PostScript
Retro Coding Fun

Nicolas Seriot, 11th April 2025

//FIXME: TODO

PLAYING GAMES ON PRINTERS

Dive into the vintage world of PostScript

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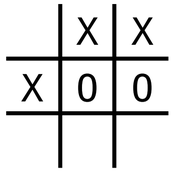
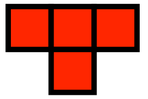
FIXME
HACKERSPACE LAUSANNE

1 **Program in PostScript?**

2 Play against a printer?



3 Games for desktop?



1975 — 1980 — 1985 — 1990

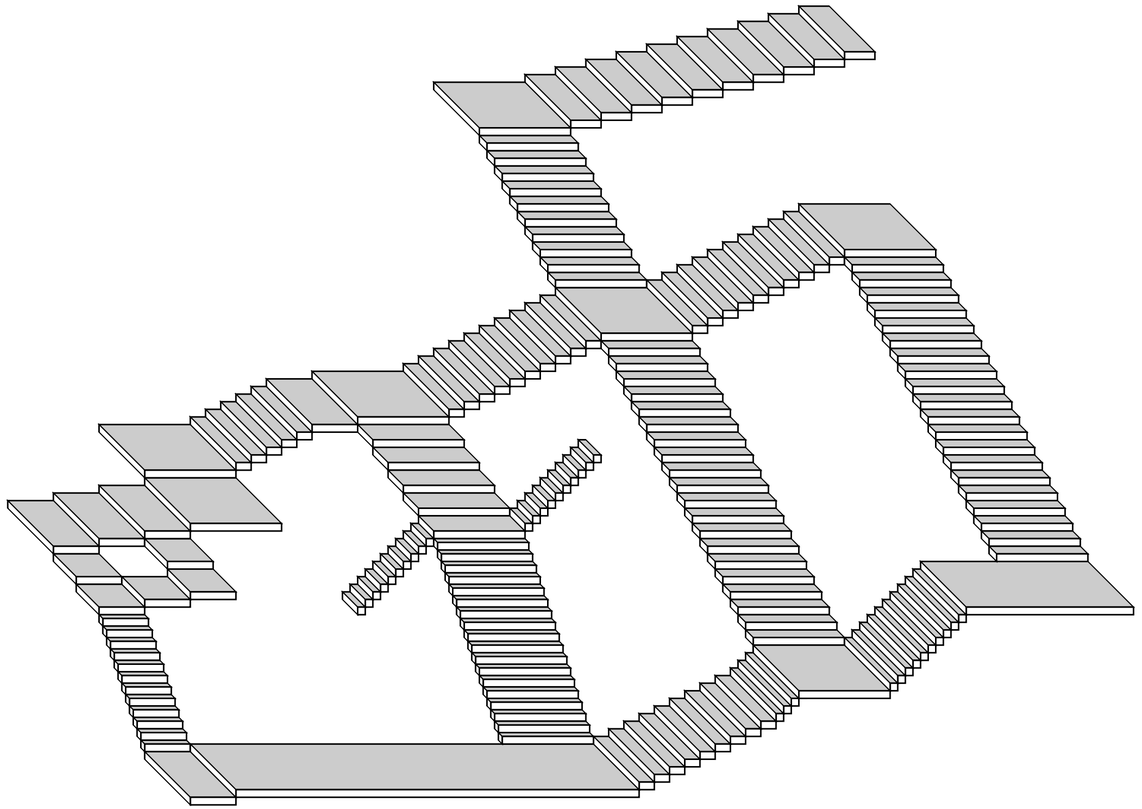
A programming language that generates graphics

Adobe PostScript

Generally software generated, then interpreted on printers

PDF

Precursor of PDF



42’000 bytes

842 bytes

stairs.ps

```
<</PageSize[800 600]>>setpagedevice/S 5 def/f{/M exch def/C exch def/h exch def
/w exch def gsave M concat C setgray 0 0 w h rectfill 0 setgray 0 0 w h
rectstroke grestore}def/b{/H exch def/W exch def gsave W H 2 div 0.8[1 0 -1 1 0
S]f W S 1[1 0 0 1 0 0]f H 2 div S 1[-1 1 0 1 0 0]f grestore}def/U{/H2 exch def{
H 2 div neg H 2 div S add translate W H2 b}repeat}def/D{/H exch def{H 2 div H 2
div neg S sub translate W H b}repeat}def/L{/W2 exch def{W2 neg S neg translate
W2 H b}repeat}def/R{/W2 exch def{W S translate W2 H b}repeat}def/s{save}def/r{
restore}def/W 60 def/H 60 def 100 200 translate 2 30 L 2 30 D s 12 5 D 1 60 D 1
265 R 9 10 R 4 5 R r 2 30 R 1 30 U 1 60 U 1 60 R 1 60 U 5 10 R 1 30 R 1 60 R s
5 20 D s 10 5 L r s 18 5 D r 10 5 R r 10 10 R 1 60 R s 20 10 D 1 60 D 10 5 R 1
110 R r s 10 10 U 1 60 U 10 20 R r 10 10 R 1 60 R 20 10 D
```

Run PostScript

```
gs stairs.ps
ps2pdf stairs.ps
```

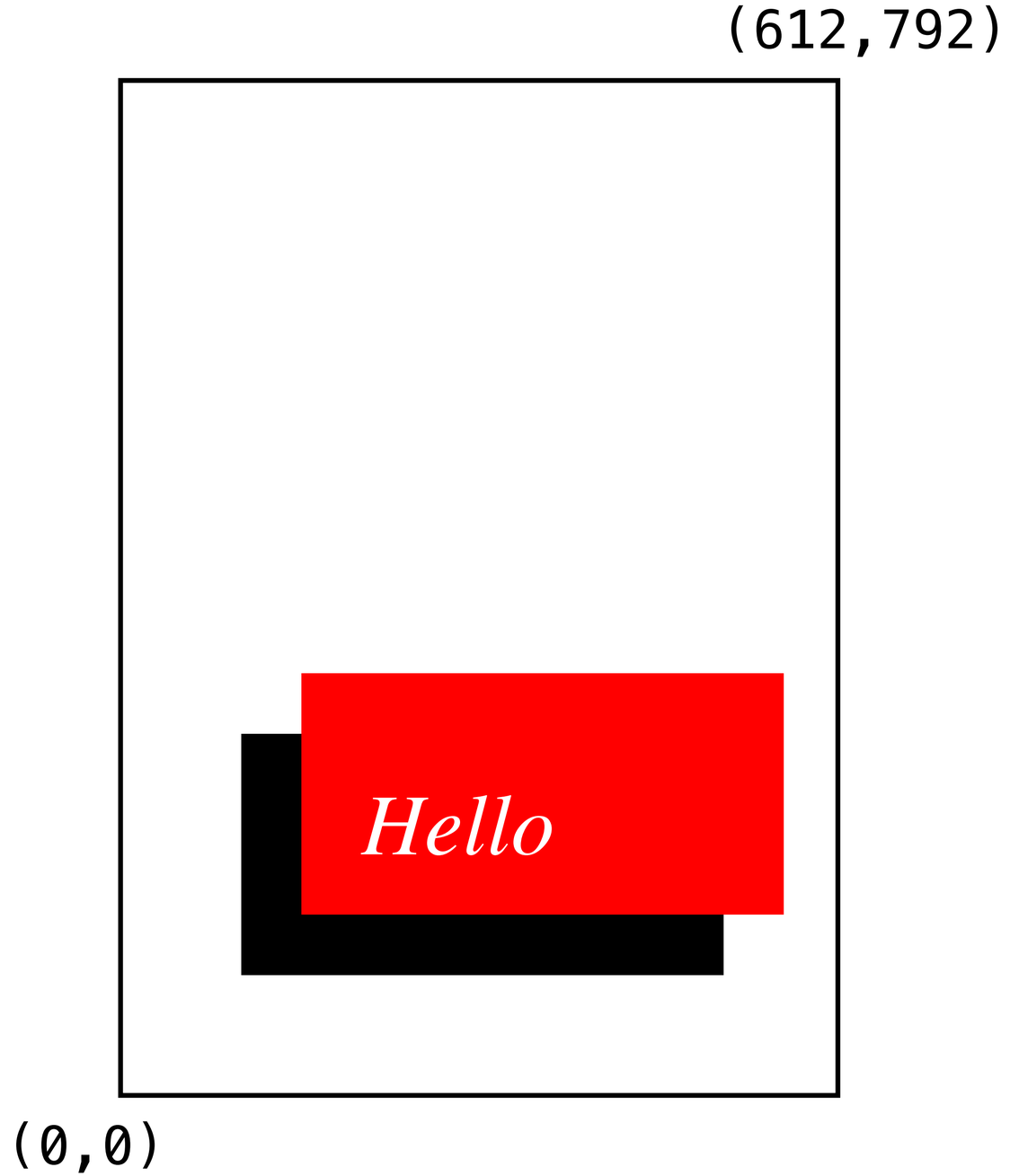
stairs.ps

stairs.pdf

https://www.ghostscript.com/

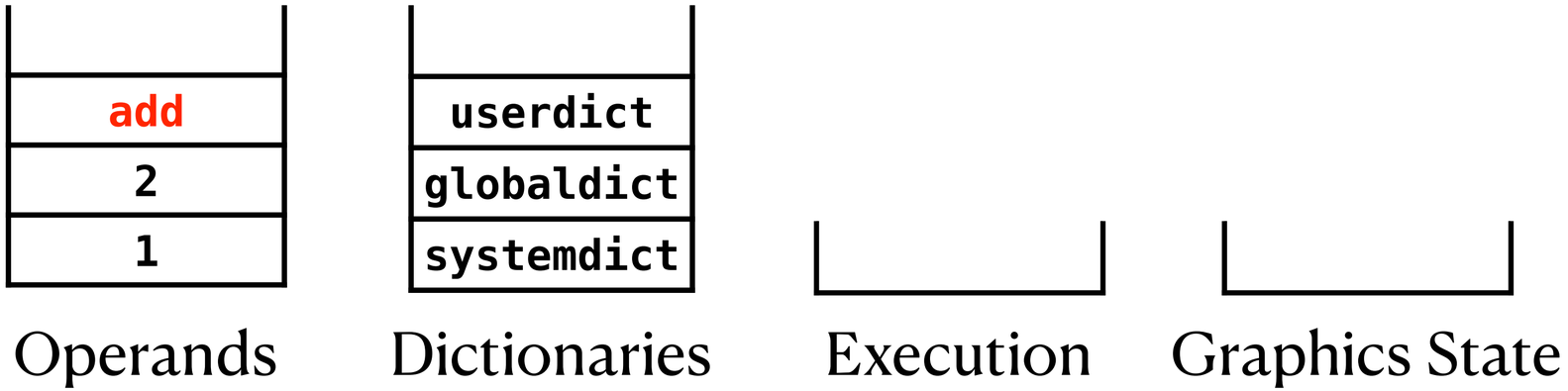
Interactive PostScript

```
% black rectangle
100 100 400 200 rectfill

% red rectangle
1 0 0 setrgbcolor
150 150 400 200 rectfill

% white text
200 200 moveto
/Times-Italic 72 selectfont
1 setgray
(Hello) show
```



The Language

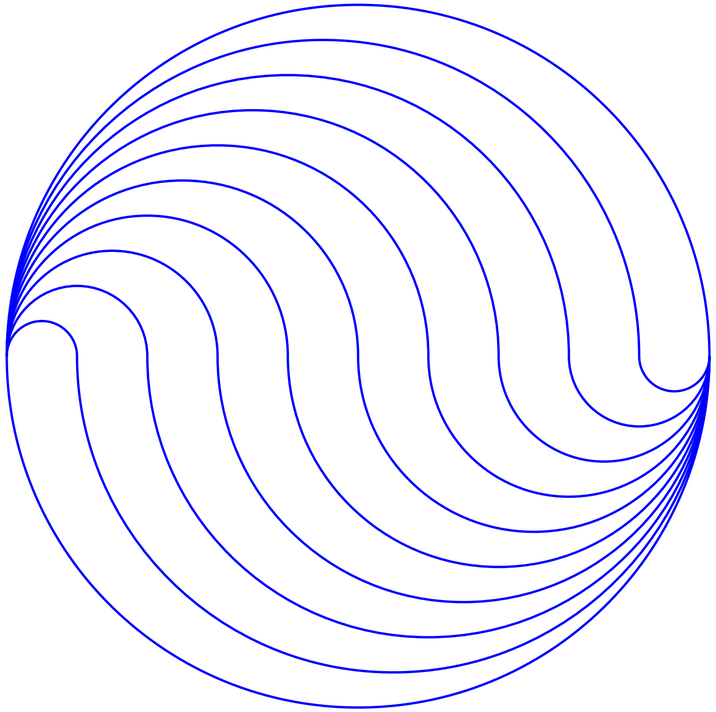
4 stacks



A simple language with a small, powerful set of operators

- PostScript command summary
- Postscript Operators
- Terence Parr PostScript lecture
- seriot.ch Quickies

