

Rogueima: the plan

A step-by-step ordering from Rogueima I MVP-4 toward something with NetWhack's shape. Each step is meant to be finishable on its own, and to leave the game playable when it lands.

For the reasoning behind the grouping, see the roadmap in `programs/rogueima/ROADMAP.md`. This page is the working list.

Part I — movement and the turn

Step 1. Collapse movement into one routine — DONE

`move_left`, `move_down`, `move_up` and `move_right` are four near-identical routines, each with its own edge check, its own `is_walkable` call and its own store. Replace them with a single

```
try_move ; CL = dx, DL = dy
```

that computes the destination, bounds-checks it, asks `is_walkable` and commits. The four existing directions become four callers.

Nothing changes on screen. This is the step that makes the next one free, and it removes three copies of a bug surface.

Step 2. Eight-way movement — DONE

Add Y U B N for the diagonals, so the vi keys form the usual 3×3. With `try_move` in place each is two instructions and a call. Keep the arrow keys (\$80-\$83) mapped to the orthogonals, and consider the numpad digits as NetWhack uses them.

Four-way movement is the most noticeable difference between Rogueima and any other roguelike. This is an afternoon.

The three direction readers

Walking was not the only thing that asked for a direction. `open_door` and `do_talk` each had their own copy of the key list, so after Step 2 you could *walk* diagonally but not *open* or *talk* diagonally — the same bug in two more places, which is exactly what Step 1 was meant to prevent.

The fix is the Step 1 move again, one level up. Four routines now do the work for all three prompts:

```
get_dir_key ; read a key, fold it to upper case
decode_dir  ; AL -> CL = dx, DL = dy, ELM -> the name, carry = valid
dir_target  ; player + CL/DL -> X, Y, carry = on the map
print_dir   ; " OPEN " + "NORTHEAST" + newline, preserving C and D
```

decode_dir is now the only place in the game that knows what a movement key is. Adding a fifth prompt that wants a direction — fire, throw, kick — costs two calls.

Two details worth keeping in mind:

- ELM and FLD are *paired* registers (EL:M, FL:D), so

FLD cannot hold a pointer while D holds a delta. print_dir

```
takes its prefix in 'GLK' and consumes it before any call.
* 'dir_target' bounds-checks, which 'open_door' and 'do_talk' never
  did. Reading a glyph one step off the edge of the map used to read
  whatever followed the map data.
```

“ OPEN DOOR ” plus “NORTHEAST” is 21 characters and the message window is 19 wide, so the prefix lost the word the prompt above it already supplies.

Step 3. A real turn loop — DONE

Today the player moves and the world does not answer. Establish the order: the player acts, every monster acts, the clock advances. The T: counter in the status panel already exists — make a successful action advance it, and give move_mon its turn immediately after.

Everything from here assumes monsters get a turn when you take one.

The turn contract

move_mon was being called from inside draw_map, so monsters moved once per *redraw*, before the player's key had even been read. It is a call in the loop now, and the loop is the whole of the ordering:

```
main_loop:
    CALL @draw_map
    CALL @get_input      ; the player acts
    JNC @main_loop       ; ...or did not: redraw and ask again
    CALL @move_mon       ; now the world answers
    CALL @inc_game_time  ; and the clock moves
    JMP @main_loop
```

Every command routine answers the same question in the carry flag:

```
^ carry ^ meaning ^
| set   | the player spent a turn |
| clear | nothing happened |
```

get_input tail-jumps to those routines, so their carry *is* its carry and no dispatch code has to know which commands cost time. Walking into a wall, naming a direction with no door in it, and pressing an unknown key are all free — the world does not get to answer a non-move. M and G conjure things out of nothing, so they are free too; they are debug commands.

Three things this uncovered

Giving monsters a real turn meant there had to *be* monsters, and there never had been:

- `init_objects` said “Write `id = 0` for this record” but the

instruction was `STB [ELM + I]`, and `B` was never zeroed. Every slot

was born with a non-zero ID – that is, “in use” – so the `''SCANQUE''` in `''spawn_monster''` and `''create_gold''` never found a free one. `***''M''` and `''G''` had been failing silently.** Whether this bit depended on what the title screen happened to leave in `''B''`.

