Voorbereiding Programmeerwedstrijden

najaar 2021

https://liacs.leidenuniv.nl/~vlietrvan1/vbpw/

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Introductie

Strings

Waarom dit vak?

- Zorgvuldiger en kritischer leren programmeren
- Nieuwe algoritmes leren
- Beter presteren bij programmeerwedstrijden
- Fun!
- Tweede keer

Programmeerwedstrijd

- LKP, BAPC, NWERC, WK
- 5 uur
- team van 3
- $\pm$ 10 opgaven
- score op basis van
  - aantal opgaven helemaal 'goed'
  - tijdstip van goede oplossingen (+ straftijd)
- standard input / output

RANK	TEAM	SCORE	A	B	C	D	E	F	G	H	I	J
1	Participants **while (false) break;** Utrecht University	**11** 1264	250 3 tries	76 2 tries	55 3 tries	220 2 tries	28 1 try	99 1 try	42 1 try	10 1 try	102 1 try	19 1 try
2	**CPUMONS** Université de Mons	**10** 1402		127 1 try	26 2 tries	293 3 tries	48 2 tries	183 2 tries	128 3 tries	12 1 try	96 1 try	63 2 tries
3	**SnackUnderflow** Utrecht University	**10** 1403	222 1 try	77 2 tries	32 2 tries	208 2 tries	104 2 tries	265 2 tries	131 1 try	10 1 try	144 2 tries	50 3 tries
4	**The Algoteers** Radboud University	**9** 906	6 tries	163 2 tries	37 2 tries	92 3 tries	72 1 try	106 1 try	22 1 try	30 1 try	136 6 tries	28 3 tries
5	**Algorithms Beat Lockdown** Université Catholique de Louvain	**9** 943	1 try	145 1 try	15 2 tries	256 1 try	40 2 tries	179 2 tries	26 1 try	10 1 try	98 2 tries	54 3 tries
6	**Segfault go BRRRR** Delft University of Technology	**9** 1147	3 tries	173 5 tries	35 2 tries	222 1 try	100 2 tries	187 1 try	90 1 try	20 1 try	79 3 tries	41 3 tries
7	**(◉ ‿(◔ ‿ ◔)‿ ☼) Migos** Delft University of Technology	**9** 1253		231 3 tries	55 4 tries	277 8 tries	63 1 try	138 2 tries	112 3 tries	10 1 try	42 2 tries	5 1 try
8	Utrecht University	**8** 720		76 2 tries	12 2 tries	256 2 tries	114 2 tries	3 tries	101 1 try	16 1 try	51 1 try	14 1 try
9	**Out of Touch** Delft University of Technology	**8** 740		139 1 try	60 3 tries	5 tries	91 1 try	205 3 tries	73 1 try	7 1 try	34 1 try	31 2 tries
10	**Perry the C+platy+** Radboud University	**8** 744		55 1 try	62 2 tries	2 tries	127 1 try	115 3 tries	175 3 tries	7 1 try	90 1 try	13 1 try
11	**Piece of cake** Eindhoven University of Technology	**8** 1017		208 1 try	45 2 tries		63 1 try	281 2 tries	115 1 try	14 1 try	209 2 tries	22 1 try
12	**The Matrix Builders** KU Leuven	**8** 1141		174 5 tries	59 2 tries	1 try	82 1 try	192 1 try	78 3 tries	19 1 try	246 5 tries	71 1 try

Toetsing

- programmeerwedstrijd, 4 uur
- datum: . . .
- individueel
- vier of vijf opgaven
- max twee pogingen
- 2.5 punt per opgave
- tweede poging: 2.0 punt
- aftrek: -0.25 als niet binnen een uur
- als niet goed: percentage van 1.5 punt
- DOMjudge (vanuit LIACS)