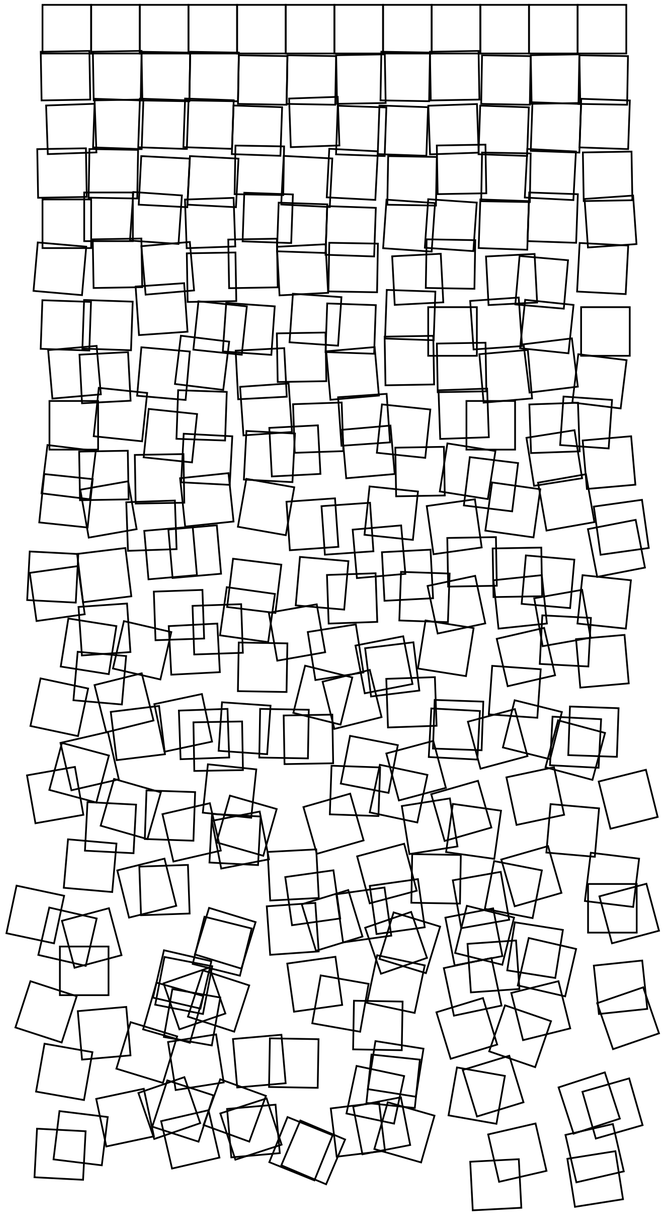
Circles



Implicit graphic context

```
0 0 1 setrgbcolor

/N 10 def
/STEP 15 def

1 1 N {
    STEP mul /r exch def
    r 0 r 0 180 arc stroke
    N 2 mul STEP mul r sub 0 r 180 0 arc stroke
} for
```

control structure



Schotter

Georg Nees, 1965

```
/COLS 12 def
/ROWS 24 def
/SIZE 28 def

/jig { rand r mod 2 mul r sub 1 add } def

1 1 COLS {
    /c exch def
    1 1 ROWS {
        /r exch def

        gsave
        c SIZE mul r SIZE mul translate
        jig rotate
        jig jig SIZE SIZE rectstroke
        grestore

    } for
} for
```

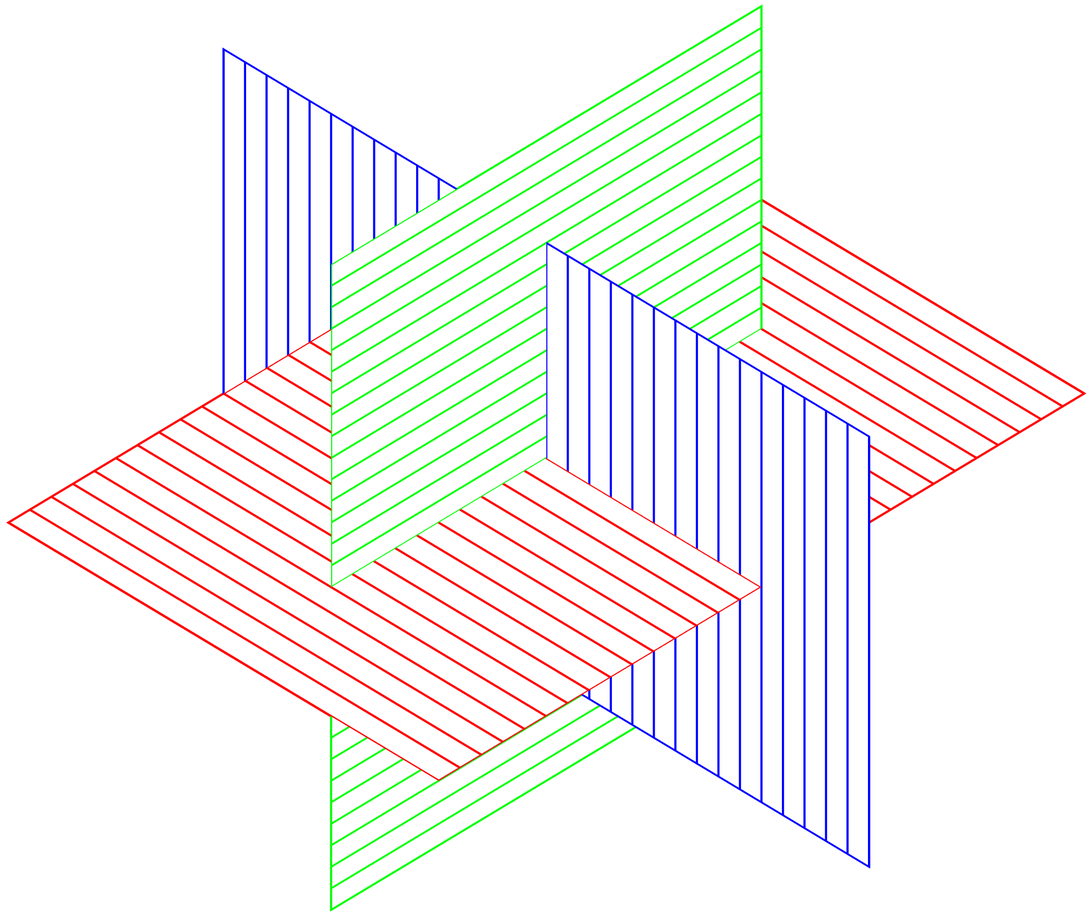
Random values

Geometric transformations

```
/S 24 def/j{rand r mod 2 mul r sub 1 add}def 1 1 12{1 1 24{
/r exch def gsave dup S mul r S mul neg S 2 add S mul add
translate j rotate j j S S rectstroke grestore}for}for
```

Minified version

Intersecting Planes

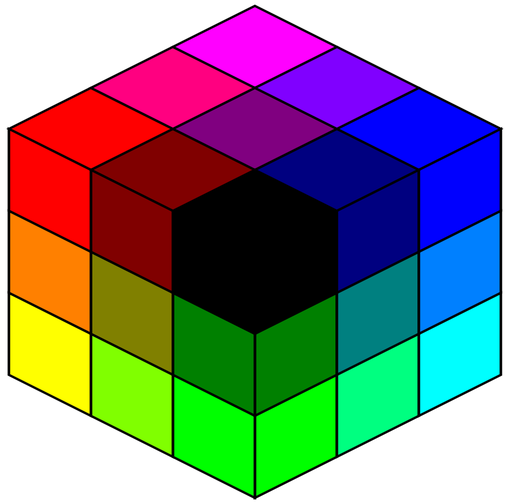


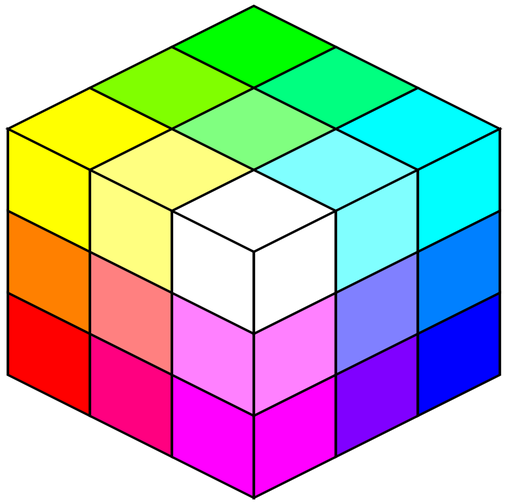
```
%!PS

200 200 translate

/W 300 def
/H 200 def
/W2 W 2 div def
/H2 H 2 div def

/P {
    1 setgray
    0 0 W H rectfill

    setrgbcolor
    0 0 W H rectstroke

    0 10 W {
        dup
        0 moveto
        H lineto
    } for

    stroke
} def

/MR [ 1   0.6 -1 0.6    50    60 ] def
/MG [ 0   1    1 0.6     0     0 ] def
/MB [ 1 -0.6   0 1     -50   200 ] def

1 0 0 gsave MR concat                        P grestore
0 1 0 gsave MG concat                        P grestore
1 0 0 gsave MR concat 0   0 W  H2 rectclip P grestore
0 0 1 gsave MB concat                        P grestore
1 0 0 gsave MR concat 0   0 W2 H  rectclip P grestore
0 1 0 gsave MG concat 150 0 W2 H2 rectclip P grestore
```

Procedures (key / value)

Clipping

CPC Color Palette





Geometric transformations

First-class functions, passed as arguments

```
/S 32 def
/N 2 def % steps 0-1-2

/_r_g_b_m_DrawSide {
    gsave
    concat
    /B exch def
    /G exch def
    /R exch def
    0 1 N { /x exch def
        gsave
        0 1 N { /y exch def
            R G B setrgbcolor
            0 0 S S rectfill
            0 setgray
            0 0 S S rectstroke
            0 S translate
        } for
        grestore
        S 0 translate
    } for
    grestore
} def

/_a_b_c_DrawCube {
    /c exch def
    /b exch def
    /a exch def

    gsave
    c 1 eq { [-1 0 0 1 0 0] concat } if % flip left-right
    { b } { c } { a } [  1  0.5 -1   0.5 0 0 ] _r_g_b_m_DrawSide % top
    { c } { b } { a } [  1  0.5  0  -1   0 0 ] _r_g_b_m_DrawSide % right
    { a } { b } { c } [ -1  0.5  0  -1   0 0 ] _r_g_b_m_DrawSide % left
    grestore
} def

gsave
{ x N div       } { y N div       } 0 _a_b_c_DrawCube
240 0 translate
{ N x sub N div } { N y sub N div } 1 _a_b_c_DrawCube
grestore
```

Golfing

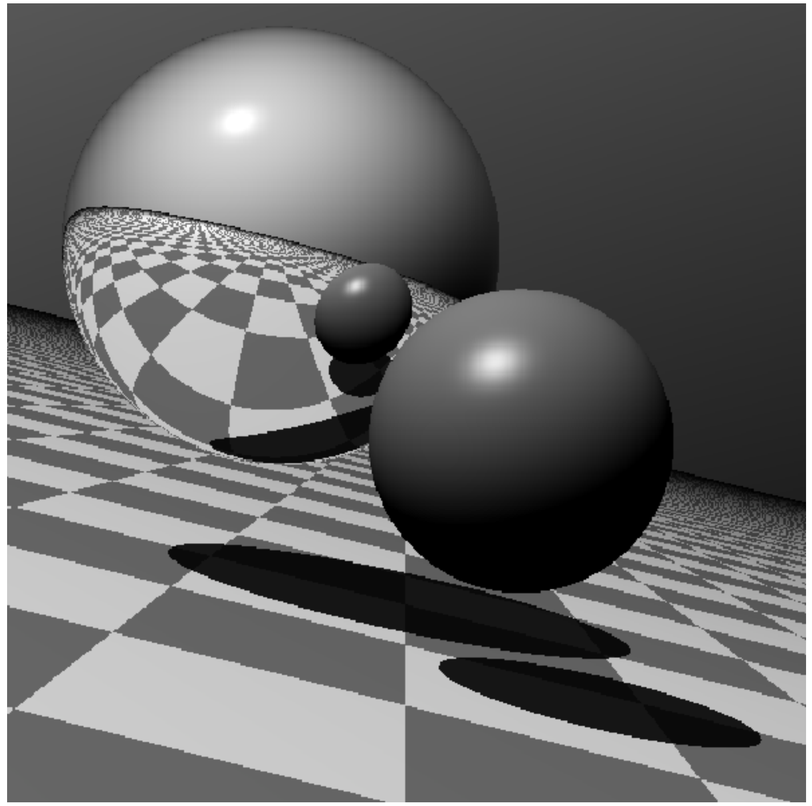
Integers encoded into chars

```
/l{lineto}def 1 0.4 0.2 setrgbcolor
(@>CC30TFCF>J>MC30TPCP>T>TJ<J<><NH41HHD0x)
{48 sub 5 mul}forall arc fill setgray
rectfill moveto l l 2{l l l arc}repeat l fill
```

Decoder

Tiny Ray Tracer

Obfuscated PostScript Contest 1993



from 760 down to 727 bytes

```
/p/floor/S/add/A/copy/n/exch/i/index/J/ifelse
/H{count 2 idiv exch repeat}def
/q/gt/h/exp/t/and/C/neg/T/dup/Y/pop/d/mul/w/d
```

Define operator aliases

```
/c(j1idj2id42rd)/G(140N7)/Q(31C85d4)/B(V0R0VR
300 T translate
/I(3STinTinTinY)/l(993dC99Cc96raN)/k(X&E9!&1!
/O(Y43d9rE3IaN96r63rvx2dcaN)/z(&93r6IQO2Z4o3A
/W 270 def
/L(1i2A00053r45hNvQXz&vUX&UOvQXzFJ!FJ!J)/D(cjS5o32rS4oS3o)/v(6A)/b(7o)
/F(&vGYx4oGbxSd0nq&3IGbxSGY4Ixwca3AlvvUkbQkdbGYx4ofwnw!&vlx2w13wSb8Z4wS!J!)
/X(4I3Ax52r8Ia3A3Ax65rTdCS4iw5o5IxnwTTd32rCST0q&eCST0q&D1!&EYE0!J!&EYEY0!J0q)
/V 3 def
/x(jd5o32rd4odSS)/a(1CD)/E(YYY)/o(1r)/f(nY9wn7wpSps1t1S)
```

Encode procedures into strings

```
{
    [
        n {
            ( )T 0 4 3 r put
            T(/)q {
                T(9)q {
                    cvn
                } {
                    s
                } J
            } {
                ($)q {
                    [
                } {
                    ]
                } J
            } J
            cvx
        } forall
    ]
    cvx def
} H
```

Extract procedures out of encoded strings

```
1 2 (add) % literal
cvx       % executable
exec      % 3
```

```
K {
    K {
        L setgray moveto B fill
    } for Y
} for
```