* `''MOD B, KL''` mixes a 16-bit destination with an 8-bit source. `''MOD''` takes its width from the destination, so this read `''REGS[30]''` – past the end of the 16-bit register file – and `''B''` came back unreduced. Monsters and gold were being placed at coordinates like (56242, 15977), off the map and out of reach. Both spawners widen the dimensions into `''I''` and `''J''` first now.

* `''move_mon''` still had a `''SED''/''CLD''` pair bracketing its commit – leftover CPU-trace instrumentation, harmless only for as long as no monster ever moved.

Machine note

The assembler rejects mismatched widths for `MOV` but accepts them for arithmetic, and the CPU then indexes the register file with the raw encoding. `MOD B, KL` is not a typo the tools will catch. Worth a width check on the arithmetic path.

Step 4. Wait — DONE

`Numpad 5` and `.` both reach `move_wait`, which is now the one move that is nothing but time: it returns carry set without touching `PX/PY`, so the monsters get their turn and the clock advances. That makes it the way to watch monster behaviour without moving, which is what makes the next several steps testable.

Part II — depth

Step 5. Turn the map into a structure — DONE

`map1_data` is literal text — 40 lines of `.bytes “####...”`. That is fine for one static level and blocks everything else. Introduce a tile array with one byte of glyph and one byte of flags per cell, and a loader that expands the text into it when a level is entered.

Keep the text as the *source* format. It is readable, it diffs well, and hand-authored levels stay easy to write.

This is the pivotal step. Stairs, generated levels and line of sight all need per-tile storage, and doing any of them first means doing them twice.

What landed

Two bytes per square, row by row, at \$030000 in bank 3 – 6,400 bytes for 80×40:

```
tile(x, y) = TILE_BASE + (y * width + x) * 2
```

flag	value	meaning
TF_WALKABLE	\$01	you can stand here
TF_OPAQUE	\$02	you cannot see through it
TF_SEEN	\$04	reserved for Step 10
TF_VISIBLE	\$08	reserved for Step 10

SEEN and VISIBLE are defined now and set on every square, so the renderer behaves exactly as it did. Installing the machinery separately from switching it on is what keeps Step 10 small.

load_level expands the text into the structure on entry; tile_flags_for is the single place that decides what a glyph means, so the loader and put_glyph cannot disagree – which they would, the first time a door opened. is_walkable is a flag test now instead of a chain of glyph comparisons, and no longer walks the object list to get there.

The test for this step is that **nothing changes on screen**: the rendered display is byte-identical before and after, with the camera scrolled.

The assembler bug underneath it

AND AL, @TF_WALKABLE is the first 8-bit immediate in the tree naming a label defined in a *later* file, and forward-reference patching got that wrong: it wrote the low byte, then wrote a second byte unconditionally, zeroing the next instruction's opcode. Here that opcode was a JZ, so is_walkable fell through its own branch and nothing on the map could be stepped on – from an image that assembled with no errors and no warnings.

Worth remembering as a shape: a program that assembles cleanly and behaves absurdly is worth a look at the emitted bytes, and then at the trace.

Step 6. A level table — DONE

map1_id, map1_name, map1_up, map1_down and map1_dim already exist — the structure anticipates several levels and the stair coordinates are already declared. Generalise them into an array of level descriptors: id, name, dimensions, up and down stair positions, and a pointer to the tile data. One entry to begin with.

Step 7. Stairs — DONE

< and >. Entering a staircase switches the active level descriptor and places the player on the matching stair of the destination. The coordinates are already in the data.

What landed

The descriptor, which is the old map1_* fields plus the two pointers they were missing:

offset	field	
0	LV_ID	1 byte
1	LV_NAME	9 bytes
10	LV_DIM	width, height
12	LV_UP	x, y of the staircase up
14	LV_DOWN	x, y of the staircase down
16	LV_SRC	→ the source text
19	LV_TILES	→ this level's tile array

Every level is built at startup and keeps its own tile array, so **levels persist** – a door you opened is still open when you come back. There is nothing to gain by discarding one: a 26-level dungeon is under 170 KB.

enter_level mirrors the dimensions and tile pointer into level_dim and level_tiles, because tile_addr and draw_world read them per square and per cell.

