

Project 5A: BYOW Design

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Data

What data will you be using? What does the data consist of and how will you parse it for your program? How will your program use the data?

World Data:

Grid via TETile[][] world storing distinct tile types for every x,y coordinate in the map

Tile Types: Floor, Wall, Nothing (outside map), Avatar, Rock, Ladder

Tile data used to render world via TERenderer

Random Seeds:

Input via N<digits>S (parsed by reading between N,S chars)

Seed initializes a Random object ensuring random but deterministic world generation

World Generation Data:

Rooms: position, width, height

Hallways: path segments (randomized)

Derived via RNG

Hallways and Rooms generated based on design limitations and pseudorandom requirements

Rock tiles defined via random subset of floor tiles

Single Rock tile contains Ladder, available after breaking rock

Player location on top of Ladder triggers new world generation (new floor discovered) or transition to previously explored lower level

Game State Data:

Player position (x,y coord)

Saved command Str

Load file content

HUD with description detail via tile-under-mouse

Depth level (how many ladders taken)

Saving/Loading Data:

Saved format: <all commands typed minus :Q>

Eg: N1237857Swasswwaddasdwassdadwwwsasd

- Include snapshots of all level states

L restores game state from prior save via level state snapshots

R replays player movements in 2x speed up to final state, allowing player to take over after

Data Structures

What data structures will you be using? How will your data structures use the data? How will your program use the data structures?

Variable	Data Structure	Purpose	Implementation
world	TETile[][]	Map representation	New TETile filled with nothing then split into tiles
rooms	List<Room>	Stores all rooms	ArrayList<Room>
hallways	List<List<Point>>	Stores all hallways segments	ArrayList<List<Point>>
floorTiles	Set<Point>	Stores all valid floor positions	HashSet
rockPositions	Set<Point>	Lookup for coords containing rocks	HashSet<Point>
ladderPos	Point	Coordinate location of ladder	Rand selection from rockPositions
rng	Random	Pseudorandom num generator	Random(seed) from parsed user input
player	Player obj	Player position and state	Class
commandHistory	StringBuilder	Records all (meaningful) player inputs	Updated in real time by keyboard
gameState	GameState Enum	Menu, seedInput, World, Saving	Appends keys as processed
levelNum	int	Depth of world (dungeon level)	Starts at 0, increments based on ladder
levelSeed	long	Seed for current level RNG	Initial levelSeed parsed from input, deeper levels derived from initial seed + levelNum
mousePos	Point	Track mouse tile for HUD	Read from StdDraw.mouseX/Y cast into int

visitedRooms	Set<Room>	Validate rooms can be reached during connection validation	HashSet<Room>
nextWorldParams	Config obj	Store params to generate next level deterministically	Class containing levelNum, levelSeed
levelState	Map<Integer, LevelState> levels	Stores necessary information per visited level to allow state persistence during level transitions	Class

Algorithms

What algorithms will you be using? How will your algorithms use the data structures and data? How will your program use the algorithms?

World Generation

input : levelSeed output: world map

Initialize world with NOTHING

Generate rooms:

- Sample rand width/height within bounds
- Choose random up/left corner
- Reject rooms that overlap or clip outside bounds
- Add valid rooms to list

Generate hallways:

- Connect rooms (spanning tree or random linking with validation)
- Pick random points along room perimeter, define and start and target
 - Add randomization bias - 70/30 towards target/lateral to target
 - Stop at distance 0 to target, create limit to ensure no wandering hallways/infinite loops, reset if hit
- Validate creation - no dead ends, no floors clipping map edge

Fill Walls:

- Surround outer edges with wall tiles

Place Rocks:

- Choose random subset of floorTiles
- Replace with ROCK tiles
- Add coords to rockPositions

Hide Ladder:

- Select single Point from rockPositions at random
- Store as ladderPos
- Initially tile remains as Rock

Place Elevator:

- Placed on Floor tile, no overlap allowed with walls, hallway turns, rocks, or ladder
- Must be reachable from player spawn
- Avoid placement that causes player clipping on exit

Place player:

- Choose random floor tile not occupied with rock
- Place avatar tile, update player x,y coords

Correctness validation:

- Ensure meet map specifications for fullness, dead ends (BFS), etc - regenerate on failure

Main Menu

States:

- Menu -> Seed input -> Playing
- Menu -> load -> playing
- Playing -> saving (when : called) -> quit

Input sequence:

- N1111111S starts game
- L loads save
- :Q saves and exits

Interactivity

Movement:

WASD:

- Compute target
 - If floor, move
 - If rock, block move
 - If ladder, move and trigger level transition
 - If Wall or nothing, block move

Rock Breaking:

Trigger with 'B'

- Determine tile in front of avatar
- If rock:
 - Replace with floor
 - Remove from rockPositions
 - (nx, ny) == ladderPos, reveal ladder

Ladder Descend:

When stepping onto ladder tile:

- Increment levelNum
- Compute new levelSeed
- Generate new world
- Place avatar

HUD

Each frame:

- Read mouse tile position
- If in bounds - display world[x][y] description
- Display current depth
- HUD updates every frame based on mouse position regardless of key presses

Saving & Loading

Saving:

- **In-Game:**
- Detect : and then Q or q
- Write commandHistory.toString() to file
- Exit program
- **Main Menu:**
- Detect Q or q - quit without saving

Loading: L (only from Main Menu - ignored in game)

- Read saved command string
- Replay characters
- World generates deterministically
- Player position and broken rock states restored through replay

Ambition Features

Primary: Level Progression:

Each level includes single Ladder tile that is hidden inside one of the rock tiles. Upon breaking rock, floor tile is replaced with ladder. Player placement on top of ladder triggers progression to new level. If player has already visited lower level, player is transferred to level with existing state. If newly discovered level, level is random generated and player is played

Each level includes a single Elevator that allows player to travel to any prior levels explored (up or down)

- Basic menu displayed with level selection upon Elevator activation with selection of previously visited levels- upon selection transition to selected level
- Upon selection, avatar is output in front of elevator tile on level - elevator placement logic ensures safe location placement

Secondary: Replay:

- Standard load via L immediately restores last game state based on:
 - Players final position
 - Current level number
 - Layout of every level previously visited
 - State of all rocks,ladder reveals, elevator discovery
 - RNG state at time of save
- Replay load via R performs a visual replay at 2x speed of all player interactions from beginning of run up to save point:
 - Replays via commandHistory
 - HUD updates allowed, but player actions may be passed
 - At end of Replay, control returned to player
 - World and RNG state at end of replay identical to Standard Load

Level State Persistence (for Level Progression and Replay functionality):

- Each level retains persistent state:
 - Rock breakages
 - Ladder visibility
 - Elevator state
 - World tiles
- When using elevator:
 - Current level state saved
 - Target level loaded from snapshot
 - Regeneration does not occur, levels are static once visited

Complexity

What is the input? How does the time and space complexity change with the input? What are the bounds?

World Generation:

- Room generation:
 - Attempt R rand rooms
 - Check overlap (worst case $O(R^2)$)

- R is typically small, so still negligible
- Hallway generation:
 - Connecting R rooms with rand hallways:
 - $O(R)$ if randomized connectivity pattern
 - $O(R \log R)$ if using spanning tree
- Wall Generation:
 - Surrounding all floor tiles with walls requiring scanning map once $O(W \times H)$
- Rock placement:
 - Selecting rock tiles requires iteration over floor tiles $O(W \times H)$
 - Maintaining rock sets is $O(1)$ per tile
- Ladder placement:
 - Random rock picked $O(1)$

Total generation:

Time: $O(R^2 + W \times H)$

Space: $O(W \times H)$ $O(R)$ for rooms $O(k)$ for rocks

Gameplay Runtime:

- Movement:
 - Each action $O(1)$
- Rock breaking:
 - Check tile in front and update $O(1)$
 - If contains ladder, update to ladder $O(1)$
- HUD:
 - Reading mouse pos and tile lookup $O(1)$ per frame
- Descending Ladder:
 - Triggers full world gen - same world gen cost above

Saving/Loading:

- Saving:
 - Writing command history to string len K $O(k)$
- Loading:
 - Reading saved string $O(k)$
 - Replaying k commands $O(k)$
 - Each command processed in $O(1)$
 - Total $O(k)$

Overall:

- Time per level:
 - $O(R^2 + W \times H)$ for world generation
 - + $O(k)$ for replaying
- Space per level:
 - $O(W \times H)$ for tiles
 - $O(R)$ for rooms
 - $O(k)$ for rocks
 - Total $O(W \times H)$

Overall relatively manageable since fixed W and H constraints that are reasonably small

Question

What questions have come up while brainstorming your design? Consider asking them in assignment section or office hours!

Open Questions

Rock density: How to ensure reasonable sparsity of rock placement, maybe block creation inside hallways?

Rock breaking cost: What impact does this have on player, if any?

Level progression: does incrementing levels have any impact on gameplay?

- Want to implement a progression system - some gameplay loop to create incremented difficulty and ability to increase player power to combat incremented difficulty

Seed Generation: $\text{baseSeed} + \text{levelNum}$ or RNG

Combat/progression: How to provide more meaningful gameplay to incentivize player progression

Closed Questions

Save/Load behavior: - parse only in game commands - ignore Quit

Seed parsing: defined as $N < \text{digits} > S$

Rock blocking: Until rock is destroyed, acts similar to Wall

Ladder placement: Randomized selection of single tile within Rocks

Ladder descent: Generates new pseudorandom world based on current world and player inputs
- allows deterministic reproduction upon save and load

State: Define LevelStates that persist state over level traversal to ensure state is not wiped upon level transition

Diagram

Draw a diagram summarizing your design. The diagram should capture the most important points about your design.

