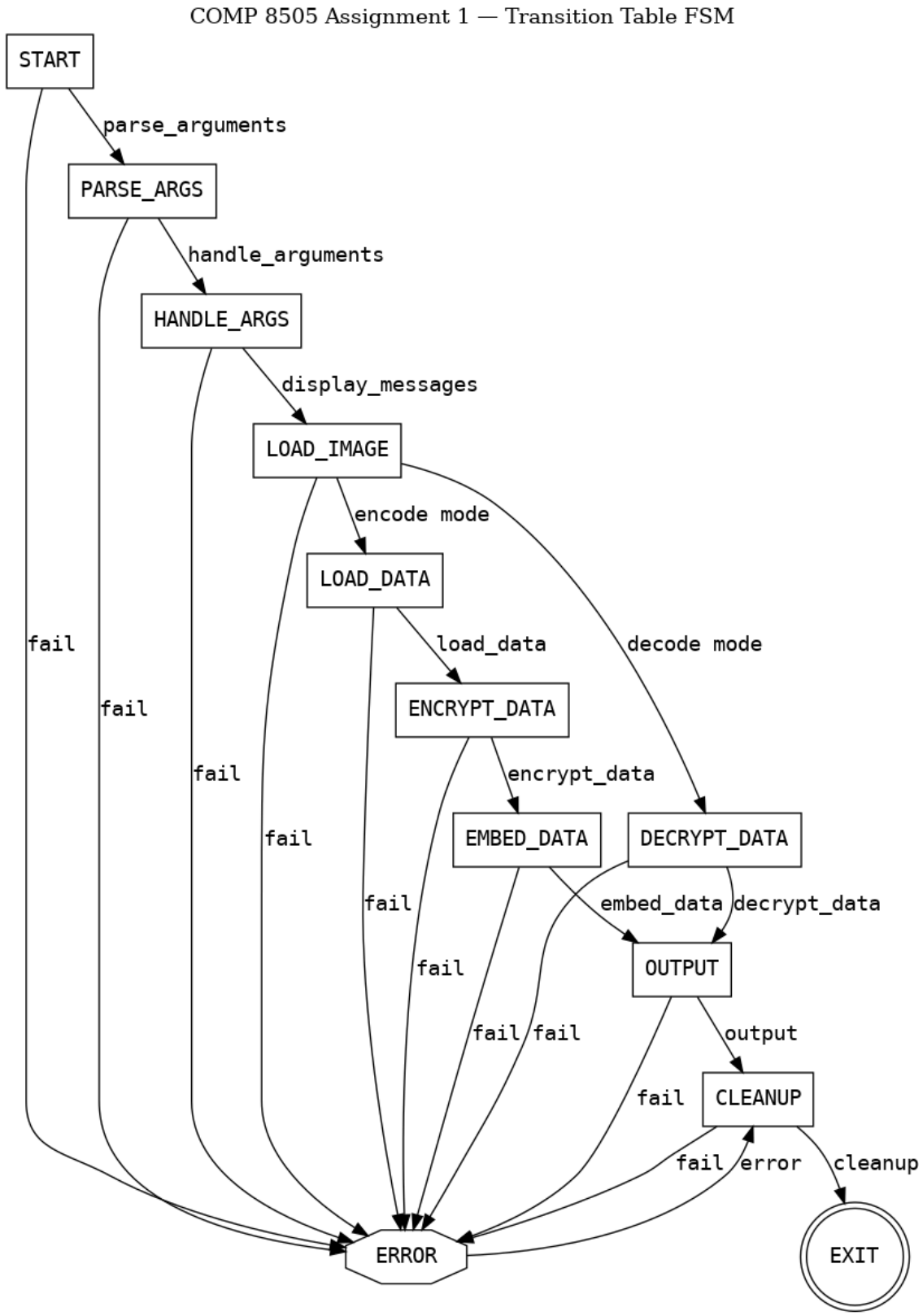
State meanings

State	Meaning
`START`	The program has begun execution, but no work has been performed
`PARSE_ARGS`	Raw input arguments are being read and identified
`HANDLE_ARGS`	Parsed arguments are being validated and converted
`LOAD_IMAGE`	PNG image is loaded and inspected
`ENCRYPT_DATA`	Input data is encrypted
`EMBED_DATA`	Encrypted data is embedded using LSB
`EXTRACT_DATA`	Hidden data is extracted from the stego image
`DECRPYT_DATA`	Extracted data is decrypted
`OUTPUT`	Output file or image is written
`ERROR`	Error is detected and reported
`CLEANUP`	Resources are released, and exit conditions are finalized
`EXIT`	The program has terminated

Transition table

State	Call (function)	Fail state	Success state
START		ERROR	PARSE_ARGS
PARSE_ARGS	parse_arguments	ERROR	HANDLE_ARGS
HANDLE_ARGS	handle_arguments	ERROR	LOAD_IMAGE
LOAD_IMAGE	load_image	ERROR	ENCRYPT_DATA
LOAD_IMAGE	load_image	ERROR	EXTRACT_DATA
ENCRYPT_DATA	encrypt_data	ERROR	EMBED_DATA
EMBED_DATA	embed_data	ERROR	OUTPUT
EXTRACT_DATA	extract_data	ERROR	DECRYPT_DATA
DECRYPT_DATA	decrypt_data	ERROR	OUTPUT
OUTPUT	output	ERROR	CLEANUP
ERROR	error	CLEANUP	CLEANUP
CLEANUP	cleanup	ERROR	EXIT

FSM diagram


COMP 8505 Assignment 1 — Transition Table FSM
START
parse_arguments
PARSE_ARGS
handle_arguments
HANDLE_ARGS
display_messages
LOAD_IMAGE
encode mode
LOAD_DATA
load_data
ENCRYPT_DATA
encrypt_data
EMBED_DATA
DECRYPT_DATA
embed_data
decrypt_data
OUTPUT
output
CLEANUP
cleanup
EXIT
ERROR
decode mode
fail

Functions

Name	Inputs	Outputs	Responsibility
`parse_arguments`	Raw command-line input	Parsed argument data	Identify mode, files and key
`handle_arguments`	Parsed argument data	Validated settings or error	Ensure inputs are valid and usable
`load_image`	PNG file path	Image buffer	Load and verify the PNG image
`encrypt_data`	Input file, key	ciphertext	Encrypt the hidden data
`embed_data`	Image, ciphertext	Stego image	Embed the data using lsb
`extract_data`	Stego image	ciphertext	Recover hidden bits from stego image
`decrypt_data`	ciphertext	Original data	Restore original image
`output`	Data or image	File output	Write output data to file
`error`	Error context	Console output	Report failure reason
`cleanup`	Program context	Exit status	Ensure orderly termination