Both commands check you are standing on the staircase, switch the descriptor, and put you on the matching stair of the destination – down arrives at the level's *up* stair, and the reverse. Both honour the turn contract: a flight of stairs is a turn, refusing to move is not.

place_stairs stamps < and > onto each level as it is built. Those coordinates had been in the data since the game was written and nothing had ever drawn them.

The table has two rows. Level 2 borrows level 1's text as a placeholder – Step 8 replaces that single pointer. Its *tiles* are already separate, which is what made the persistence testable: open a door on level 1, and the same square on level 2 is still shut.

Step 8. A second level — DONE

Hand-authored, in the same text format. Proves the machinery of Steps 5-7 before any of it depends on a generator.

The machinery is already in place and exercised – what is left is **content**. One pointer in level_table row two changes from @map1_data to @map2_data.

What landed

BrynnWell, the well maze from NetWhack's `src/netwhack/world/mapgen/BrynnWell.java` - 20 x 30. Exactly one pointer in the table changed, which is what Steps 6 and 7 were for.

Glyph for glyph: NetWhack's `.` is our `"`, `'` `#` and `+` carry over, and its six secret doors (`s`) are ordinary doors here. There is no search command yet, so a secret door would be a wall you could never get through; they can go back to being secret once something can find them.

It is a **20 x 30 level**, not a 20 x 30 maze padded out to match level 1. That needed two fixes in `draw_world`, which was the last place still assuming one map size:

- the camera clamp computed `(map_width - view_width)`, which underflows

when the map is the narrower of the two. A map that fits has nowhere to

```
scroll to, so the answer is zero.
```

```
* the render loop drew 58 x 23 squares unconditionally, so past the right
edge of a narrow map it carried on into the start of the next row.
Squares outside the map draw as nothing now.
```

Maps *larger* than the view always worked – that is the scrolling case. Everything else had carried per-level dimensions since Step 6. Level 1 is unaffected and provably so: its rendered screen is byte-identical before and after, walked to the same square with the same door open.

Verified by rebuilding the level out of its tile array and diffing against the Java source: all 30 rows match, with `<` and `>` stamped where the descriptor says.

Step 9. DungeonMaker — DONE

Rooms and corridors, seeded from the RNG so a level is reproducible from its depth and seed. Appendix III of *Writing Games in Assembly Language* sketches this already, and NetWhack's `DungeonMaker.java` (633 lines) is the working reference.

With 16 MB there is no reason to discard a level once made: an 80×40 map is 3,200 bytes, so a 26-level dungeon fits inside a single bank. Levels can simply persist.

What landed

`programs/rogueima/dungeon.sda`. Fill the level with rock, mine one room in the middle, then repeatedly find a wall with **exactly one** floor square beside it and build on the far side, leaving a door in the wall you dug through.

That one-floor-neighbour rule is doing two jobs. It stops a level collapsing into a single cave, and it is also why every level comes out connected: each new piece is reachable through the door that made it. Connectivity is a property of the construction, not something checked afterwards.

Levels 3, 4 and 5 are generated, 78 x 22. `LV_SRC` of 0 in the level table means “there is no text to expand, build it”, and the generator writes `LV_UP` and `LV_DOWN` into the descriptor itself – a level that does not exist yet cannot say where its stairs are. Generated levels persist exactly like the hand-made ones.

The corridors NetWhack never built

addfeature in DungeonMaker.java reads:

```
switch (feature_type) {
    case 1: success = makeshop(...); break;
    case 2:
    default: success = makeroom(...); break;
}
```

case 2: is an empty label falling straight into default:, so it builds a room like everything else. TileData.CORRIDOR exists and readmapline can produce one, but nothing ever generated one. The branch was never written rather than broken – which is why BDungeon levels are rooms hanging off rooms.

Writing it costs almost nothing, because **a corridor is a room with one dimension collapsed to zero**, and makeroom's geometry already handles that: building EAST with height 0 gives $a.y = b.y = yloc$, a single row. So rooms and corridors are one routine called with different sizes, and the feature roll now actually branches.

Verification

Dump the tile array and analyse it rather than looking at it. Level 3 came out 310 floor squares with all 310 reachable by flood fill; level 4, 388 of 388. Solid border, 18 and 20 doors, both staircases placed, and the two levels different from each other. Corridor squares – floor with exactly two opposite floor neighbours – numbered 70 on level 3.

