

$$\begin{array}{r}
 '7' \\
 '9' \\
 '0' \\
 \hline
 16
 \end{array}
 \quad \swarrow \quad 160 \text{ to } 6$$

Operation Echelon: • Hidden educational game where players solve matrix puzzles using elementary row operations

$$\begin{bmatrix}
 1 & -2 & 4 & 0 \\
 -1 & -1 & -2 & -1 \\
 8 & 0 & 0 & 2
 \end{bmatrix}$$

• typical play board

• Negative numbers are red soldiers, positive are blue soldiers

• Troops go from 1, 2, 4, 8 (maybe 16?)

• Private, Sergeant, Captain, General

• Operations are: increase the class of ea. troop in a row (including enemies), decrease the class, pin rows against each other (battle), swap rows (march)

$$\begin{bmatrix}
 -1 & -1
 \end{bmatrix}$$

$$\begin{bmatrix}
 -1 & 1 \\
 -1 & 2
 \end{bmatrix}$$

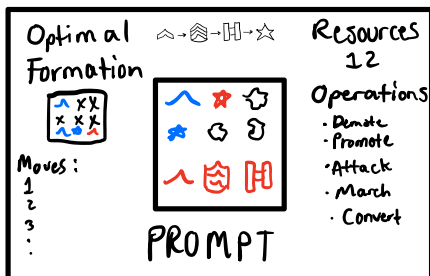
• Goal is to either match a formation or eliminate all enemies

• Promote, demote, Attack, March,

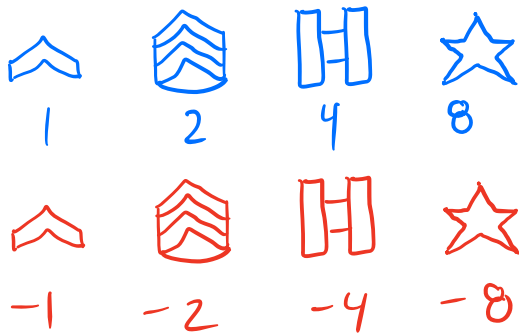
Convert

• Get a certain amount of points (resources) to use

• Each operation requires resources

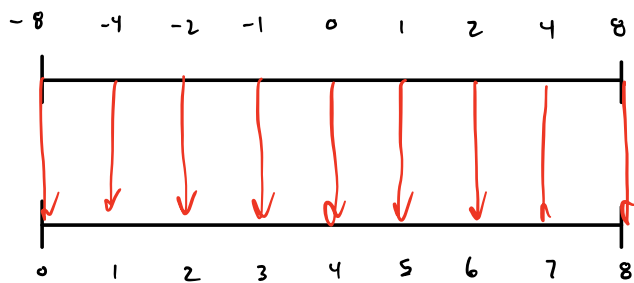


Screen



Resources
2

$$\begin{bmatrix} -1 & 2 & -4 \\ 0 & 0 & 0 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & -2 & 4 \\ 0 & 0 & 0 \end{bmatrix}$$

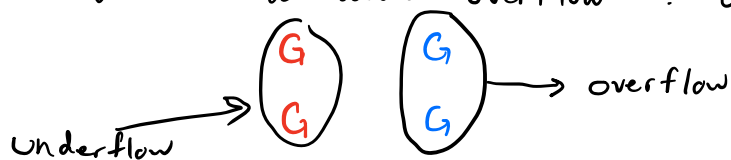


bijection (Troop)

- 1) Abs value
- 2) take \log_2
- 3) Get $\text{Max}(0, \text{num})$
- 4) Multiply by
Sign
- 5) add offset (4)

When to allow attack

: Want to avoid overflow & under flow



0	1	2	4	8
↓	↓	↓	↓	↓
0	1	2	3	4

Levels:

9

$-2 -2 -2 -2$
 $-1 \ 0 -1 -1,$
 $-2 -2 -2 -2$
 $-2 \ 0 -2 -2,$
 $-2 \ 0 -2 -2$
 $-2 -2 -2 -2,$
 $2 \ 0 \ 2 \ 2$
 $-2 -2 -2 -2,$
 $2 \ 0 \ 2 \ 2$
 $2 \ 2 \ 2 \ 2$

10

$1 \ 1 \ 0 \ 1$
 $0 \ 0 \ 0 \ 0,$
 $1 \ 1 \ 0 \ 1$
 $-2 -2 \ 0 -2$
 $1 \ 1 \ 0 \ 1$
 $0 \ 0 \ 0 \ 0$

