CSc 372

Comparative Programming Languages

34 : Icon — String Scanning

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String Parsing

find

- find(x,S) generates all the positions in S where the string x occurs.

```
][ S := "hello world";
][ .every find("l",S);
   3
   4
   10
```

find...

- Beware that when a string “changes”, there’s actually a new string constructed.

```
][  S := "axaxa";
][  every i := find("x",S) do {
       write(i); S[i]:="yy"; write(S)
    };
2
ayyaxa
4
ayyyyxa
```

Removing Nested Comments

- Idea: repeatedly remove any comments that don’t contain any other comments.

```
procedure decomment(S);
   while (1) do {
      if f := find("/*",S) &
         t := find("*/",S,f+2) &
         not (find("/*",S,f+2) < t) &
         not (find("*/",S,f+2) < t) then
         S[f:t+2] := ""
      else
         break
   }
   return S;
end
```

Nested Comments. . .

```
procedure main()
   write(decomment("/* hello world */"))
   write("---")
   write(decomment("foo /* hello world */ bar"))
   write("---")
   write(decomment("/* hello/* there */ world */"))
   write("---")
   write(decomment("foo /* hello/* there */ world */ bar"))
   write("---")
   write(decomment("foo /* hello */ there /* world */ bar"))
end
```

Nested Comments. . .

```
> icont comments.icn
> comments

---
foo  bar
---

---
foo  bar
---
foo  there  bar
```

csets

- A `cset` is a basic Icon type that describes sets of characters.
- Csets are written as a string of characters between single quotes.
- Predefined csets:

  &digits: digits between 0 to 9.

  &letters: all letters.

  &ascii: all ASCII characters

  &lcase: lower case letters.

  &ucase: upper case letters.
- The normal set operations can be performed using `++` (union), `**` (intersection), `--` (set difference), and `~` (complement).

csets...

- A string that occurs in a context where a cset is expected will be converted automatically.

```
][ write(&letters);
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghij...
][ write(&ascii);
 !"#$%&’()*+,-./0123456789:;<=>?@ABC...
][ x := ’abc123’;
][ x ** &letters;
   r13 := ’abc’  (cset)
][ "456" ++ x;
   r14 := ’123456abc’  (cset)
```

upto

- upto(x,S) generates all the positions in S where any of the characters in the cset x occur.

```
][ S := "hello world";
][ .every upto(’l’,S);
   3
   4
   10
][ write(upto(’x’,S));
Failure
][ every write(upto("l",S));
3
4
10
```

many

- many(x,S) produces the position after the longest initial substring of S containing only characters in the cset x. many(x,S) fails if the first character of S isn’t in x.

```
][ S := "hello 42 world";
][ write(many(’hel’,S));
5
][ write(many(’xyz’,S));
Failure
][ write(many(&letters,S));
6
][ write(many(&letters++’ ’,S));
7
][ write(many(’xyz’,"bbbxxxxccc"));
Failure
```

any

- any(x,S) produces 2 if the first character in S is in the cset x, and fails otherwise.

```
][ S := "hello world";
][ write(any(’hxl’,S));
2
][ write(any(’xl’,S));
Failure
```

match

- match(x,S) succeeds if the string x is a prefix of S, and fails otherwise.
- On success, match(x,s) returns the position after x.

```
][ S := "hello world";
][ write(match("hell",S));
5
][ write(match("ell",S));
Failure
][ write(match("",S));
1
][ write(match(S,S));
12
```

Removing Whitespace

- Removing initial whitespace:

```
][ S := "   hello world";
][ S[1:many(’ \t’,S)] := "";
][ S;
   r35 := "hello world"
```

String Scanning

String Scanning

- The expression s ? e makes s the subject to which string processing operations in e apply.
- The program below prints 3, 13, and 23:

```
line := "a fish is a fish is a fish"
every line ? write(find("fish"))
```

String Scanning. . .

- All the string manipulation functions above (match, many, etc.) can be used in string scanning.
- When we initiate a string scanning expression s ? e, Icon sets a special variable &subject to s, and another variable &pos (the current position) to 1.
- match, many, etc. operate directly on &subject and &pos.
- Note that find gets its argument implicitly:

```
][ "hi there" ? {write(&pos);write(&subject)};
1
hi there
][ "hi there" ? {write(find("th"))};
4
```

move

- move(i) advances the position by i characters.
- move returns the substring of the subject that is matched as a result of changing the position.
- The program below sets t to a string containing the characters of line followed by periods:

```
t := ""
line ? while t := t || move(1) || "."
```

Snapshots

- Use snap() in ie to show the current subject and position:

```
][ "hi there" ? {move(2);snap();move(3);snap()}
&subject =  h i   t h e r e
&pos =  3      |
&subject =  h i   t h e r e
&pos =  6            |
```

- You can do this in your own programs by saying link scan and calling the function snapshot().

move. . .

```
][ "hi there" ? {s := move(3); snap(); write(s)
&subject =  h i   t h e r e
&pos =  4        |
hi
```

move...