Part III — sight

Step 10. Per-tile seen and visible bits — DONE

Add the two flags to the tile structure from Step 5, and teach the renderer three states: visible (bright), seen but not visible (dim), unseen (blank). Then mark every tile seen and visible, so **nothing changes on screen yet**.

Installing the machinery separately from switching it on keeps the next step small and makes a regression obvious.

What landed

The flags have existed since Step 5, set on every square. The renderer reads them now:

state	drawn	colour
TF_VISIBLE	lit	\$07 light grey on black
TF_SEEN only	dim	\$08 dark grey on black

state	drawn	colour
neither	not at all	-

They are still set on every square, so **nothing changes on screen** – which is the point. Step 11 only has to start clearing TF_VISIBLE.

Colour arrives with this step, because “dim” needs one. Palette 5, CGA as an IBM 5153 showed it, and the indices are NetWhack's own: its ColorMap puts light grey at 7 and dark grey at 8 in the same order, so a colour there is a colour here. TileData also colours by *tile kind* – doors BROWN, staircases WHITE – which maps onto the same palette and is worth adding.

Two traps worth writing down:

- draw_borders clears the screen every redraw, and the clear repaints

the colour plane with the mode's default. The colours have to go back on

after it, not once at startup.

```
* 'print_char' takes its colour from 'VIDEO_CHAR_COLOR', not from the
plane. That is how the status panel is painted, and without setting it the
panel comes out dark grey on brown under a CGA palette.
```

Verified by dumping both planes: glyphs unchanged, colour uniformly \$07 across all 2000 cells. Clearing TF_VISIBLE on one square by hand drew it dim with its glyph intact; clearing TF_SEEN as well drew nothing, leaving a gap in the wall.

Step 11. Line of sight — DONE

Each turn, clear visible, then walk a line from the player to every tile within a radius, stopping at anything opaque; mark what is reached visible and seen. NetWhack's Level.visline() and makevis() are the reference.

Integer Bresenham over tiles — not the PPU's line primitive, which draws pixels.

This is the step that changes how the game feels more than any other on this list. A lit corridor ahead and a remembered room behind is the difference between a map and a dungeon.

What landed

programs/rogueima/los.sda. NetWhack's visline() unchanged, but cast to a **radius of 8** rather than to the edge of the map.

makevis() there casts to every square on the map boundary – about 200 rays of up to 78 steps, which its own comment calls “a terrible waste of resources”. A radius is the same code with nearer endpoints: about 68 rays of at most 11 steps, some thirty times less work, and it gives a torch instead of sight to the far wall. LOS_RADIUS is one constant.

The radius is **circular**: a square is in range only if $dx*dx + dy*dy \leq 64$, so the corners of the box do not see further than the sides. Two MULs per square.

Bresenham is the error-accumulator form, which keeps every quantity non-negative – the signs live in `LOS_SX/LOS_SY` and are applied as 8-bit wraparound. No signed comparisons, which on this machine would have meant testing `N` against `V` by hand.

Switching it on was **one line**: `TF_FLOOR` and `TF_WALL` stop carrying `SEEN` and `VISIBLE`, so a square starts unknown. That is what Step 10 was for.

Three things came with it:

- `put_glyph` preserves `SEEN` and `VISIBLE`. Opening a door changes

what a square *is*, not whether you have been there.

- a known floor draws as `.`, because floor is stored as a space and a

blank square is what “never seen” looks like – lit floor was invisible.

- monsters and items are only drawn where `TF_VISIBLE` is set, or you see

them through walls.

Verification

Dump the glyph and colour planes together and separate lit from remembered by colour. In the open: a clean circle of lit floor spanning exactly $px \pm 8$ and $py \pm 8$, with a dim crescent trailing from where the player walked. In BrynnWell's maze, standing in a corridor:

```
1. #
```

```
+....@.+
```

```
1. #
```

the corridor, the walls above and below it, the closed doors at each end, and nothing through them.

Part IV — things to carry

Steps 12-14. Inventory, item classes, wield and wear — DONE

Planned as three steps and built as one, because none of them is any use alone: an item you cannot carry, a pack you cannot look in, or a suit you cannot put on. All of it lives in the new `item.sda`.

