Postscript Control Flow

CSE 413, Autumn 2005

Programming Languages

http://www.cs.washington.edu/education/courses/413/05au/

Variables

- Postscript uses dictionaries to associate a name with an object value
  - » /x 3 def
    - associate value 3 with key x
  - » /inch {72 mul} def
    - define function to convert from inches to points
- Postscript dictionaries are similar to Java HashMaps
  - » key / value pairs

Several Dictionaries

- When the interpreter encounters a name, it searches the current dictionaries for that key
- At least three dictionaries are always present
  - » user dictionary
    - writeable dictionary in local virtual memory associates names with procedures and variables for the program
  - » global dictionary
    - writeable dictionary in global virtual memory
  - » system dictionary
    - read-only dictionary associates keywords with built-in actions

Dictionary Stack

- References to the dictionaries are kept on the dictionary stack
- Interpreter looks up a key by searching the dictionaries from the top of stack down
  - » search starts with *current dictionary* on top of stack
  - » initially, user dictionary is top of stack
  - » system dictionary is bottom of stack
  - » can define and push additional user dictionaries on top

Virtual Memory

- Postscript environment includes stacks and virtual memory
- Operand stack contains simple objects (eg, integers) and references to composite objects (eg, strings, arrays)
- Virtual memory (VM) is a storage pool for the values of all composite objects

save and restore

- Simple user programs define their objects in local VM
- The save operator makes a snapshot of local VM
- The restore operator throws away the current local VM and restores the state from the last save
- Local VM with save/restore pairs is used to encapsulate information whose lifetime conforms to a hierarchical structure like a page

Defining and using a variable

- Define a variable ppi and give it a value
  - » /ppi 72 def
  - » push the name ppi on the operand stack as a literal
  - » push the number 72 on the operand stack
  - » pop both items and store in the current dictionary using ppi as the key and 72 as the value
- Use the variable's value
  - » ppi 2 mul
  - » find the value of ppi (72) and push it
  - » push the number 2
  - » pop both operands, multiply, push the result

Defining and using a procedure

- Define a procedure name and give it a value
  - » /inch {72 mul} def
  - » push the name inch on the operand stack as a literal
  - » push mark, 72, mul on the operand stack
  - » pop to the mark, create an executable array, and store in the current dictionary using inch as the key and the executable array as the value
- Use the procedure's value
  - » 2 inch
  - » push the number 2
  - » look up the name inch, find the procedure, execute
  - » push 72, pop both numbers, multiply, push the result

fm constructors are procedures

```
% Circle constructor.

% FM call format => Circle(radius)
% PS call format => radius Circle.Circle
% Result: Reference to a fields array with
%         values set by arguments or defaults.

/Circle.Circle {
Circle.fields.SIZEOF array % Create the array
dup Circle.fields.radius   % radius field
4 -1 roll put              % store radius

dup Circle.fields.grayfill 0.5 put
dup Circle.fields.graystroke 0.0 put
dup Circle.fields.linewidth 1.0 put
} def
```

Boolean operators

- Comparison operators
  - » eq, ne, gt, lt, ge, le
- logical operators
  - » not, and, or, xor
  - » true, false

```
GS>2 3 ge
GS<1>==
false
GS>2 2.0 eq ==
true
GS>(abc) (acc) lt ==
true
GS>[1 2 3] dup eq ==
true
GS>[1 2 3] [1 2 3] eq ==
false
GS>
```

Conditionals and loops

- There are several operators for specifying the flow of control in a Postscript program
- Executable arrays are a basic element for the control flow operators
  - » the code block (executable array) is defined in-line
  - » {add 2 div} - calculate 2-value average
  - » the curly brackets defer interpretation of the code and force the creation of a new executable array (procedure) object

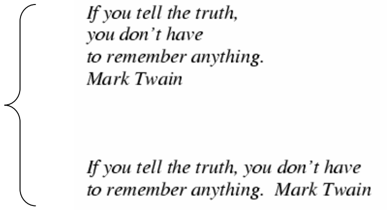
if, ifelse operators

- Take a boolean object and one or two executable arrays on the stack.
- Select and execute one of the executable arrays depending on the boolean value
- leaves nothing on the stack
  - » the code that executes may leave something ...
  - » *bool proc* if
  - » *bool* $proc_1$ $proc_2$ ifelse

an if example

```
% if current point beyond right margin, do LF CR.

/chkforendofline
{currentpoint pop          % discard y position
RM gt                      % current x > right margin?
{
0 lineheight neg translate % "linefeed"
LM 0 moveto                % "carriage return"
} if
} def
```



conditional.ps

If you tell the truth,
you don't have
to remember anything.
Mark Twain

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to remember anything. Mark Twain

repeat operator

- Repeat a procedure body n times
- *n proc* repeat

```
GS>1 2 3 4 3 {pop} repeat
GS<1>==
1
GS>
```

for operator

- Controls the standard indexed counting loop
- *initial increment limit proc* for
  - » the control value is calculated
  - » if greater than limit, the loop exits
  - » otherwise the control value is pushed and the procedure is executed

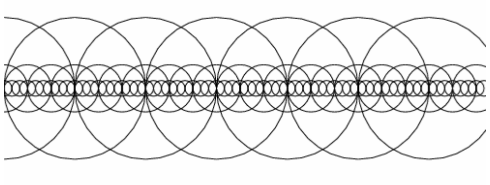
```
GS>1 1 4 {} for
GS<4>pstack
4
3
2
1
GS<4>clear
GS>0 1 1 4 {add} for
GS<1>==
10
GS>
```

loop and exit operators

- Repeat a procedure an indefinite number of times, usually until some condition is met
- The loop operator takes a procedure and executes it until an exit command is encountered within the procedure
- *proc* loop
  - » there must be an exit encountered within the body of the procedure, or the code will loop forever

loop example

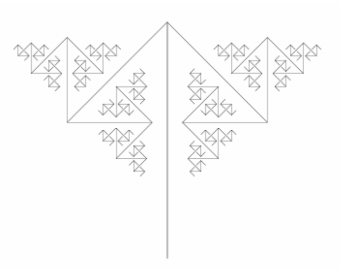
```
% call: radius y lineofcircles
/lineofcircles {
/ypos exch def
/radius exch def
/xpos 0 def
{xpos pagewidth le
  { doCircle increase-x }
  { exit }
  ifelse
} loop
} def
```



Recursion

- A loop can be set up in a program by having a procedure call itself
  - » recursion must always:
    - have a base case (an exit condition)
    - make progress towards the base case during recursion

Recursion example



```
/fractArrow {
gsave
kXScale kYScale scale
kLineWidth setlinewidth
down
doLine
depth maxdepth le
{135 rotate fractArrow
-270 rotate fractArrow
} if
up
grestore
} def
```