12

$1 \ -1 \ 2 \rightarrow -1 \ -3 \ 1 \rightarrow -1 \ -3 \ 1$
 $2 \ 2 \ 1 \quad 2 \ 2 \ 1 \quad -3 \ -3 \ -2$

$$\begin{array}{cccccc}
 13 & 1 & 0 & 0 & 0 & 0 & 0 \\
 & 1 \rightarrow 1 \rightarrow 2 \rightarrow -2 \rightarrow -2 \rightarrow -2 \\
 & 1 & 1 & 1 & 1 & 3 & -3
 \end{array}$$

$$\begin{array}{cccccc}
 14 & 1 & 0 & 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \\
 & 0 & 1 \rightarrow 0 & 1 \rightarrow -1 & 2 \rightarrow -1 & 2 \rightarrow -1 & 2 \\
 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & -2 & 2
 \end{array}$$

$$\begin{array}{cccc}
 G & \leftarrow & C & \leftarrow & S & \leftarrow & P & \times \\
 -1 & & -2 & & -3 & & -4
 \end{array}$$

$$\begin{array}{cccc}
 P & \rightarrow & S & \rightarrow & C & \rightarrow & G \\
 1 & & 2 & & 3 & & 4
 \end{array}$$

$$\begin{array}{cccc}
 \downarrow & 1 & 1 & 1 \\
 & -2 & -3 & -4 \rightarrow & 1 & 1 & 1 \rightarrow & P & P & P \\
 & & & & -1 & -2 & -3 & P & S & C
 \end{array}$$

- It's a cool game
- Know it's based off matrix ops
 - Don't need to know that
 - Can deduce based on symbols $\frac{1}{3}$ colors
- Suggestion
 - Another conversion puzzle 1×3 ✓
 - Helps solidify the conversion move rule
 - Keep same colour to limit confusion
- After first conversion puzzle
 - How many puzzles w/ just conversion 3-4
 - Incorporate other ranks with conversion puzzles
- For swap 2-3 puzzles
 - Independent from convert
- $\begin{array}{cc} P & \\ P & \end{array} \rightarrow \begin{array}{cc} P & \\ P & \end{array}$ good 6th or 7th puzzle
- $\begin{array}{cc} X & P \\ P & X \end{array} \rightarrow \begin{array}{cc} P & X \\ X & P \end{array}$ good follow-up
- Wait to introduce empty space 3rd puzzle for swap $\frac{1}{3}$ convert ✓
- Explicit warning msg for why you can't do a move or why it fails
- Explicit msg for Battle not affecting row 1.
 - Attack is better ✓

- Deploy X
- Highlight active row ✓
- Better communication ✓
- New level goal
 - 3 levels for each Operation
 - 15 levels
 - ✓ $5C_1$ →
 - $5C_2 + 5C_3 + 5C_4 + 5C_5$

$$10 + 10 + 5 + 1 = 26 \cdot 3 = 78$$
 - # of cats = 31

C ✓
 S ✓
 CS ✓
 P ✓
 CP ✓
 SP ✓
 CSP ✓
 D ✓
 CD ✓
 SD ✓
 PD ✓
 CSD ✓
 CPD → need ✓
 SPD ✓
 CSPD ✓
 A ✓
 CA ✓
 SA ✓
 PA ✓
 DA ✓
 CSA ✓ → used random
 CPA ✓ generation
 CDA ✓ for, may
 SPA ✓ need more
 SDA ✓ whitespace
 PDA ✓
 CSPA ✓
 CSDA ✓
 CPDA ✓
 SPDA ✓
 CSPDA ✓

* Whitespace helpful for solving puzzles as well as alternating colors

- Slow down around CS03
- SD03 more than 2 generals
- CPD03 is broken haha
- Attack not apparent
 - Reinforcement better
- A07 difficulty gap
- CA03 good puzzle
- SA03 good puzzle
- May help to have win panel at bottom of screen so players can see how they messed up

- PA01 good
- DA02 hard
- Error noise
- Attack is allowed to select same row twice

- Attack verbage bad
- Deduct a move if you attempt an incorrect move
- Promote, Swap

1	2	3	4	0
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1 1 1 1 1 1 1 1
 0 -2 A A A
 0 0
 0 0 1 1 2 2 3 3

 -1 -1

3 3

P A D A
A D A P
C A S
A C S P
A A C S P

CSDA01: S S A A D C

SPA03: AASP

CSDA02: ACADS

CSDA03: ACADDAS

CPDA01: CACAPD

CPDA02: DAPC

CPDA03: CADAP

SPDA01: SDAP

SPDA02: S A P A D

SPDA03: SASPD

CSPDA01: SACAPD

CSPDA02: PADCAAS

CSPDA03: SACAPD



Test 02: Aidan

- Like the typing sounds
- Like pacing of getting used to new mechanics
- "You win" is annoying
- Like the hover preview
- Tooltip timer may be too short

- Flying thru first 10 levels, slow down a bit after levels with 3 allowed operations
- CDO2 good level, SDO2 was "tricky"
- Promote demote levels easy
- Like this game so far (round 41)
- A03 seems tough at first
- A07 first failure
- "Wish I could see the failed outcome"
- PA03 hard
- "Need to swap these rows at some point" - good observation that matches how levels were actually designed
- CSA04 → has extra move
- "Can swap at any time"
- CSA05 → C(1), R(1,0), R, S [Very hard it seems]
- CPA02 may have redundant row
- CPA03 may be confusing
 - The fact that you can solve a puzzle w/out using an allowable move
- SPA03 "pissing me off" → ~~impossible~~ **FIXED**
 - If no convert, all red columns can never become blue
 - If resulting formation has all identical rows, swap is useless

- Reset before operation cancel is a glitch
- SDA03 **FIXED**
- Remove CSPA02 from output (hard tho)