Main call

A Turing-Complete Language

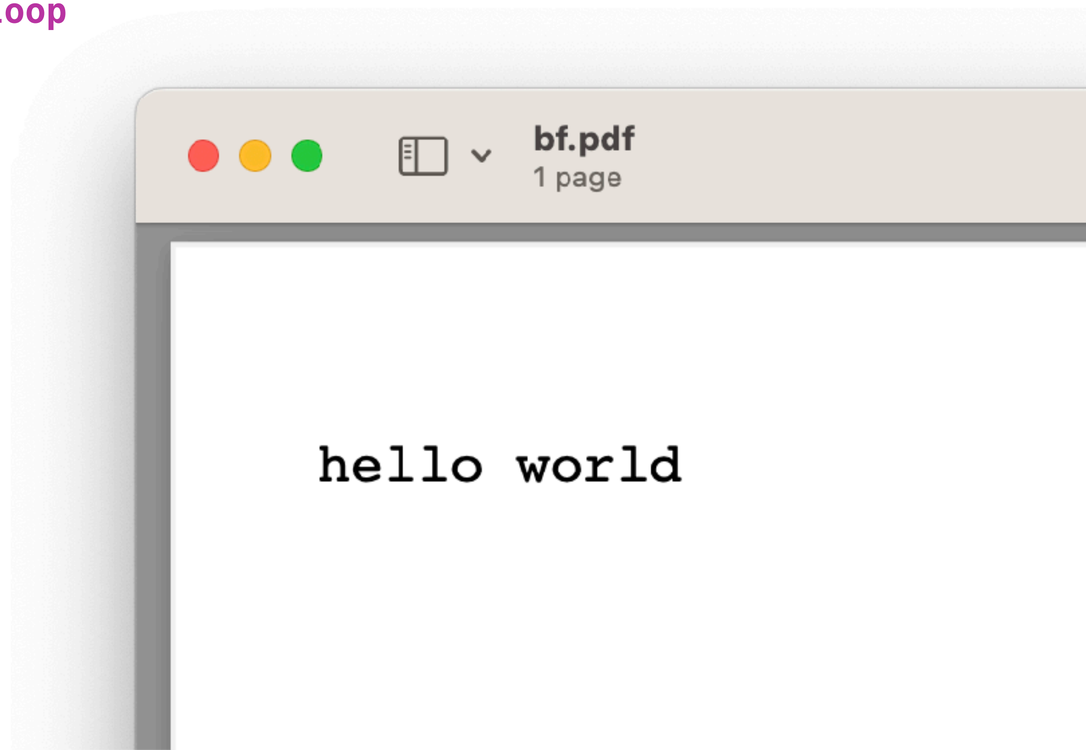
```
/Courier findfont 12 scalefont setfont 32 740 moveto

/P (+[-[<<[+[--->]-[<<<]]]>>>-]>-.-- -.>..>.<<<<-.<+.>>>>>.>.<<.<-.) def

/d{def}def/p 0 d/_{/p p 1 add d}d/C{P p 1 getinterval}d/M 30000 string d/m 0 d
/V{M m get}d{p P length ge{exit}if C(+)eq{M m V 1 add 255 and put}if C(-)eq{M m
V 1 sub 255 and put}if C(>)eq{/m m 1 add d}if C(<)eq{/m m 1 sub d}if C([)eq{p V
0 eq{mark{C([)eq{0}if C(])eq{pop}if counttomark 0 eq{pop exit}if _}loop}if}if C
(])eq{/x exch d V 0 ne{/p x d p}if}if C(.)eq{/s 1 string d s 0 V put s show}if
C(,)eq{/f(%lineedit)(r)file d f read pop M m 3 -1 roll put}if _}loop
```

PostScript can interpret a TC language, so it's TC as well

bf.ps

Comman	Description
`>`	Move the pointer to the right
`<`	Move the pointer to the left
`+`	Increment the memory cell at the pointer
`-`	Decrement the memory cell at the pointer
`.`	Output the character signified by the cell at the pointer
`,`	Input a character and store it in the cell at the pointer
`[`	Jump past the matching `]` if the cell at the pointer is 0
`]`	Jump back to the matching `[` if the cell at the pointer is

https://esolangs.org/wiki/Brainfuck



PostScript Capabilities

Interpreters can interact with (part of) their environment

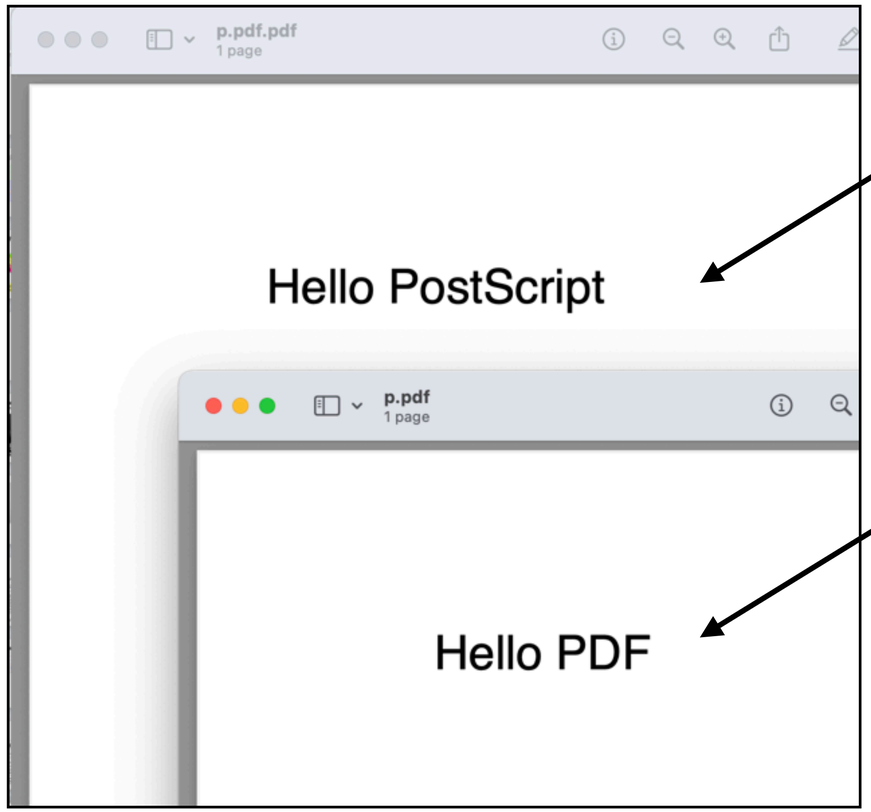
- ❌ syscalls
- ❌ network access
- ❌ threads
- ❌ Unicode support
- ❌ strong typing

1985

- **A programming language**
- **Generates graphics**
- Program might never stop
- Number of pages unknown

1993

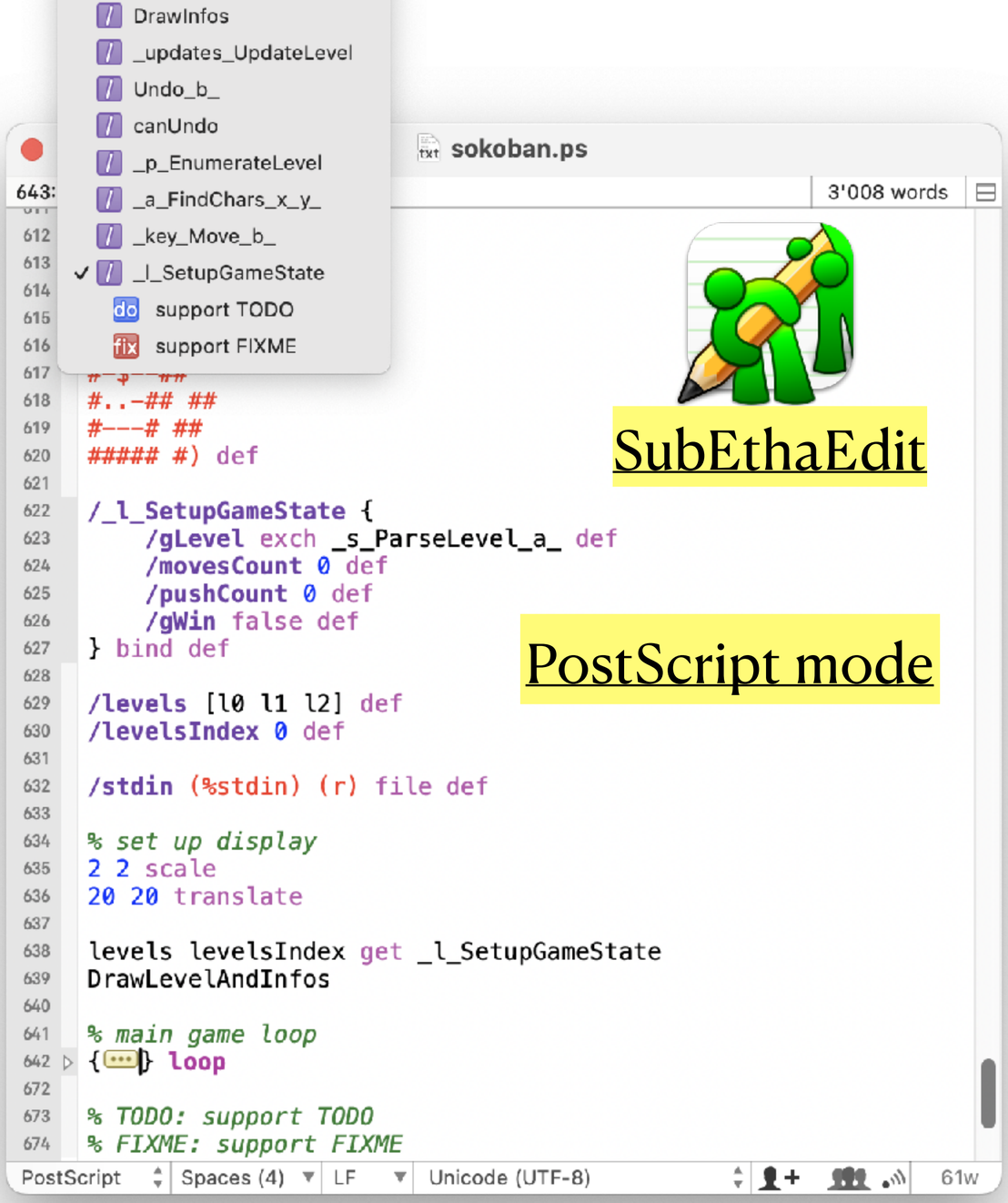
- **A document format**
- **Describes final appearance**
- Predictable behavior
- Can reference individual pages
- Can contain hyperlinks, forms… JavaScript!




```
%!PS
%PDF-1.4

/Helvetica findfont 20 scalefont setfont
100 700 moveto (Hello PostScript) show showpage stop

1 0 obj << /Type /Catalog /Pages 2 0 R >> endobj
2 0 obj << /Type /Pages /Kids [3 0 R] /Count 1 >> endobj
3 0 obj <<
  /Type /Page
  /Parent 2 0 R
  /MediaBox [0 0 612 792]
  /Resources << /Font << /F1 5 0 R >> >>
  /Contents 4 0 R
>> endobj
4 0 obj << /Length 41 >> stream
BT /F1 20 Tf 100 700 Td (Hello PDF) Tj ET
endstream endobj
5 0 obj <<
  /Type /Font
  /Subtype /Type1
  /BaseFont /Helvetica
>> endobj

xref
0 6
0000000000 65535 f
0000000110 00000 n
0000000159 00000 n
0000000216 00000 n
0000000352 00000 n
0000000443 00000 n
trailer << /Size 6 /Root 1 0 R >>
startxref
523
```

A polyglot file

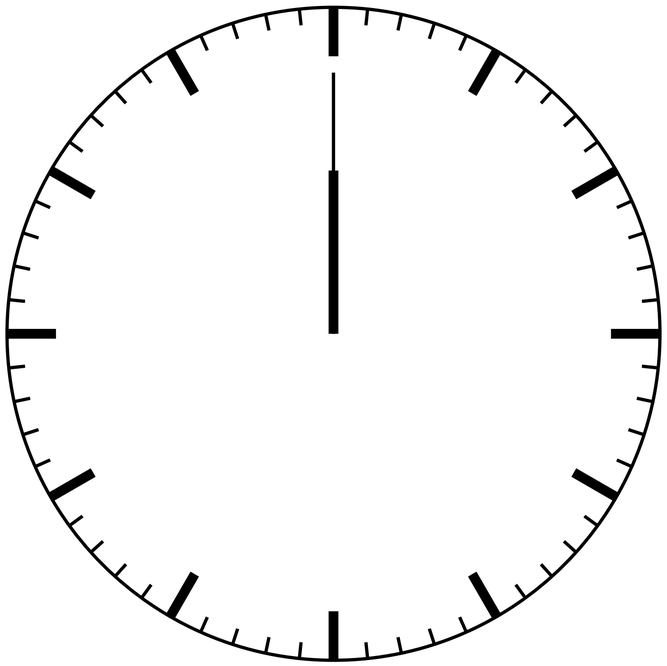
Write PostScript




```
$ gs x.ps
```

Purpose	Instructions
print	`==`
print string	`(asd) ==`
print stack	`pstack stop`

Clock



17:44

```
/datetime (%Calendar%) currentdevparams def

/H datetime /Hour get def
/M datetime /Minute get def

/x 150 def
/y 170 def
/r 100 def

% Clock circle
newpath
x y r 0 360 arc
stroke

x y translate

% Side marks
gsave
0 1 59 {
    r 0 moveto
    5 mod 0 eq {
        3 setlinewidth
        r 0.85 mul 0 lineto
    } {
        1 setlinewidth
        r 0.95 mul 0 lineto
    } ifelse
    stroke
    6 rotate
} for
grestore
```

ifelse

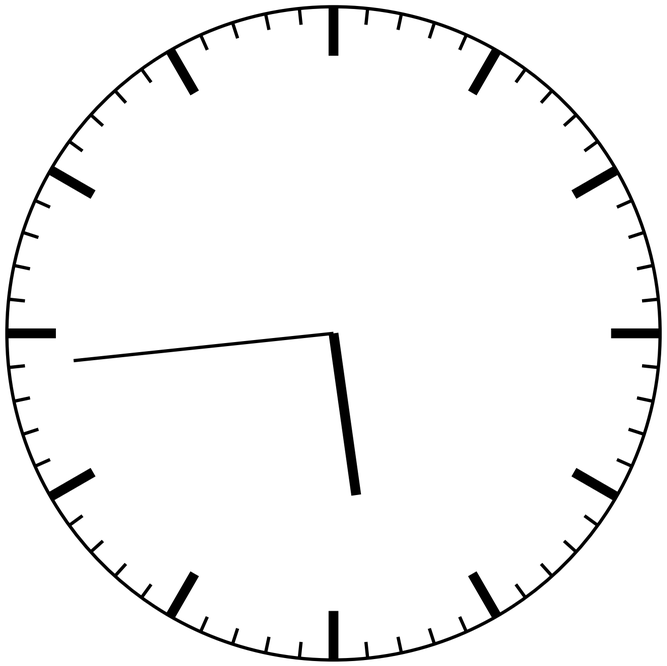
Enviroment data in various dictionaries

```
% Minutes hand
gsave
0
neg rotate

0 0 moveto
0 r 0.8 mul lineto
1 setlinewidth
stroke
grestore

% Hours hand
gsave
0
neg rotate

0 0 moveto
0 r 0.5 mul lineto
3 setlinewidth
stroke
grestore
```

← ?

← ?