The item table

NetWhack knows what an item is from its **class**: `Armor` extends `Item`, carries an `acmod`, and takes its name and numbers from `ArmorData[kind]`. Here the class is the `OBJ_TYPE` tag and the per-class payload is `OBJ_DATA1` — a tagged union, which is the same shape without the inheritance. What the tag does *not* give you is the data, and that is the table:

```
.equ IT_TYPE 0      ; which class this is
.equ IT_GLYPH 1
.equ IT_STAT 2      ; the class's one number
.equ IT_NAME 4      ; -> the name
.equ IT_SIZE 7
```

```
item_table:
    .bytes 3, ')', 3, 0, @str_dagger      ; WEAPON, 1d3
    .bytes 4, '[', 10, 0, @str_leather    ; ARMOR,  acmod 10
```

IT_STAT is the one number the class needs — a weapon's damage sides, a suit's ac modifier — exactly as WeaponInfo carries dmg and ArmorInfo carries acmod. **A new item is a row here, not a branch in make_item.**

The pack

A second queue over the *same* fixed node array the world uses. Picking something up is REMQUE from the world list and INSQUE into the pack; the node itself never moves and nothing is copied. That is what INSQUE/REMQUE are for, and it is why draw_items stops drawing something the moment you take it — it walks the world queue, and the node is no longer on it.

The screen

ADOM by way of NetWhack: a full page, grouped by category, one letter per item. Letters are the item's position in the pack, so an item keeps its letter whichever heading it appears under.

INVENTORY

```
Weapons
  a - dagger (wielded)
Armour
  b - leather armor (worn)
```

1. - press any key -

I to look, E to wield, W to wear, R to take everything off, D to drop, and the existing , extended to pick items up. X is a debug command that drops one of each at your feet.

What it does to combat

do_combat used to land every time and take off exactly 1. Now it rolls **2d(attack) against 2d(defense)**, as NetWhack does, with ties to the defender; wielding anything at all is worth +10 attack, armour adds its acmod, and damage is the wielded weapon's die.

Verification

A miss proves nothing, so the rolls are called directly rather than played. `test_combat.sda` runs a thousand trials each way and leaves four totals in memory:

```
hit by a monster, unarmoured      458 / 1000
hit by a monster, in leather      148 / 1000
damage over 1000 swings, fist    1000      (a fist is always 1)
damage over 1000 swings, dagger  2006      (1d3, mean 2)
```

Armour makes you harder to hit and the weapon changes the damage, which were the two things this step set out to show.

The memory map, which moved

The step also flushed out a real bug. The game sat at `$02C000` with the object array 12 KB above it at `$02F000`. The code grew past that line, so `init_objects` cleared the node array **over the game's own instructions** — which presents as the player being unable to move, with the assembler reporting nothing.

The game now loads at `$020100`: `USER_ORIGIN`, the address the shell and `INT $20` already load programs to, so an assembled Rogueima is a program the shell can run by name like any other. Everything it allocates is a whole bank away, one bank per kind:

```
$020100    bank 2: code and data, growing up    (55 KB to the FS command
block)
$030000    bank 3: game data -- the objects
$040000    bank 4: the maps -- one tile array per level
```

The bases are labels and everything derives from them, so the second map bank a real dungeon will need is one line. `.equ learned @label + N` to make that possible.

Two smaller fixes fell out of testing: `draw_items` only ever drew gold, so a dropped dagger vanished (it now draws every object that is not a monster), and `inv_ask` compared item letters against lowercase a while `get_dir_key` folds keys to upper case, so no item could ever be selected.

Step 15. Consumables and an effects hook

Food, potions, scrolls, and a small effect dispatch table they trigger. NetWhack keeps 12 of each and an `Effect` class; a dozen effects is plenty to start.

Part V — pressure

Step 16. Hunger, as an energy meter — DONE

A food clock, and e to eat. Taken ahead of Step 15 because it is the one that changes how the game is played: it is the reason to go down rather than explore forever.

Inverted

This is NetWhack's `Engine.pc_hunger()` with the sign flipped. There, `pc.hunger` counts **up** from zero and every test asks how big it has got:

```
pc.hunger++;  
if (pc.hunger > 5000) { ... }  
if (pc.hunger > 4000) { ... } else if (pc.hunger > 3200) { ... }
```

Here the same number counts **down** from `EN_MAX` and is called energy. They are the same meter — every threshold is 5000 minus NetWhack's — but the down-counting one can go on the status panel and be read without explaining. *Energy: 800* says you are nearly out of something. *Hunger: 4200* does not.