- Split up a string in odd and even characters.

```
procedure sep(S)
   O := E := ""
   S ? while O ||:= move(1) & E ||:= move(1)
   suspend O | E
end

procedure main()
   every i := sep("a1b2c3d4e5") do write(i)
end

> icont sep.icn
> sep
abcde
12345
```

tab

- tab(i) moves to position i in the subject and returns the substring between the old and new positions.

```
][ "hi there" ? {s := tab(5); snap(); write(s)}
&subject =  h i   t h e r e
&pos =  5          |
hi t
```

String Scanning Functions

- The other string scanning functions behave the same as previously shown, except that they operate on &subject and &pos implicitly.
- upto(s) returns the position of any of the characters in s, starting at the current position (&pos).
- many(s) returns the position following the longest possible substring containing only characters in s starting at the current position.

```
][ "xxyyxxxxxzzz" ? {tab(5); write(many('x'))};
10
][ "abxxyyzzz" ? {tab(4); every write(upto('xy'))};
4
5
6
```

Extracting Vowels

- Generate all the vowels in a string.

```
procedure vowels(S)
   S ? every tab(upto('aeiou')) do suspend move
end

procedure main()
   every i := vowels("foobar") do write(i)
end

> icont vowels.icn
> vowels
o
o
a
```

String Scanning Functions. . .

- any(c) succeeds if the first character in the subject string is in the cset c.

```
][ "booyah" ? {write(any('b'))};
2
][ "booyah" ? {write(any('c'))};
Failure
```

String Scanning Functions. . .

- match (t) succeeds if t matches the initial characters of the subject string and returns the position after the matched part.

```
][ "booyah" ? {write(match("boo"))};
4
   r33 := 4  (integer)
][ "booyah" ? {write(match("koo"))};
Failure
```

Combining String Scanning Functions

- It's common to combine tab and move with the other string scanning functions to extract pieces of text.

```
][ "booyah" ? {write(tab(match("boo"))); snap()
boo
&subject =  b o o y a h
&pos =  4         |
][ "xxx123yyy" ? {tab(many(&ascii--&digits));
                  snap()};
&subject =  x x x 1 2 3 y y y
&pos =  4         |
   r36 := &null  (null)
][ "xxx123yyy" ? {tab(many(&ascii--&digits));
                  write(tab(many(&digits)))};
123
```

Combining String Scanning Functions

- tab(match(S)) is so common that a shorthand has been created.
- =S returns the string S if it matches the beginning of &subject, and also moves &pos to the position after S.

```
][ "booyah" ? {write(="foo");snap()};
&subject =  b o o y a h
&pos =  1  |
][ "booyah" ? {write(="boo"); snap()};
boo
&subject =  b o o y a h
&pos =  4        |
```

Extracting Words

```
procedure getword(str)
        str ? while tab(upto(&letters)) do {
                word := tab(many(&letters))
                suspend word
        }
end
```

- tab(upto(&letters)) advances the position up to the next letter.
- tab(many(&letters)) matches the word and assigns it to word.
- The while terminates when tab(upto(&letters)) fails because there are no more words in str.

Extracting Words. . .

- The program below lists the most commonly used words in its input and their frequencies of occurrence.

```
procedure main(args)
   k := integer(args[1]) | 10
   words := table(0)
   while line := read() do
      every words[getword(line)] +:= 1
   words := sort(words, 4)
   every 1 to k do
      write(pull(words), "\n", pull(words))
end
```

Summary

Summary — Position Functions

- These functions take strings or csets as arguments and either fail or return exactly one position in the string as result.

any(c)	Returns 2 if the first charcter in &subject is in the cset c.
many(c)	Returns the position following the longest initial substring of &subject consisting only of characters from the cset c.
match(s)	If the string s occurs at the beginning of &subject then returns the position following s.

Summary — Position Generators

- These functions take strings or csets as arguments and generate zero or more positions as results.

find(s)	Generates all the positions in &subject at which the string s occurs.
upto(c)	Generates all the positions in &subject containing characters from the cset c.

Summary — Position Movers

- These functions take a position as argument and move to a new position (if it exists), returning the substring from the initial to the new position as result.

move(p)	Moves p characters forward in &subject. Returns the substring which was passed over during the move.
tab(p)	Moves to position p in &subject. Returns the substring which was passed over during the move.

Examples — Position Functions

"foo" ? any('f')	Succeeds and returns 2.
"foo" ? any('b')	Fails.
"ooodles" ? many('od')	Succeeds and returns 5.
"nooodles" ? many('od')	Fails.
"foobar" ? match("foo")	Succeeds and returns 4.
"boofar" ? match("foo")	Fails.

Examples — Position Generators

"fooboo" ? find("oo")	Generates the positions {2,5}.
"fooboo" ? find("aa")	Fails.
"foobar" ? upto('ao')	Generates the positions {2,3,5}.
"foobar" ? upto('xy')	Fails.

Examples — Position Movers

`"foobar" ? write(move(3))`	Moves three steps forward (i.e., sets `&pos:=&pos+3` (4)) and writes `"foo"`.
`"foobar" ? write(tab(3))`	Sets `&pos` to `3` and writes `"fo"`.

Readings and References

- Read `Christopher, pp. 53--55, 57--58`.

Acknowledgments

- Some material on these slides has been modified from William Mitchell's Icon notes:

  `http://www.cs.arizona.edu/classes/cs372/fall03/handouts.html`.
- Some material on these slides has been modified from Thomas W Christopher's Icon Programming Language Handbook,

  `http://www.tools-of-computing.com/tc/CS/iconprog.pdf`.