Clock



17:44

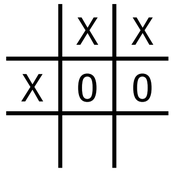
```
/datetime (%Calendar%) currentdevparams def

/H datetime /Hour get def
/M datetime /Minute get def

/x 150 def
/y 170 def
/r 100 def

% Clock circle
newpath
x y r 0 360 arc
stroke

x y translate

% Side marks
gsave
0 1 59 {
    r 0 moveto
    5 mod 0 eq {
        3 setlinewidth
        r 0.85 mul 0 lineto
    } {
        1 setlinewidth
        r 0.95 mul 0 lineto
    } ifelse
    stroke
    6 rotate
} for
grestore

% Minutes hand
gsave
360 60 div M mul
neg rotate

0 0 moveto
0 r 0.8 mul lineto
1 setlinewidth
stroke
grestore

% Hours hand
gsave
360 12 div H mul
360 12 div 60 div M mul add
neg rotate

0 0 moveto
0 r 0.5 mul lineto
3 setlinewidth
stroke
grestore
```

Agenda

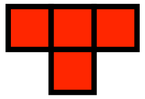
RICOH M C240FW
Digitec, 275 CHF

1. Program in PostScript?

2. **Play against a printer?**



3. Games for desktop?



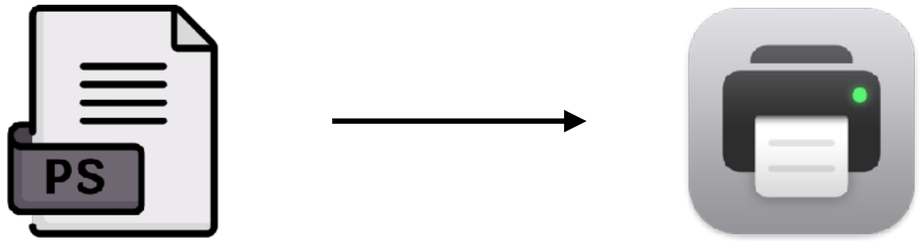
Communication with Printer

```
cat stairs.ps | nc 172.16.158.21 9100
```

Executive Mode

```
nc 172.20.10.4 9100
%!PS
executive
```

DEMO



Bi-directional communication

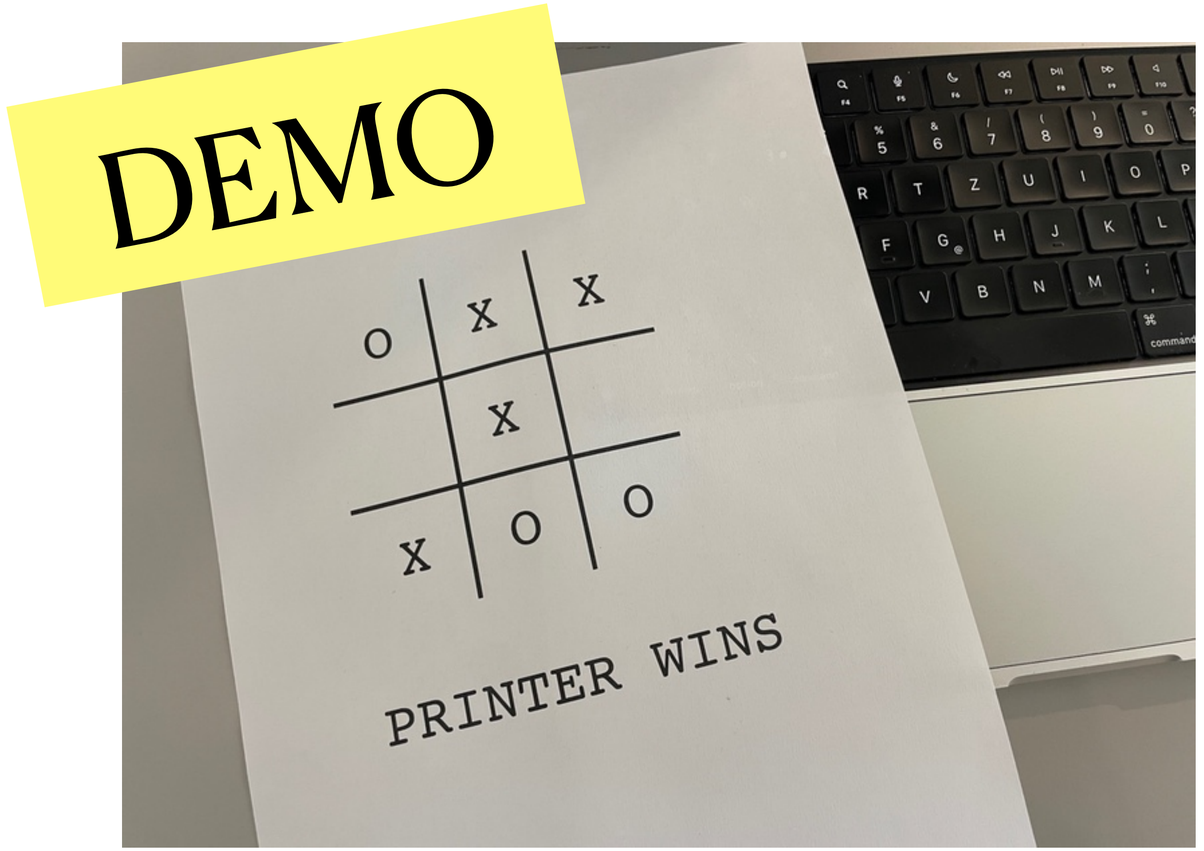
```
cat x.ps - | nc 192.168.2.10 9100
```

Dash “-“ to read stdin

Read user Input

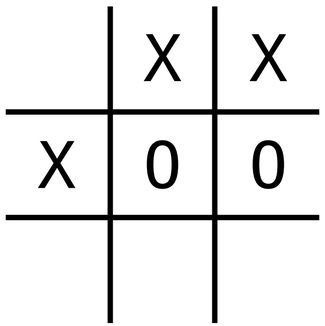
```
(%lineedit) (r) file (         ) readline pop
```

Tic-Tac-Toe



Data Structure

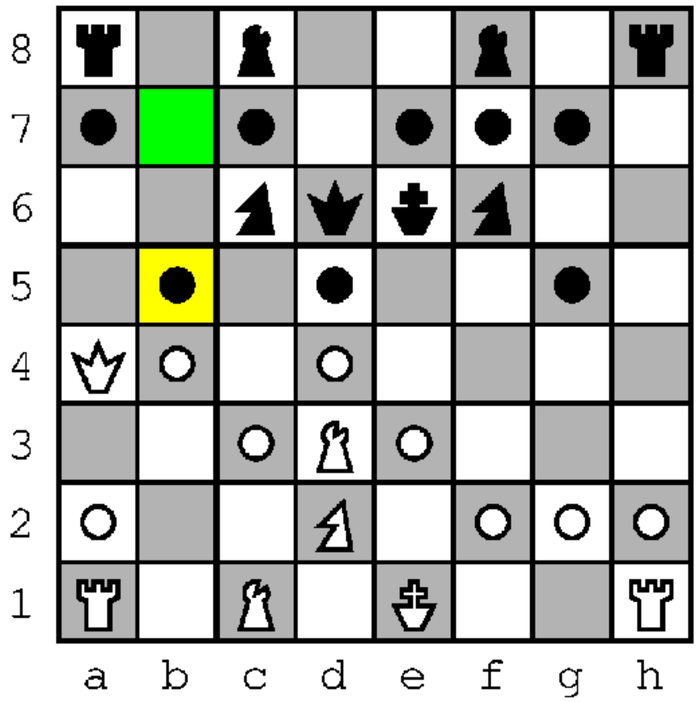
```
/b (.........) def

/numberOfFreePos {
    0 % reduce
    b { 46 eq { 1 add } if } forall
} def
```



Algorithm

```
LOOP:
    IF someone_wins:
        EXIT
    ELIF can_win:
        win
    ELIF can_block_human:
        block_human
    ELSE:
        play_randomly
get_human_input
```

PSChess




```
black b7 b5
-375

-

white turn
```

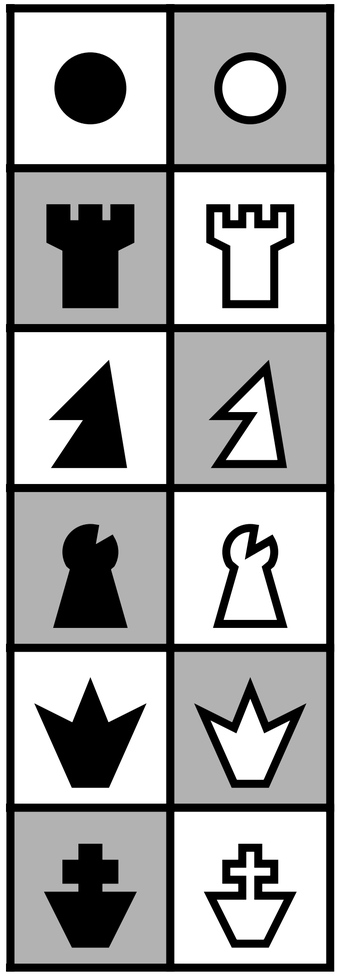
```
r...r...        black h8 e8
pppkb.Q.        320
..bqp...
...p..Np        P..............
...B.Pn.        npp............
..P...PB
PP.NP..P        -
..KR...R        white turn
```

DEMO

"PostScript is deep magic that I admire from a distance. This is some mad scientist stuff. Great work."

–tambourine_man on Hacker News

Design



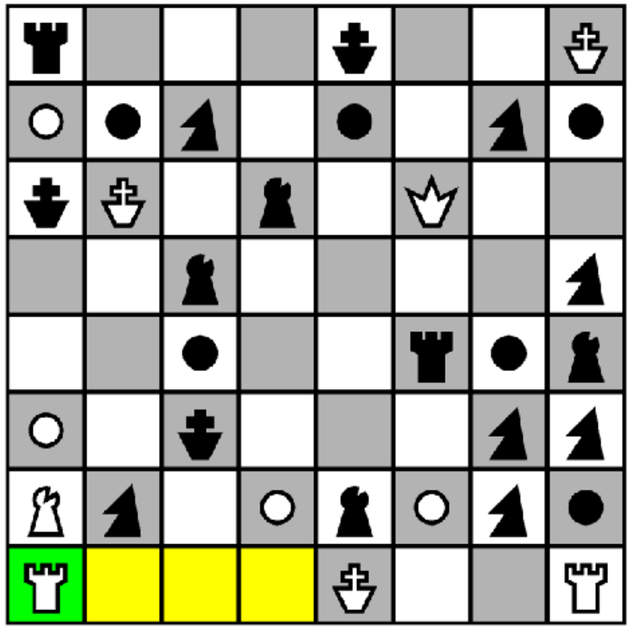
```
/m { moveto } def
/l { lineto } def

/p { newpath SQUARE_SIZE 2 div SQUARE_SIZE 2 div 4 0 360 arc closepath } def

/r { newpath 5 15 m 7 15 l 7 13 l 9 13 l 9 15 l 11 15 l 11 13 l 13 13 l
     13 15 l 15 15 l 15 11 l 13 10 l 13 3 l 7 3 l 7 10 l 5 11 l 5 15 l
     closepath } def

/n { newpath 12 15 m 14 3 l 6 3 l 10 9 l 6 9 l closepath } def

/b { newpath 14 3 m 12 10 l 10 12 3 -30 30 arc
     10 12 l 10 12 3 80 210 arc 8 10 l 6 3 l closepath } def

/q { newpath 4 12 m 8 10 l 10 15 l 12 10 l 16 12 l 12 3 l 8 3 l closepath } def

/k { newpath 8 3 m 5 9 l 9 9 l 9 11 l 7 11 l 7 13 l 9 13 l 9 15 l 11 15 l
    11 13 l 13 13 l 13 11 l 11 11 l 11 9 l 15 9 l 12 3 l closepath } def
```

Imports and Tests

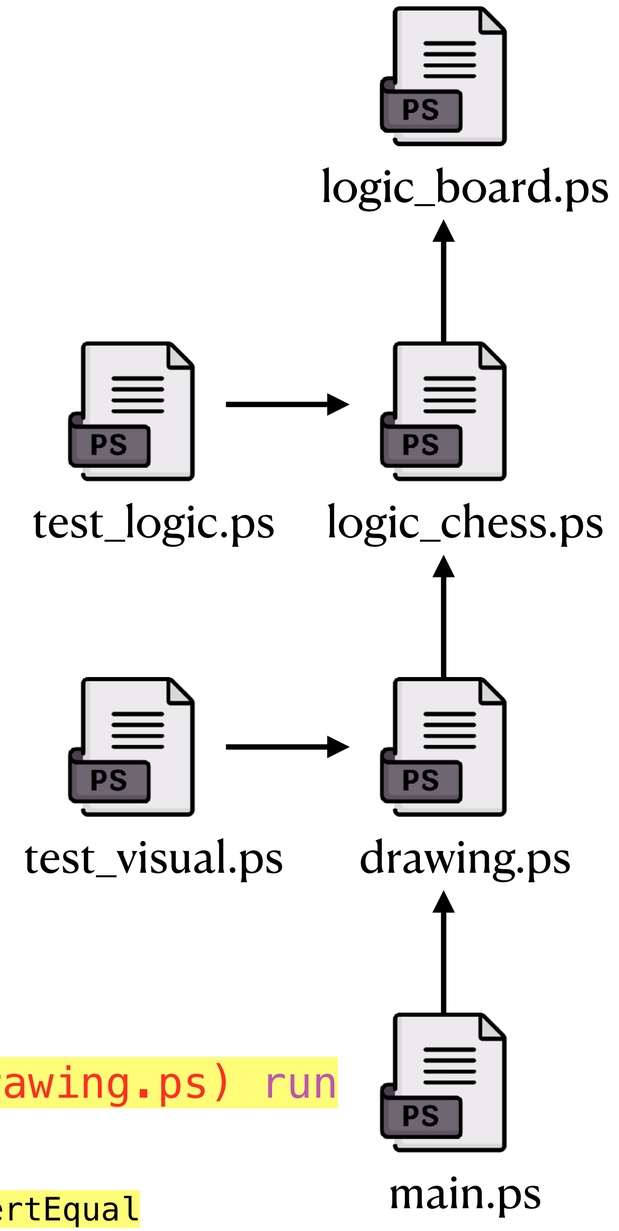
test_logic.ps

```
/TestEnPassant {
    (TestEnPassant) CS_PUT

    save

    /board (\
........\
...p....\
........\
....P...\
........\
........\
........\
........\
) _s_Dup_s_ def

    % black pawn moves 2 steps forward
    % white takes it "en-passant"

    GameState (CURRENT_PLAYER) (black) put

    (TEST TestEnPassant.1) { GameState (EN_PASSANT_BLACK_CANDIDATE) get } _s_proc_AssertNull

    board (d7) (d5) false _board_fc_tc_dry_Move_canMove_squaresStatus_msg_
    /_canMove exch def
    /_highlights exch def
    /_msg exch def

    (TEST TestEnPassant.2) { GameState (EN_PASSANT_BLACK_CANDIDATE) get } { (d5) } _s_p1_p2_AssertEqual
```