NetWhack	Rogueima	says	odds
<code>hunger > 800</code>	<code>energy < 4200</code>	You're feeling a might peckish.	1 in 500
<code>hunger > 1600</code>	<code>energy < 3400</code>	Your stomach is grumbling.	1 in 500
<code>hunger > 2400</code>	<code>energy < 2600</code>	You are feeling hungry.	1 in 500
<code>hunger > 3200</code>	<code>energy < 1800</code>	You are feeling very hungry.	1 in 400
<code>hunger > 4000</code>	<code>energy < 1000</code>	You are starving!	1 in 250
<code>hunger > 5000</code>	<code>energy == 0</code>	starving.. TO DEATH! (-1 hp)	1 in 50

Two consequences of the inversion, both small:

- eating **adds and clamps at the top** rather than subtracting toward zero,

so the bug to avoid is an unsigned overflow rather than an underflow.

```
NetWhack lets hunger go negative on a big meal; a meter has a maximum.  
* starving is energy **at** zero rather than hunger past 5000. NetWhack's  
hunger keeps climbing past its own limit and nothing reads it up there, so  
nothing is lost by parking at the bottom instead.
```

The clock

NetWhack calls `pc_hunger` when `(gametime % TICKS_PER_TURN) == 0`, because its `gametime` is fine-grained and ticks far faster than the player acts. Rogueima's `game_time` already counts player turns and only advances when one is spent, so the modulo is the identity here — `main_loop` just calls it once a turn.

At one point of drain per turn, a full meter is **five thousand turns**. That is deliberately a minor concern for now: it is there, it works, and the numbers are the thing to argue about when balance is the concern.

Eating

e eats. A ration is `FoodData[2]` — 500 nutrition, glyph % — and it is a **row in item_table**, not a branch anywhere, which is what Step 13 bought. `NetWhack's Food.event_eat` also heals a point when `Dice.roll(1, nutrition) > 200`, so a ration is a three-in-five chance of one hp back.

Disposal is the fiddly part, and it is not a `REMOVE` alone. `make_item` finds a free node by scanning the **world** queue for one with a zero id, so an item taken off the pack queue and put on no queue at all is leaked rather than freed. Eating therefore puts the node back on the world queue and only then zeroes the id — the same disposal `pick_up_gold` does, from the other end.

Verification

Five thousand turns of drain is not something you can sit through, and a complaint that fires one turn in five hundred is not something you can see by playing. `test_hunger.sda` calls `pc_hunger` directly with the meter **pinned** at a chosen level, which holds it inside one band of the chain, and asks whether that band says anything — by clearing the message buffer first and counting the non-zero bytes after.

drain past the bottom	0	(floors, does not wrap)
hp lost at empty over 5000 turns	105	(1 in 50, so about 100)
messages at energy 4300	0 bytes	(above every band: silent)
messages at 4100/3300/2500/1700/900	247 bytes	each

The silent row is the one that matters as much as the loud ones: it pins the `EN_PECKISH` boundary from above, so an inverted comparison could not pass.

And in the real loop, poked down to 30 and left to walk: energy floored at 0 and hp went 10 → 6 while starving.

A bug it turned up

`pick_up_items` listed the types that *could* be carried, so the ration was un-pickable the day it was added. That is the same shape as `draw_items` only ever drawing gold, found in Step 12. Both now name the one type they **exclude** — a new kind of item should not need a line in either place.

Step 17. Regeneration and death

HP returning slowly with time, resting to pass turns safely, and a proper death — tombstone, final score, and a return to the prompt rather than a hang.

Part VI — a world worth returning to

Step 18. A monster table — DONE

There used to be `make_rat`, `make_snake` and `make_spider`: three routines, each with its own hit-point roll and its own hard-coded glyph, and a `random_monster` that rolled 1..3 and branched to one of them. **Adding a fourth monster meant writing a fourth routine.**

Now there is one routine and a table. `montable.sda` is all 28 rows of NetWhack's `MobData.mobdata[]`, with every field it carries.