Toetsing

- opgaven tussendoor (4 weken: 1 a 2 per week)
- individueel
- 2.5 punt per opgave (genormeerd naar totaal 10)
- tweede poging: 2.0 punt
- derde poging: 1.5 punt
- als niet goed: percentage van 1.5 punt
- DOMjudge (vanuit LIACS)

Toetsing

- 80% * programmeerwedstrijd + 20% * opgaven tussendoor
- bonus bij LKP2021 / BAPC2021
- 0.5 punt als bij bovenste kwart
- 0.25 punt als bij tweede kwart
- eindcijfer ≤ 10

Gehaald als

- cijfer inclusief bonus ≥ 5.5
- én cijfer programmeerwedstrijd ≥ 5
- 2 EC extracurriculair

College / boek

- hoorcollege: maandag, 09.15–11.00 (zaal 312)
- werkcollege (practicum):
  donderdag, 09.15–11.00 (zaal 307/309/303)
- zes/zeven weken
- Steven S. Skiena & Miguel A. Revilla
  Programming Challenges – The programming contest training manual
- hoofdstukken 3, 6, 7, 8, 9, 10, 13 (deels, en meer)

Online judge

`https://onlinejudge.org`

- register and confirm
- Remember me
- Browse problems (from book)
- submit / submission ID

Website

- `https://liacs.leidenuniv.nl/~vlietrvan1/vbpw/`
- slides, behandelde stof

Brightspace

- cijfers, opnamen hoorcollege

2.3. Read problem statement carefully

Flying Safely

Source: BAPC2013

2.3. Read problem statement carefully

- extract essential information
- in particular, input/output specification
- sample input/output, but . . .
- estimate required efficiency (maximum input size)

3.1. Character Codes

ASCII

- numbers
- 0,. . . ,127
- 48,. . . ,57 $\approx$ '0',. . . ,'9'
- 65,. . . ,90 $\approx$ 'A',. . . ,'Z'
- 97,. . . ,122 $\approx$ 'a',. . . ,'z'
- 1 byte in C/C++

3.1. Character Codes

Advantages of Sequential placement

- iterate through letters: from 'a' to 'z'
- determine rank of letter: 'C' - 'A'
- convert upper case to lower case v.v.: 'C' - 'A' + 'a'
- char x is uppercase, if and only if . . .

Alphabetical order: "aa" $<$ "AB"

3.2. Representing Strings

- null terminated char array
- class string with member functions (like size)
- linked list of char's

Choice of Representation

- amount of space
- constraints on string represented
- constant-time access to i'th character
- efficient check if i'th character is within string
- efficient deletion / insertion
- maximum length (un)specified

3.3. Corporate Renamings

Replace exact matchings of corporate names in text

Input:

```
4
"Anderson Consulting" to "Accenture"
"Enron" to "Dynegy"
"DEC" to "Compaq"
"TWA" to "American"
5
Anderson Accounting begat Anderson Consulting, which
offered advice to Enron before it DECLARED bankruptcy,
which made Anderson
Consulting quite happy it changed its name
in the first place!
```

```
4
"Anderson Consulting" to "Accenture"
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```

Output:

```
Anderson Accounting begat Accenture, which
offered advice to Dynegy before it CompaqLARED bankruptcy,
which made Anderson
Consulting quite happy it changed its name
in the first place!
```

Specification details

- at most 100 corporate changes
- at most 1000 characters on line of text

Representation. . .

Input:

```
4
"Anderson Consulting" to "Accenture"
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```

Representation - Char array

```
const int MAXLEN = 1000;     // longest possible string
const int MAXCHANGES = 100;  // maximum number of name changes

typedef char mystring[MAXLEN+1];

mystring mergers[MAXCHANGES][2];  // store before/after company names
```

Representation - String

```
const int MAXCHANGES = 100;      // maximum number of name changes
string mergers[MAXCHANGES][2];   // store before/after company names
```

Read changes...

```
4
"Anderson Consulting" to "Accenture"
"Enron" to "Dynegy"
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```

Read changes - Char array

```
void read_changes (int &nmergers)
{ int j;  // counter

  scanf ("%d\n", &nmergers);
  for (j=0;j<nmergers;j++)
  { read_quoted_string (mergers[j][0]);
    read_quoted_string (mergers[j][1]);
  }

}  // read_changes
```

Read changes - Char array

Without checks. . .