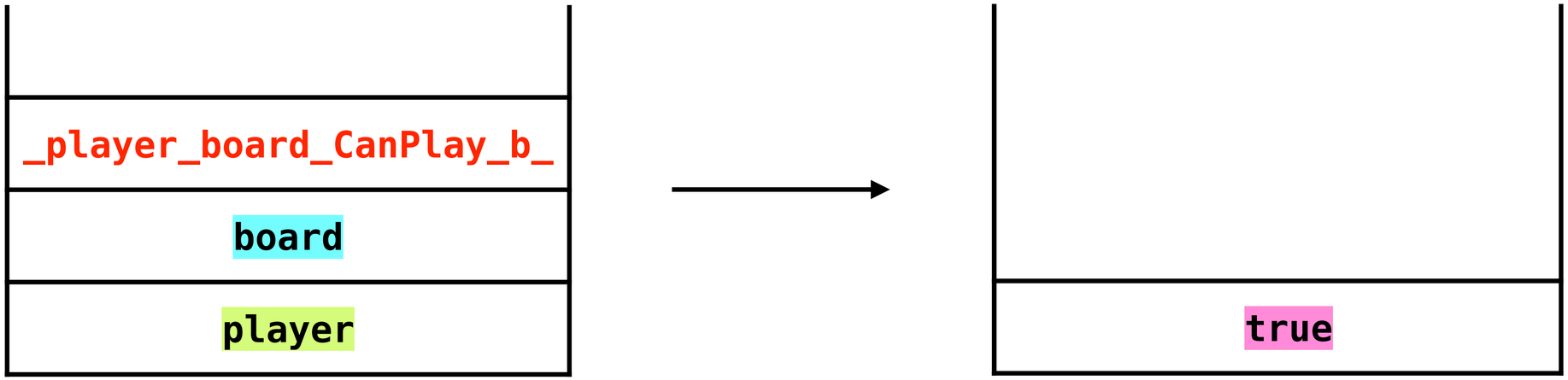
Data Structure



test_visual.ps



Naming Conventions

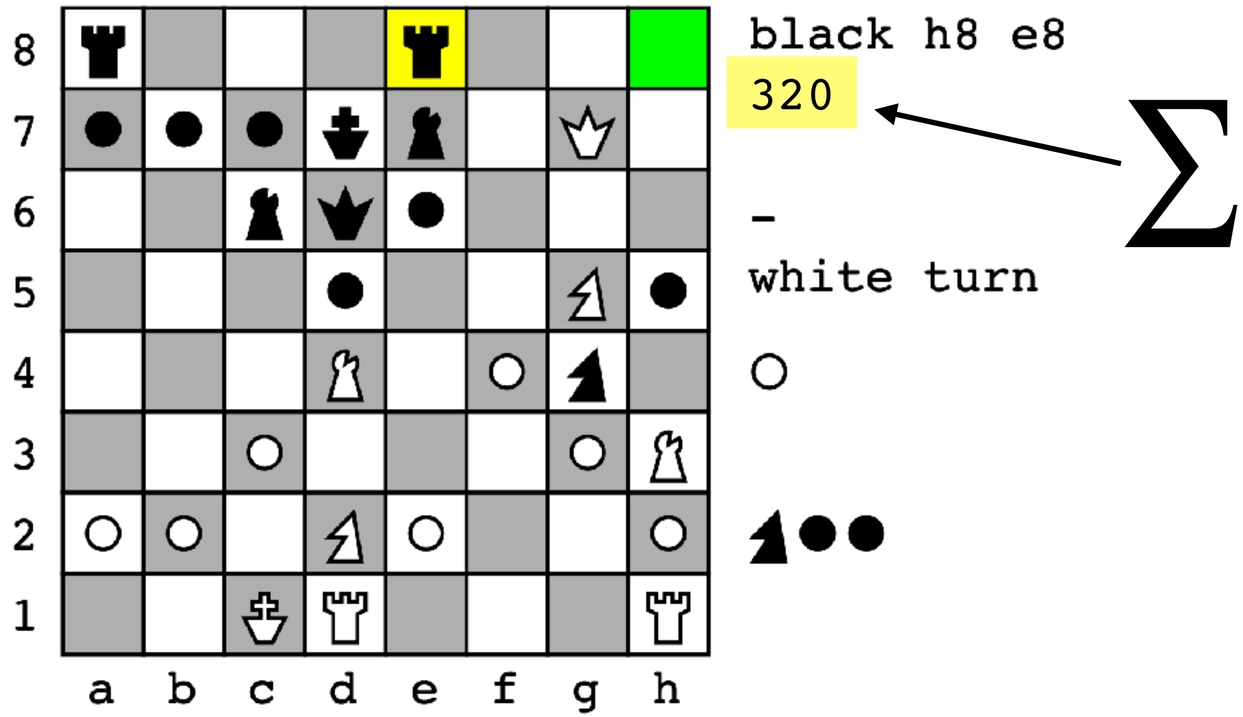



```
/_player_board_CanPlay_b_ { } def

player board _player_board_CanPlay_b_ { } if

def canPlay(player, board) -> bool
```

Evaluation Function

```
/WhitePieceValueDict
<<
    (P) 100
    (N) 320
    (B) 330
    (R) 500
    (Q) 900
    (K) 20000
    (.) 0
>> def

(N) [ -50 -40 -30 -30 -30 -30 -40 -50
      -40 -20   0   0   0   0 -20 -40
      -30   0  10  15  15  10   0 -30
      -30   5  15  20  20  15   5 -30
      -30   0  15  20  20  15   0 -30
      -30   5  10  15  15  10   5 -30
      -40 -20   0   5   5   0 -20 -40
      -50 -40 -30 -30 -30 -30 -40 -50 ]

(B) [ -20 -10 -10 -10 -10 -10 -10 -20
      -10   0   0   0   0   0   0 -10
      -10   0   5  10  10   5   0 -10
      -10   5   5  10  10   5   5 -10
      -10   0  10  10  10  10   0 -10
      -10  10  10  10  10  10  10 -10
      -10   5   0   0   0   0   5 -10
      -20 -10 -10 -10 -10 -10 -10 -20 ]

% ...
```

(Tomasz Michniewski)

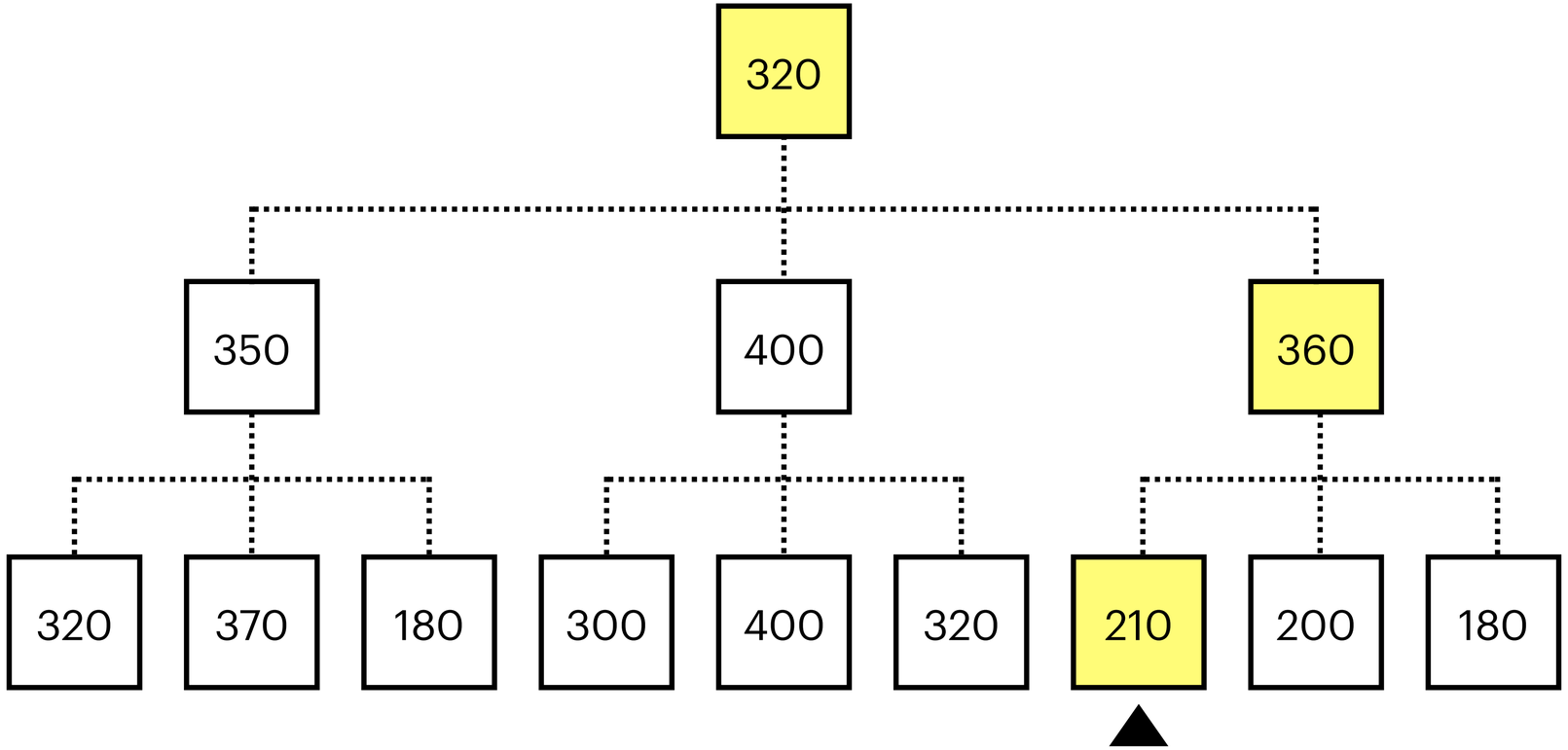


Minmax

Black moved

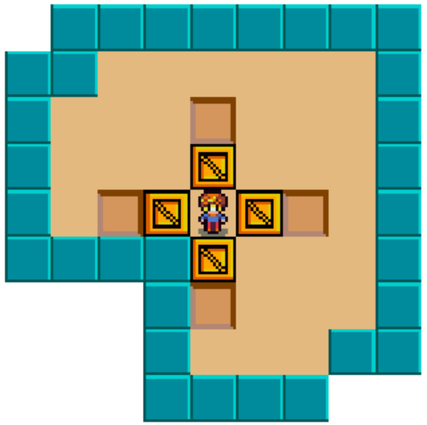
White may move

Black may move



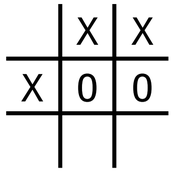
Minimize opponent's advantage

Agenda

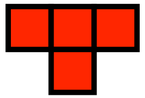


1. Program in PostScript?

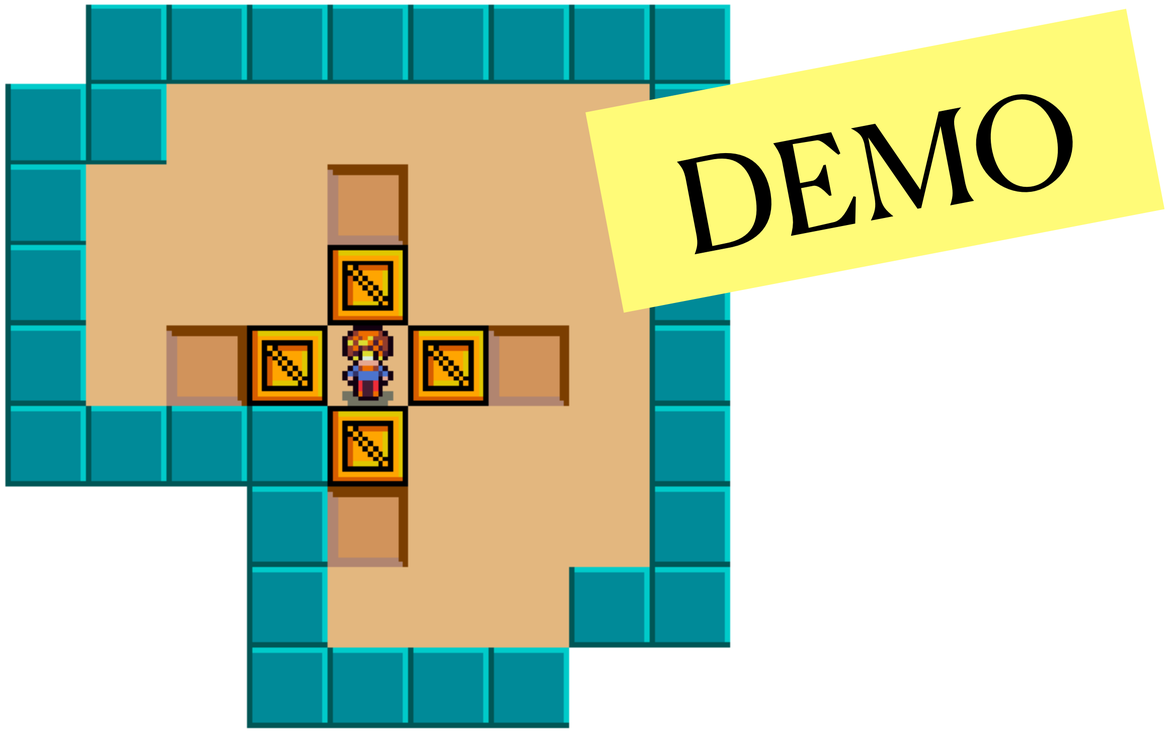
2. Play against a printer?