Generated, not transcribed

The table is produced by `tools/gen_montable.py`, which reads NetWhack's Java directly — resolving monsym symbols to glyphs, `ColorMap` names to CGA indices, Attack/Damage constants to numbers, and dice strings like “1d2-1” to (n, sides, bonus). Twenty-eight rows of symbolic fields is exactly what gets copied wrong by hand, and NetWhack's table will change again. Re-run it; do not edit the output.

`ColorMap` turned out to be the standard CGA order already, so the colours came across as-is.

The record

MO_GLYPH	0	MO_AC	3	MO_MSPEED	6	MO_NATK	13
MO_COLOR	1	MO_PROB	4	MO_ASPEED	8	MO_ATK	14 (3 x 5 bytes)
MO_LEVEL	2	MO_ALIGN	5	MO_NAME	10	MO_SIZE	29

An instance keeps two things: `OBJ_DATA1` is current hit points, which change, and `OBJ_DATA2` is the **kind**, which does not. Everything else is read back out of the table from that kind, so an instance costs no more than it did.

What is wired

- **glyph, colour, name.** Colour is not decoration: 28 monsters share 6

glyphs, and without it a dog and a wolf are the same d.

- **level** — hit points are `level d8`, as Mobile rolls them, and

`10 x level` is the attack rating. `getAttackRating()` is

```
'10*xp_level + 3*DEX + STR + bonuses'; monsters here have no stat block,
so the level term is what is left.
* **armour class**, added to the defence, as 'getDefenseRating()' does.
* **probability**, and **the attacks**.
```

Every monster used to rate a flat 10 — which is exactly what `10 x level` comes to at level 1. So **the first floor plays as it always did** and the deeper ones get harder, which is what importing the levels was for.

Spawning follows `randomkind(plevel, zlevel)`: the window is $(plevel + zlevel) / 6$ to $/ 2$, by rejection sampling as NetWhack does it. Floors 1 and 2 hold level-1 monsters only; by floor 9 it is anything up to level 5. There is no experience system yet, so the player's level is 1 and depth widens the window alone.

What was left behind

All of it is **imported**; these are the fields nothing reads yet:

- `MO_MSPEED / MO_ASPEED` — there is no speed system. A rock mole at

1500 and a phase rat at 400 currently move at the same rate. This is the

```
big one, and it is a scheduler, not a data problem – which is the point of
importing the numbers now.
* 'MO_ALIGN' – no alignment, no peaceful monsters, no 'Really attack?'
* 'MOA_DMGT' – no damage types, so a salamander's fire is ordinary.
* 'MOA_TYPE' is stored and half-used: 'do_attack' picks one attack at
random from the list, which this does, so a wererat's two attacks and a
salamander's three already work. What is unused is the claw/bite/spit
distinction in the message.
```

Row 0 is the player. Its probability is 0 so it can never be picked; it is kept so an index here is an index into `MobData`.

Verification

A wrong offset in a 29-byte record reads as a monster that is subtly too strong, not as a crash, so `test_mon.sda` asks questions with known answers:

depth 1 level window	1 .. 1	
depth 10 level window	1 .. 5	
salamander hit points	14 .. 57	(8d8)
sewer rat damage	0 .. 1	(1d2-1)
battle orc damage, highest	6	(2d3)
salamander attack / defence	80 / 81	(level 8, ac 1)
wererat attacks in the table	2	
orc damage over 200 real swings	804	(through do_combat)

The last one goes through `do_combat` rather than calling `mon_damage` directly, because that is where a register clobbered across a call shows up. And one did: **FLD is FL:D**, so the pair aliases the D register, and using D as scratch while walking a row silently overwrote the low sixteen bits of the pointer. Every field then read as zero, the code took its “no attacks” early-out, and **every monster in the game did no damage at all** — with no crash and no assembler warning. `mon_damage` uses C.

Step 19. Pathfinding

NetWhack's PathMap . java is a Dijkstra map — flood the distance-to-player across walkable tiles, and every monster moves downhill. It replaces “step toward the player” with something that goes around corners, and it costs one pass per turn rather than one search per monster.

Step 20. Save, restore, and scores

S to save and resume. The file services already exist behind INT \$15. A high score table after that.

If only three steps get done

Steps 2, 7 and 11 — eight-way movement, stairs to a second level, and line of sight. That is the difference between a demo and a roguelike, and none of the three is large.

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