```
void read_quoted_string (char *s)
{
  int i = 0;  // counter
  char c;  // latest character

  while ((c=getchar()) != '\"');
  while ((c=getchar()) != '\"')
  { s[i] = c;
    i ++;
  }
  s[i] = '\0';

}  // read_quoted_string
```

Read changes - String

```
void read_changes (int &nmergers)
{ ...   // declarations j, mergerline, endpos

  cin >> nmergers;
  getline (cin, mergerline);  // to get to the line following nmergers

  for (j=0;j<nmergers;j++)
  { getline (cin, mergerline);
    endpos = read_quoted_string (mergers[j][0], mergerline, 0);
    if (endpos!=string::npos)
      endpos = read_quoted_string (mergers[j][1], mergerline, endpos+1);

    // error message, if applicable
  }

}  // read_changes
```

Read changes - String

```
size_t read_quoted_string (string &name, string mergerline,
                           size_t beginpos)
{ size_t endpos;

  beginpos = mergerline.find_first_of ("\"", beginpos);
  if (beginpos!=string::npos)
  { endpos = mergerline.find_first_of ("\"", beginpos+1);
    if (endpos!=string::npos)
    { name = mergerline.substr (beginpos+1, endpos-beginpos-1);
        // beginpos+1, because we do not store the quotes themselves
    }
  }
  else
    endpos = string::npos;

  return endpos;
}  // read_quoted_string
```

Searching for patterns...

```
4
"Anderson Consulting" to "Accenture"
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```

Searching for patterns - Char array

```
int findmatch (char *p, char *t)
{ ...   // declarations i, j, plen, tlen

  plen = strlen (p);
  tlen = strlen (t);

  for (i=0;i<=(tlen-plen);i++)
  { j = 0;
    while ((j<plen) && (t[i+j]==p[j]))
      j++;

    if (j==plen)
      return i;
  }  // for i

  return -1;
}  // findmatch
```

Searching for patterns - String

```
beginpos = s.find (mergers[j][0]))
```

No KMP, either

No need for KMP, anyway

Manipulating strings. . .

- computing length
- copying string
- reversing string
- replacing substring. . .

Replacing substring - Char array

```
void replace_x_with_y (char *s, int pos, int xlen, char *y)
{ ...  // declarations i, slen, ylen

  slen = strlen (s);    ylen = strlen (y);

  if (xlen>=ylen)  // shift suffix to the left
  { for (i=pos+xlen;i<=slen;i++)  // including EOS
      s[i+(ylen-xlen)] = s[i];
  }
  else  // shift suffix to the right
  { for (i=slen;i>=pos+xlen;i--)  // including EOS
      s[i+(ylen-xlen)] = s[i];
  }

  for (i=0;i<ylen;i++)  // insert y into s
    s[pos+i] = y[i];
}  // replace_x_with_y
```

Replacing substring - String

```
prefix = s.substr (0, beginpos);
beginpos2 = beginpos + mergers[j][0].size();
suffix = s.substr (beginpos2, s.size()-beginpos2);
s = prefix + mergers[j][1] + suffix;
```

Main - String

```
for (i=1;i<=nlines;i++)
{ getline (cin, s);

  for (j=0;j<nmergers;j++)
  {
    while ((beginpos = s.find (mergers[j][0])) != string::npos)
    {  // we found an occurrence, starting at beginpos
      prefix = s.substr (0, beginpos);
      beginpos2 = beginpos + mergers[j][0].size();
      suffix = s.substr (beginpos2, s.size()-beginpos2);
      s = prefix + mergers[j][1] + suffix;
    }  // while

  }  // for j

  cout << s << endl;
}  // for i
```

Problems with problem statement

. . .