3. **Games for desktop?**

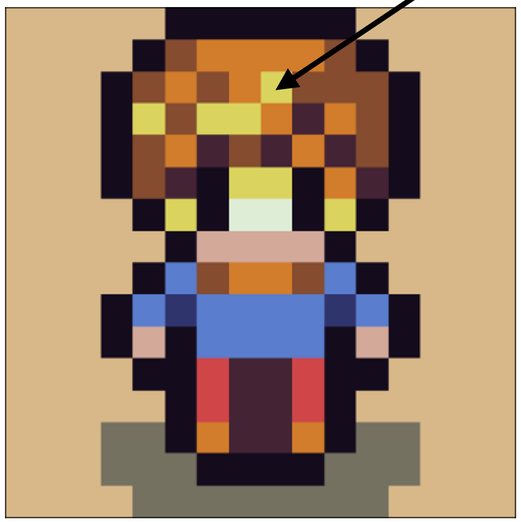


PSSokoban



Level:0 Moves:0 Push:0

Images



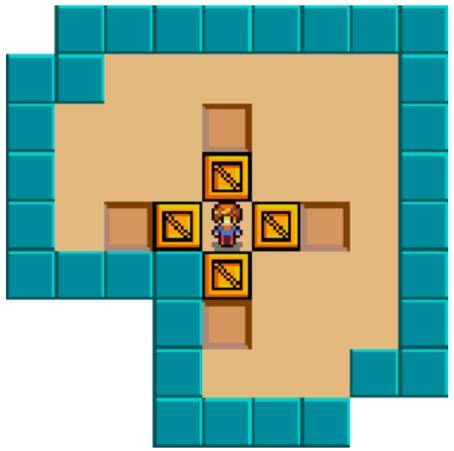
https://opengameart.org/

DD5

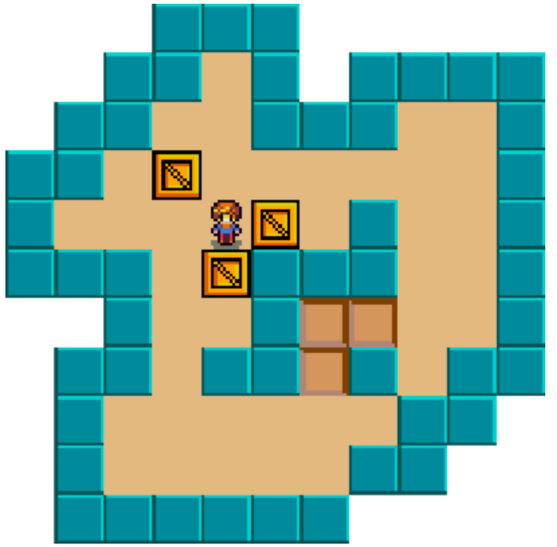
```
/DeviceRGB setcolorspace

/imageData {
    (
        DB8 DB8 DB8 DB8 DB8 101 101 101 101 101 101 DB8 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 101 843 D72 D72 D72 D72 843 101 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 101 843 D72 843 D72 DD5 843 843 843 101 DB8 DB8 DB8
        DB8 DB8 DB8 101 DD5 843 DD5 DD5 D72 423 D72 843 101 DB8 DB8 DB8
        DB8 DB8 DB8 101 843 D72 423 843 423 D72 423 843 101 DB8 DB8 DB8
        DB8 DB8 DB8 101 843 423 101 DD5 DD5 101 D72 423 101 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 101 DD5 101 DED DED 101 DD5 101 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 DB8 101 DA9 DA9 DA9 DA9 101 DB8 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 101 57C 843 D72 D72 843 57C 101 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 101 57C 336 57C 57C 57C 57C 336 57C 101 DB8 DB8 DB8
        DB8 DB8 DB8 101 DA9 101 57C 57C 57C 57C 101 DA9 101 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 101 101 D44 423 423 D44 101 101 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 DB8 101 D44 423 423 D44 101 DB8 DB8 DB8 DB8 DB8
        DB8 DB8 DB8 776 776 101 D72 423 423 D72 101 776 776 DB8 DB8 DB8
        DB8 DB8 DB8 776 776 776 101 101 101 101 776 776 776 DB8 DB8 DB8
        DB8 DB8 DB8 DB8 776 776 776 776 776 776 776 776 DB8 DB8 DB8 DB8
    )
} def

<<
    /ImageType          1
    /Width              16
    /Height             16
    /BitsPerComponent   4   % 0-F
    /ColorSpace         /DeviceRGB
    /ImageMatrix        [1 0 0 -1 0 0]
    /DataSource         imageData /ASCIIHexDecode filter
>>
image
```

Levels

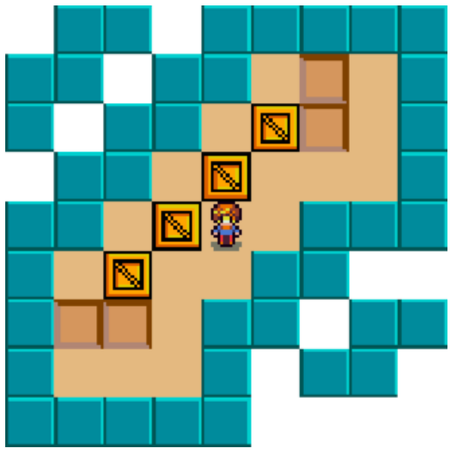
```
% Game symbols:
% (@) Man
% (+) ManOnGoal
% ($) Box
% (*) BoxOnGoal
% (#) Wall
% (.) Goal
% ( ) or (-) Floor
```



```
/l0 (
########
##------#
#---.---#
#---$---#
#-.$@$.-#
####$---#
   #.---#
   #---##
   #####) def
```

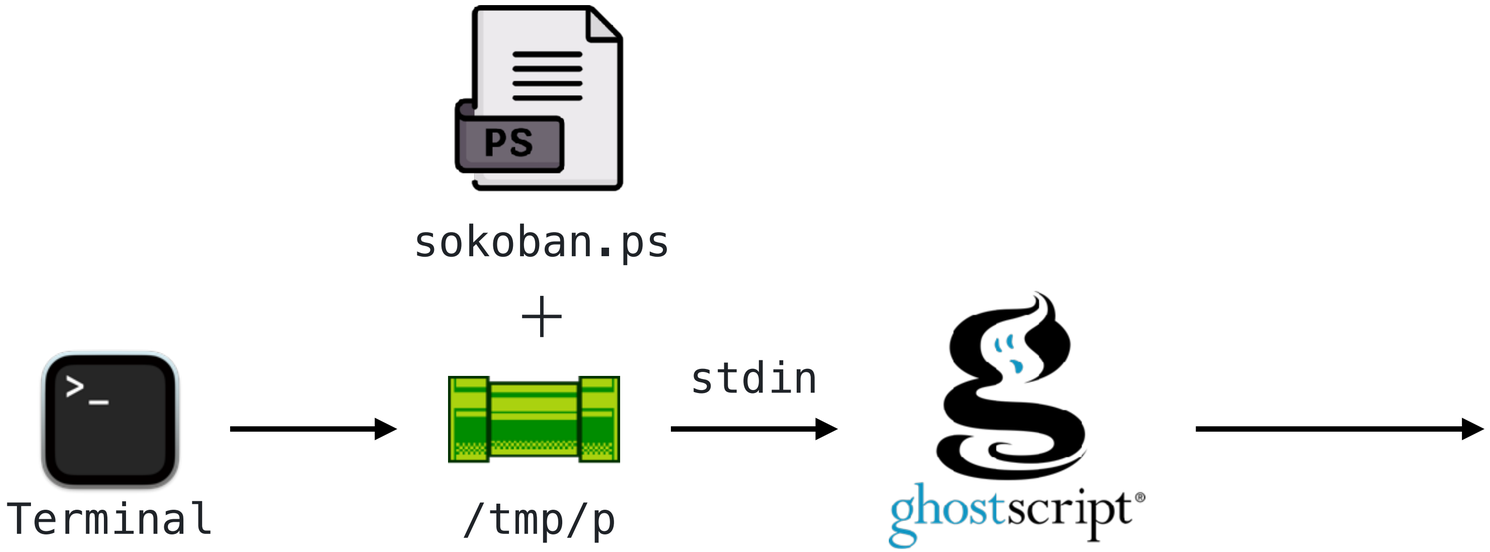


```
/l1 (
    ###
  ##-# ####
 ##--###--#
##-$------#
#---@$-#--#
###-$###--#
  #--#..--#
 ##-##.#-##
 #------##
 #-----##
 #######) def
```



```
/l2 (
 ## #####
## ##-.-#
# ##-$.-#
 ##-$---#
##-$@-###
#-$--##
#..-## ##
#---# ##
##### #) def
```

Keystrokes



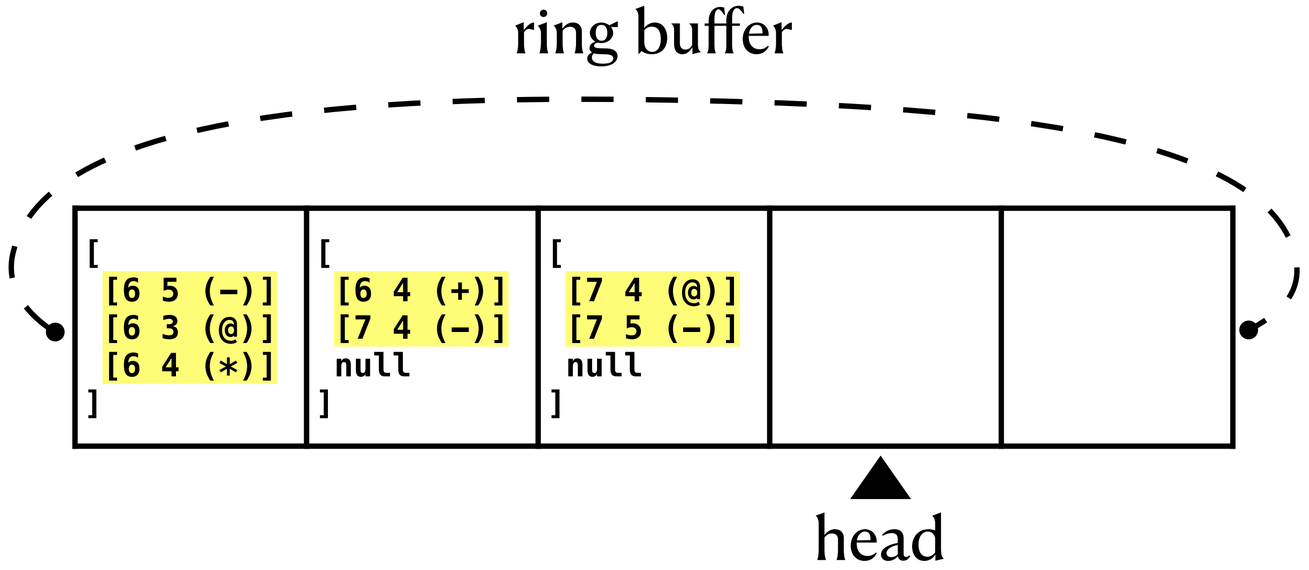

```
$ mkfifo /tmp/p; cat sokoban.ps /tmp/p | gs -
$ stty raw -echo; cat > /tmp/p
```

immediate input,
no enter, no newline

standard input is coming
from a file or a pipe

```
(%stdin) (r) file read {
    /key exch def

     65 key eq { } if % UP
     66 key eq { } if % DOWN
     67 key eq { } if % RIGHT
     68 key eq { } if % LEFT
} {
    exit
} ifelse
```

Undo Manager



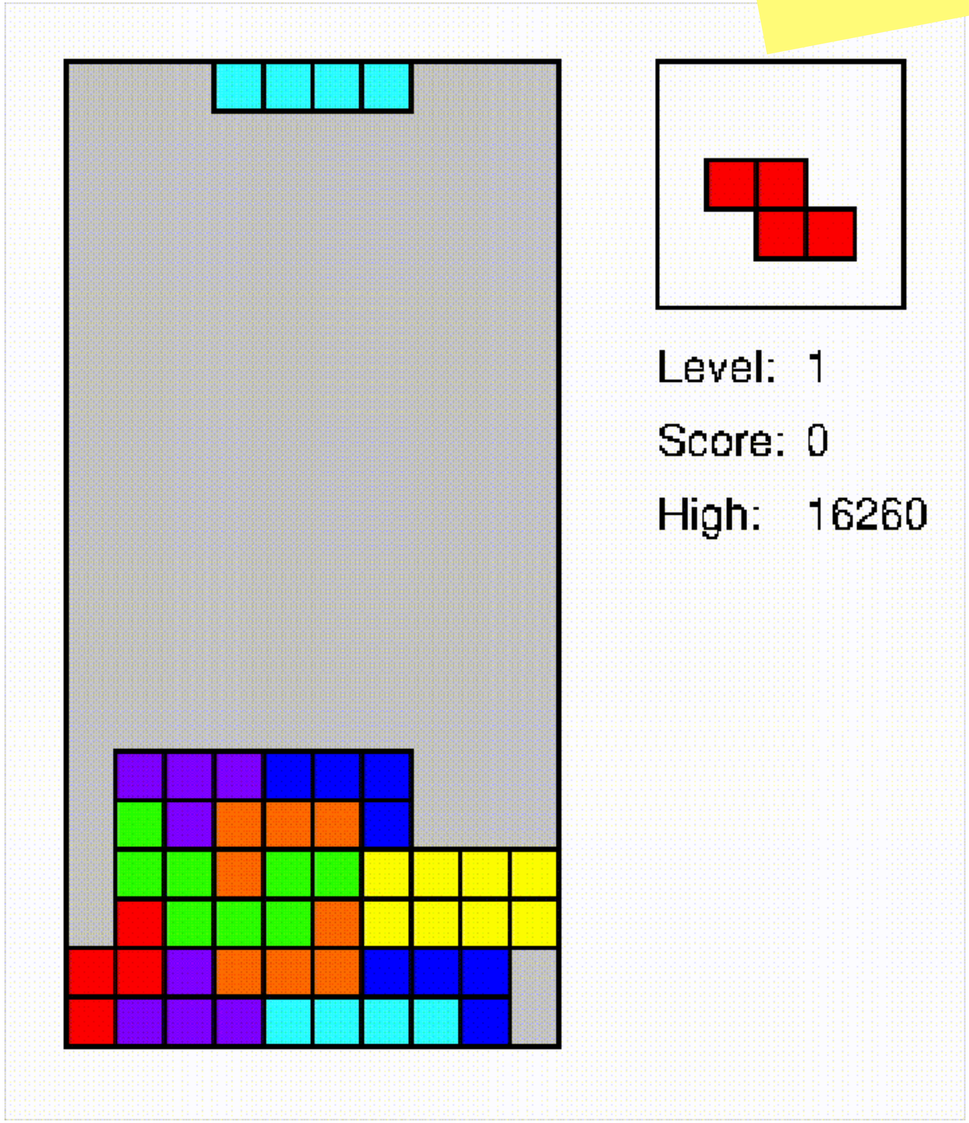

```
/umSize 1000 def
/umRingBuffer umSize array def
/umHead 0 def
/umDo {
    umRingBuffer umHead 3 -1 roll put
    /umHead umHead 1 add umSize mod def
} def
/umUndo {
    /umHead umHead 0 eq { umSize 1 sub } { umHead 1 sub } ifelse def
    umRingBuffer umHead get % result
    umRingBuffer umHead null put
} def
```

store former contents of changed cells

(see OOP attempt)

PSTris

DEMO

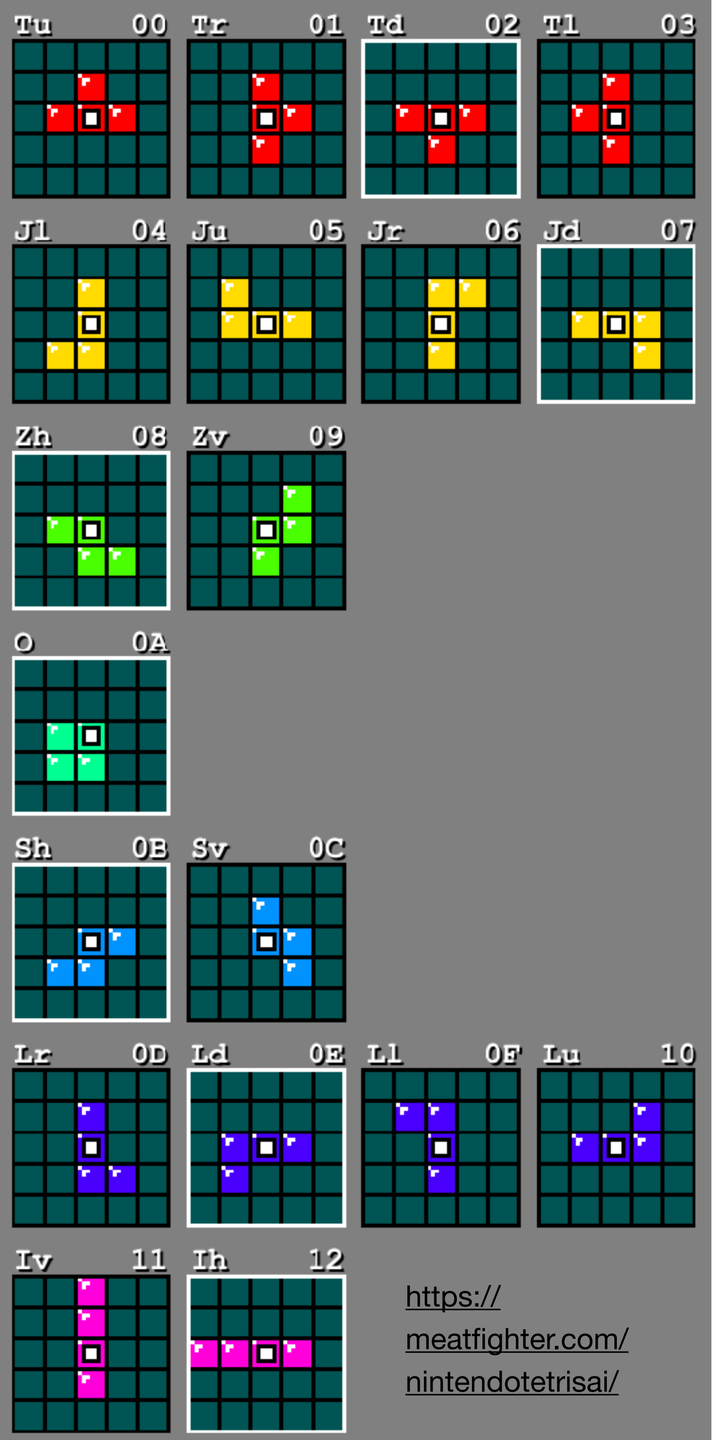


“The sheer existence of this creation is both equally impressing and depressing.”

–MBussard45 on Reddit

“using raw postscript in this perverse way to get interactivity is truly inspired. My hat is off to the author.”

–hamburglar on Hacker News



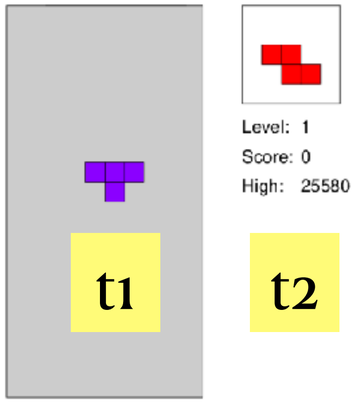
https://
meatfighter.com/
nintendotetrisai/

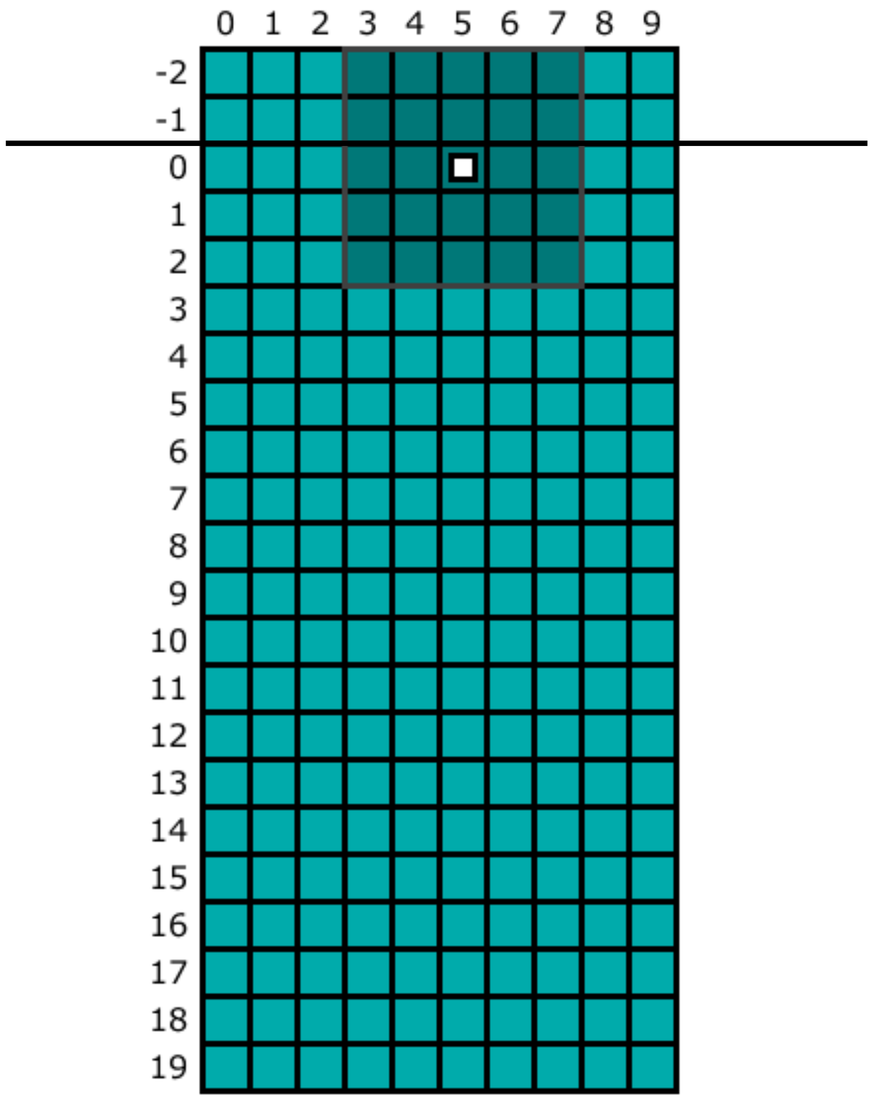
```
/Tu [0 0 0 0 0 0 0 1 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0] def
/Tr [0 0 0 0 0 0 0 1 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0] def
/Td [0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 0 0 0 0 0 0 0] def
/Tl [0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0 0] def
/Jl [0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 0] def
/Ju [0 0 0 0 0 0 1 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0] def
/Jr [0 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0] def
/Jd [0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 1 0 0 0 0 0] def
/Zh [0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0] def
/Zv [0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0] def
/O  [0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 1 1 0 0 0 0 0 0] def
/Sh [0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0] def
/Sv [0 0 0 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0] def
/Lr [0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 0 0] def
/Ld [0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 1 0 0 0 0 0 0 0] def
/Ll [0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0] def
/Lu [0 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0] def
/Iv [0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0] def
/Ih [0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0] def
```

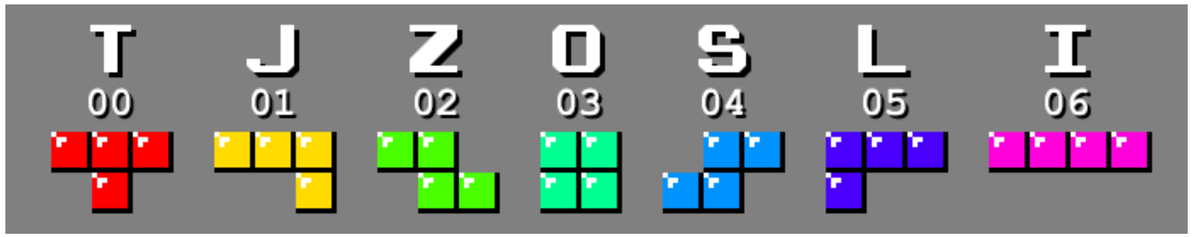
```
/Tetriminos [
    [Td Tl Tu Tr]
    [Jd Jl Ju Jr]
    [Zh Zv]
    [O]
    [Sh Sv]
    [Ld Ll Lu Lr]
    [Ih Iv]
] bind def
```

Data Structures

```
/t1c NewTetrimino_i_ def % code
/t1r 0 def               % rotation

/t2c NewTetrimino_i_ def % code
/t2r 0 def               % rotation
```





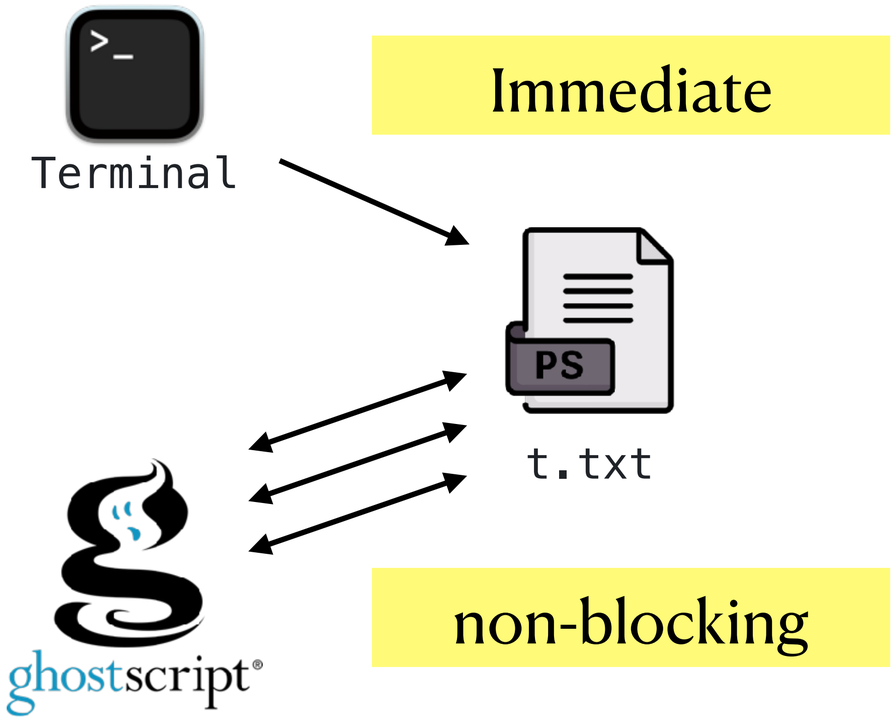


+10 for active tetrimino

				10	10	10			
					10				
		1	1	1		0	2	2	
6	6	6	6	1	0	0	0	2	2

User Input

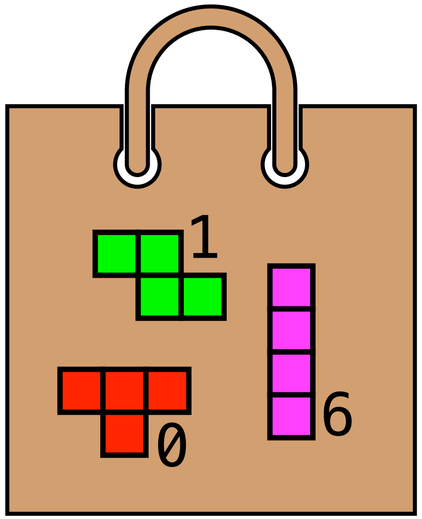
```
$ stty raw -echo; cat >> t.txt
```

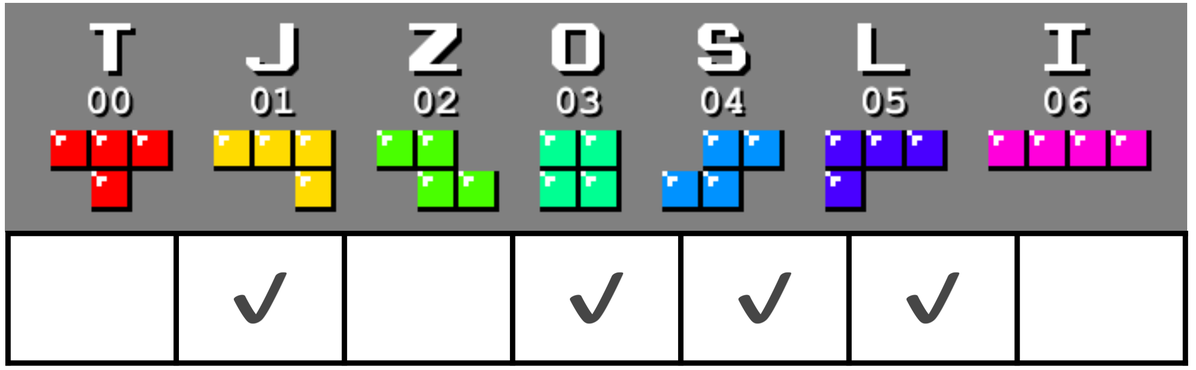



```
$ gs -sNOSAFER tetris.ps
```

```
/ReadInput_s_ {
    (t.txt) (r) file 8 string readstring pop
    dup length 0 ne { (t.txt) (w) file closefile } if
} def

{   % read continuously
    ReadInput_s_ {
        /key exch def
        gameIsOver {
            key 110 eq { } if % new game
        } {
            key 67  eq { } if % right
            key 68  eq { } if % left
            key 66  eq { } if % down
            key 65  eq { } if % rotate
            key 32  eq { } if % drop
        } ifelse
    } forall
} loop
```

Random Bag






```
/BAG_SIZE 7 def
/randomBag BAG_SIZE array def

/NewTetrimino_i_ {

    % pick random index with null value, set value to true
    {
        /i rand BAG_SIZE mod def
        randomBag i get null eq { randomBag i true put exit } if
    } loop

    i % leave this index on stack

    % if array is filled with true, create a new empty array
    /isFull true def
    randomBag { null eq { /isFull false def exit } if } forall
    isFull { /randomBag BAG_SIZE array def } if
} def
```

Levels, Speed and Scoring

```
hasFullRows {
    % ...

    % count lines cleared
    /linesCleared linesCleared n add def

    % next level every 10 lines
    /level linesCleared 10 idiv 1 add def

    % increase speed as level increase
    /delay 300 level 1 sub 30 mul sub def

    % Nintendo scoring system
    /score [40 100 300 1200] n 1 sub get level mul score add def

} if
```

LEVEL	0	1	2	3	4	5	6	7	8	9
Single	40	80	120	160	200	240	280	320	360	400
Double	100	200	300	400	500	600	700	800	900	1000
Triple	300	600	900	1200	1500	1800	2100	2400	2700	3000
TETRIS	1200	2400	3600	4800	6000	7200	8400	9600	10800	12000

* This table applies to both game A and B.
* The score increases in the same way at LEVEL 10 and higher.