Problems with problem statement

- company name split between lines
- overlapping corporate names (even with same name)
- new name may contain old name
- subsequent changes
- cyclic changes
- length of corporate names may be more than 1000
- length of new text line may be more than 1000

1.3. Programming Hints

- write comments first
- document each variable
- use symbolic constants
- use enumerated types for a reason
- use subroutines to avoid redundant code. . .

```
while (c!='0')
{ cin >> c;
  if (c == 'A')
  { if (row-1 >= 0)
    { temp = b[row-1][col];
      b[row-1][col] = ' ';
      b[row][col] = temp;
      row = row-1;
    }
  }
  else if (c=='B')
  { if (row+1 <= BOARDSIZE-1)
    { temp = b[row+1][col];
      b[row+1][col] = ' ';
      b[row][col] = temp;
      row = row+1;
    }
  }
  ...
```

2.3. Going to War

- 52 playing-cards
  A, K, Q, J, T, 9, 8, 7, 6, 5, 4, 3, 2
  s, h, d, c

- rules. . .

Sample input

```
4d Ks As 4h Jh 6h Jd Qs Qh 6s 6c 2c Kc 4s Ah 3h Qd 2h 7s 9s 3c 8h Kd
8d 8c 9c 7c 5d 4c Js Qc 5s Ts Jc Ad 7d Kh Tc 3s 8s 2d 2s 5h 6d Ac 5c
```

2.4. Hitting the Deck

representation for (packets of) cards. . .

2.4. Hitting the Deck

representation for (packets of) cards: two queues of:

- pairs of characters / strings of length 2. . .
- pairs of numbers
- only value numbers. . .
- values of ranking function

Ranking function

```
const int NCARDS = 52;  // number of cards
const int NSUITS = 4    // number of suits
char values[] = "23456789TJQKA";
char suits[] = "cdhs";

int rank_card (char value, char suit)
{ int i, j;   // counters

  for (i=0; i<(NCARDS/NSUITS); i++)
    if (values[i]==value)
      for (j=0; j<NSUITS; j++)
        if (suits[j]==suit)
          return (i*NSUITS + j);

  cout << "Warning: bad input value=" << value
       << ", suit=" << suit << endl;
}
```

Unranking functions

```
char suit (int card)
{
  return (suits[card % NSUITS]);
}

char value (int card)
{
  return (values[card / NSUITS]);
}

int intvalue (int card)
{
  return (card / NSUITS);
}
```

Ranking / unranking functions also useful for other combinatorial objects.

2.7. Testing and Debugging

- test given input
- test incorrect input (if necessary)
- test boundary conditions,
  e.g., empty input, one item, values that are zero
- test instances where you know answer
- test big instances

2.7. Testing and Debugging

- get to know debugger

- display non-trivial datastructures

- test invariants rigorously. . .

```
for (i=0; i<NCARDS; i++)
  if (i != rank_card (value(i), suit(i)))
    cout << "Error: rank card(" << value(i) << "," << suit(i) << ")="
         << rank_card (value(i), suit(i)) << " not " << i << endl;
```

2.7. Testing and Debugging

- make your print statements mean something

- make your arrays a little larger

3.8.2. Where's Waldorf?

3.8.2. Where's Waldorf?

- representation grid
- base 1
- upper case / lower case
- multiple occurrences of word (≥ 1)
- blank line before every input and between consecutive outputs
- algorithm. . .
- subroutine for searching in one direction
- representation directions

3.8.3. Common Permutation

3.8.3. Common Permutation

- understand the problem
- algorithm. . .
- boundary case. . .

1.6.1. The $3n + 1$ Problem

1.6.1. The $3n + 1$ Problem

- brute force fast enough?

- store and re-use values computed before (upto a certain maximum?)

3.8.6. File Fragmentation

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- two fragments per file

- algorithm. . .