High Scores

Save arbitrary files, persisted across sessions.

High scores, full games and state secrets alike.

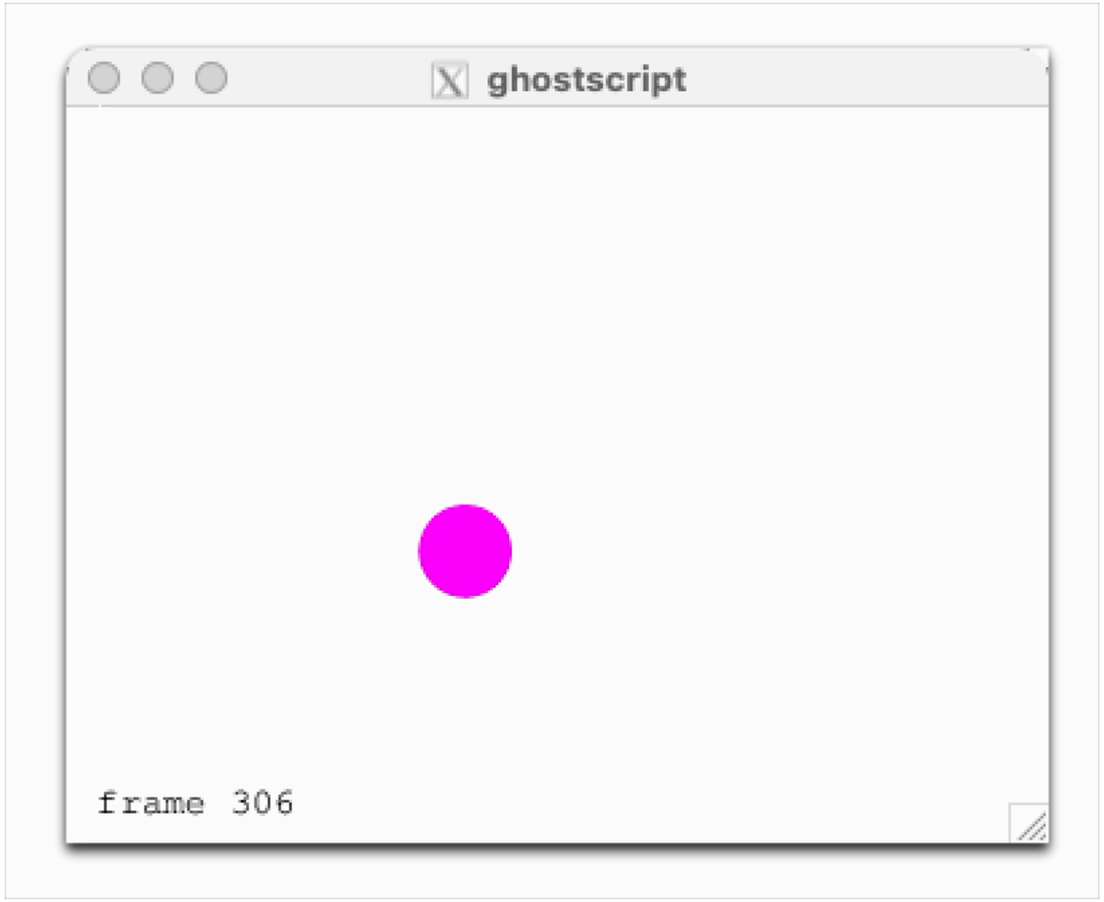
```
/ListFiles {
    (*) { == } 256 string filenameforall
} def
```

```
/_s_fn_WriteFile {
    /f exch (w) file def
    f exch writestring
    f flushfile
    f closefile
} def
```

```
/_fn_ReadFile_s_ {
    (r) file
    256 string
    readstring
    pop
} def
```

```
PS>ListFiles

PS>(coucou) (x.txt) _s_fn_WriteFile

PS>ListFiles
(x.txt)

PS>(x.txt) _fn_ReadFile_s_ ==
(coucou)
```

Animations



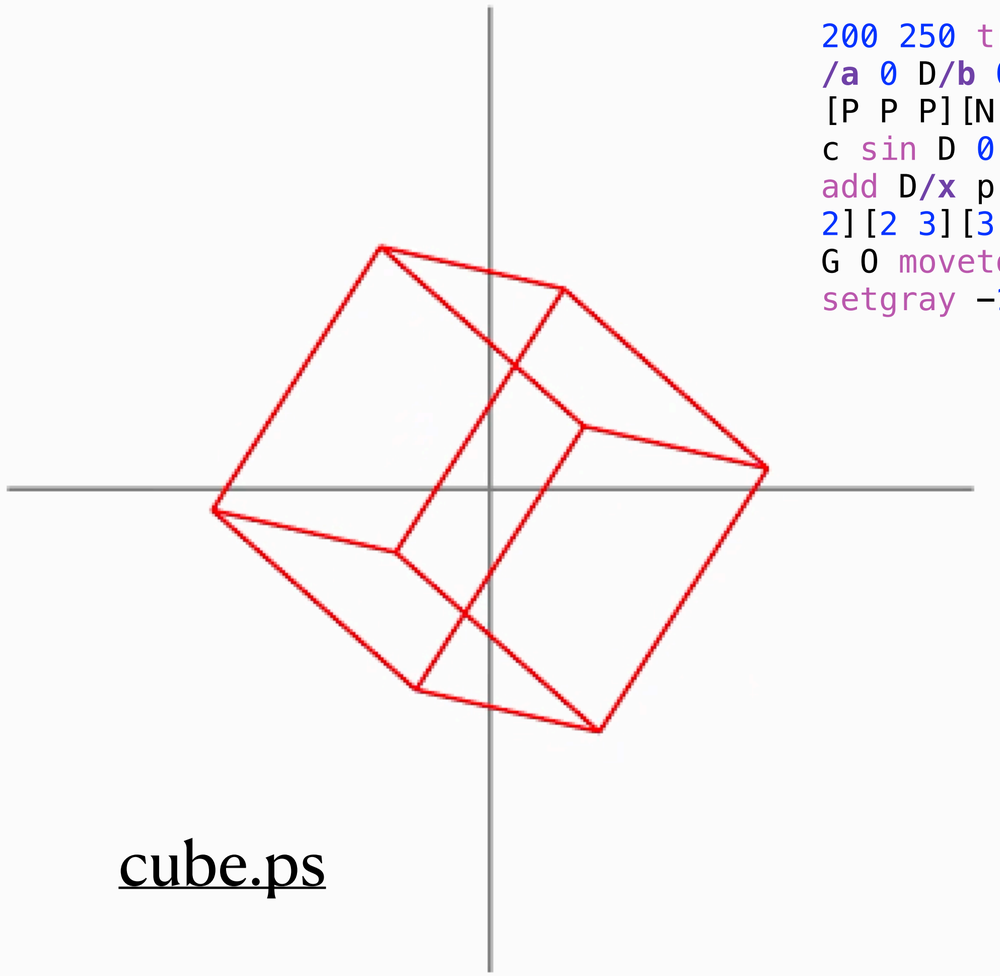

```
/W 320 def /H 240 def /R 15
/x 100 def /y 50 def def /x_ 2 def /y_ 1 def
<< /PageSize [W H] >> setpagedevice

{
    % Clear
    1 setgray 0 0 320 240 rectfill

    % Draw
    x R sub 0 lt x R add W gt or {
        /x_ x_ -1 mul def
    } if
    y R sub 0 lt y R add H gt or {
        /y_ y_ -1 mul def
    } if
    /x x x_ add def /y y y_ add def
    newpath x y R 0 360 arc 1 0 1 setrgbcolor fill
    10 10 moveto 0 setgray
    flushpage

    % Sleep
    1000000 {} repeat
} loop
```

Clear

Draw

Sleep

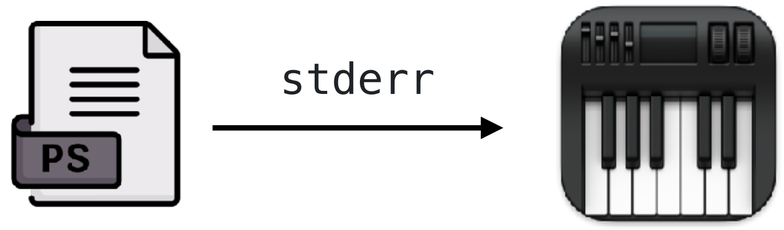
3D and Music



cube.ps

```
200 250 translate/D{def}def/M{mul}D/Z{2000000{}repeat}D/P 50 D/N{P neg}D/G{get}D
/a 0 D/b 0 D/c 0 D/o{0 G}D/O{1 G}D{/v[[N N N][P N N][P P N][N P N][N N P][P N P]
[P P P][N P P]]D/w 8 array D/f a cos D/d b cos D/e c cos D/s a sin D/t b sin D/u
c sin D 0 1 7{/i exch D/p v i G D/y p O f M p 2 G s M sub D/z p O s M p 2 G f M
add D/x p o d M z t M add D w i[x e M y u M sub x u M y e M add]put}for[[0 1][1
2][2 3][3 0][4 5][5 6][6 7][7 4][0 4][1 5][2 6][3 7]]{/E exch D w E o G o w E o
G O moveto w E O G o w E O G O lineto}forall 0 setgray stroke flushpage Z 1
setgray -100 dup 200 dup rectfill/a a 0.1 add D/b b 0.3 sub D/c c 0.5 sub D}loop
```

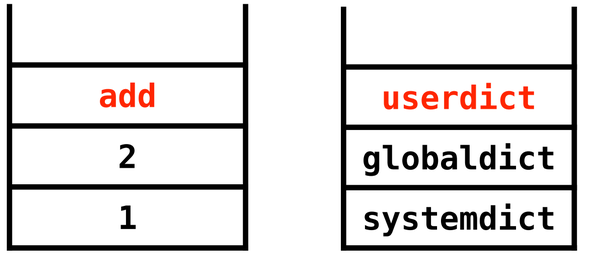
Send MIDI messages to MIDI synthetizer



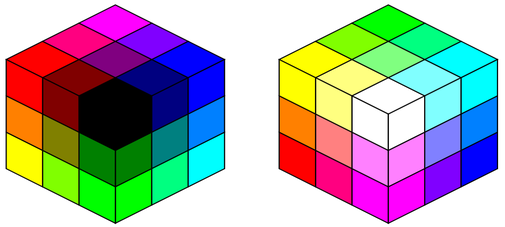
music.ps

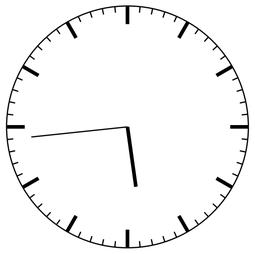
1

Program in PostScript?



Operands Dictionaries

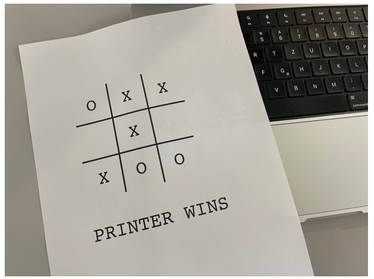


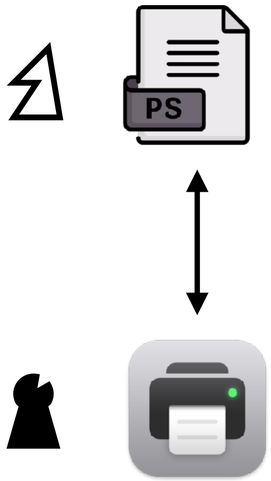


17:44

2

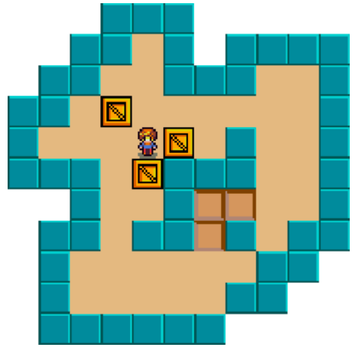
Play against a printer?



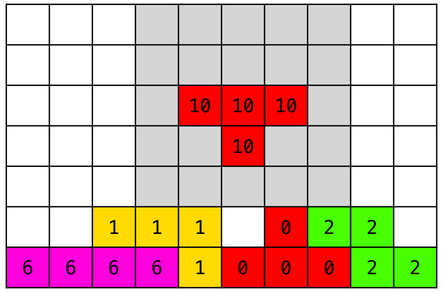


3

Games for desktop?



```
/l1 (
   ###
  ##-# ####
 ##--###--#
##-$------#
#---@$-#--#
###-$###--#
  #--#..--#
 ##-##.#-##
 #------##
 #-----##
 #######) def
```



Take Aways

- You will never **look at printers** the same way again
- Maybe supposedly dumb tools are not that dumb
- Constraints foster **creativity**
- Building unexpected things with unexpected tools is great fun
- **Hacking** is not just about security, it's also about **fun and art**

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