

Midterm π

CS164, Spring 2001

April 1, 2001

- Please read all instructions (including these) carefully. I know you've skipped over the instructions already, so it's a lost cause.
- There are 8 pages in this exam and 7 questions, many with multiple parts. No question spans multiple pages.
- You have as long as you like to work on this exam.
- The exam is open book, and you may also refer to your two pages of handwritten notes if you like.
- Please write your answers wherever you like. You may use the backs of the exam pages as scratch paper. You may use additional scratch paper.
- Solutions will not be graded. However, you can talk to Wes about what the reference solutions might be. Partial solutions will only get you partial brownie points.
- You may perform community service in lieu of taking this exam.

Nickname: _____

Favorite Number: _____

email address: _____

Circle the time of your section: 9:00 10:00 11:00 12:00 1:00 2:00 3:00 4:00

1 Regular Expressions and Finite Automata

Consider the follow newgroup posting:

Subject: Bosnia Peace Conference

From: gnb@bby.com.au (Gregory Bond)

Keywords: topical, chuckle, originally appeared in first quarter, 1993

The Bosnian peace talks continued in Geneva today. The only thing that Alija Izetbegovic, Radovan Karadzic and Slobodan Milosovic could agree on was that John Major has a funny name.

- a) Given the alphabet $\Sigma = \{a, \dots, z, \text{space}\}$ (case does not matter), write the smallest regular expression you can that accepts the first three world leader names but rejects "John Major".
- b) Draw the NFA for your regular expression.

Consider the following newsgroup post:

Subject: Colorless Green Perl (Was: Is Perl better than HTML?)

From: Jeff Zucker <jeff@vpsservices.com>

Newsgroups: comp.lang.perl.misc

Q. What does "/\" mean in this code: "my(\$a,\$b)=split(/\\|/, \$c);" ?

A. What does "nua" mean in this sentence: "Read the manual." ?

- c) Given the alphabet $\sigma = \{a, \dots, z, ", \backslash, \}$, write a regular expression that accepts quoted strings. Such quoted strings may contain quote characters escaped with a \backslash . Ignore case. For example, the following are valid:
 - "Colorless green ideas sleep furiously"
 - "\ "The way is void\" wrote Musashi"

But the following are not:

- I never felt a felt that felt like that felt felt
 - "This song is just six words long \"
- d) Draw a DFA for your regular expression.

2 Operational semantics, “if”

Consider the following newsgroup post:

```
Subject: Re: Story ID req: (juvenile?) Kids and clear stair room...
From: wishda@weblnk.net (William Davis)
Newsgroups: rec.arts.sf.written
```

jsbassior@aol.com (Jordan S. Bassior) wrote:

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>Note the "if" in my statement. I do *not* believe that Vince Foster was
>murdered. I believe that *if* he was murdered that Clinton is the most likely
>culprit.
```

"I do not believe the Antichrist exists, but if he does, then I believe Clinton is the most likely Hellspawn."

"I do not believe that aliens have infiltrated the U.S. government, but if they have, I believe Clinton is from Alpha Centauri."

"I do not believe it was a world leader who stole my bicycle, but if it was, then I believe Clinton is the thief."

You're on thin ground here.

- a) Give the operational semantics for the normal “if” expression in Cool.
- b) Imagine that we add a new boolean construct to Cool. This construct, written “implies”, represents logical implication. “ b_1 implies b_2 ” is equivalent to “(not b_1) or (b_2)” and features short circuit evaluation. Give the typing rule for “implies”.
- c) Give the two operational semantics rules for “implies”.

Consider the following entry to the Obfuscated C Contest:

```
int i;main(){for(;i["<i;++i){--i;}"];read('-'-'-',i+++ "hell\
o, world!\n",'/\''/));}read(j,i,p){write(j/p+p,i---j,i/i);}
```

- d) This program actually compiles and runs. What is the output of this program?

3 History of Programming Languages

Consider David Rabson's essay: "**Latin 90**"

Professor Kard has been at the university for as long as anyone can remember, going back indeed to when everyone in the department spoke Latin on a daily basis. It is Kard's unshakable belief that things have gone down-hill ever since. "1H,30H SMALL LETTERS ARE A NEOLOGISM," he always Hollers in faculty meetings, pointing out that classical writers couldn't possibly have used them. In our department, you can't say that the rules aren't carved in stone, as it is in stone that Kard did his best work thirty-five years ago, continues to do his work, and intends to go on doing his work.

The academic journals have grown in the last thirty-five years. While it is hard to believe, Kard used to carve out his fluid-dynamics calculations on tiny 4-kilobyte stone tablets. Now he thinks nothing of allocating half a gigabyte (statically, since that's the only way he knows how), but he still does everything in Latin. Latin, in case you think I'm prejudiced, is a fine language for talking about gladiators and chariots and even for discussing Spinoza, but it stretches the vocabulary to solve differential equations in it, let alone write operating systems or look at chaotic trajectories. Kard's papers are unreadable by anyone else.

Things got a little better around 1977, when a few (then) junior professors bullied him into structuring his DO loops and adding a few modern words. His code, however, still looked like Latin.

Just the other day, Kard met me in the hallway (ave!) and started talking excitedly (forgive the free translation). "I'm finally going to get the rest of you to go back to talking Latin," he said. "How's that, Kard?" "I've thought about your objections, about the missing vocabulary and syntax" – a few of us had recently been pestering him over structures and classes, although at the time none of it seemed to be sinking in, except to elicit the occasional comment about how anything worth doing could be done in the ablative – "and I think I can meet your objections, on your own terms".

"While strictly speaking it has no classical precedent, I've spent the last ten months building on the language, adding four new cases, five tenses, six conjugations, three-hundred-sixty new verbs, and 1144 new nouns. The grammar book, alas, no longer fits in the pocket, but at least you and the rest can stop complaining about the lack of flexibility. I call the modified language 'Latin-90'."

He was true to his word. Latin-90 had all the structure and object orientation a writer could ask for. It accepted lower case letters (translating them internally to upper case), allowed for recursive argumentation, and discarded any special meaning column 72 might once have had. Julius Caesar wouldn't have been able to distinguish it from Gallic.

To the rest of us, unfortunately, it still looks like Latin. It doesn't help that Kard has yet to produce a working set of chisels for it, and that the only papers written in Latin-90 still sit in Kard's brain. At least he put Holleramus constants to rest and no longer requires six spaces before each genitive. He'll probably be able to get some better work done in Latin-90, if he ever implements it. In the meantime, I shall continue to write in the vernacular.

- a) What are the real-life equivalents of Professor Kard, Latin and the chisels?
- b) Explain why Fortran's famous `do7i=3` syntax requires a backtracking scanner.

4 Language Design

Consider the following newsgroup post:

Subject: Re: New Angband Port, Opinions??? Possibly Angband 3.0
From: st@ferd2.thristian.org (Screwtape)
Newsgroups: rec.games.roguelike.angband

David Thornley schrieb:

```
>In article <20000210123234.05471.00000462@ng-bg1.aol.com>,
>LucFrench <lucfrench@aol.com> wrote:
>>Let's see, what else... I could go into big-endian vs. little-endian, but
>>that's mostly pointless. Emacs resembles MS Word. vi is almost impossible to
>>use. GNOME is buggy, and KDE is illegal. (That should cover all the bases.)
>
>Oh come on, you can offend more people than that. Macs have lousy memory
>management, and Microsoft Windows can be made unusable with a bad program
>installation. If I were to design a C-type language, I'd do a lot better
>than Java; it does nothing better than other languages, and would be DOA
>if it wasn't for the hype. Netscape crashes constantly, and Internet
>Explorer has security holes designed right in.
```

No, you're not getting the point. See what LucFrech did? He made **untrue** accusations. Now go and try again.

- a) How would you design a better language than Java or C++? Be specific, commenting on at least three areas or features.

5 Algorithms

Consider the following newsgroup post:

Subject: Re: Review Session subjects
From: "Jordan Erenrich" <jse8@cornell.edu>
Newsgroups: cornell.class.cs312

"Chris Sims" <crs27@cornell.edu> wrote in message
news:3adc9f9e.1128432001@newsstand.cit.cornell.edu...
> What should we know about Dijkstra's Algorithm?

You must know historical information. In case you can't find it in your notes, I've typed it up:

In 1966, the shortstop of The New York Mets, Lenny Dijkstra, devised the algorithm to figure out the shortest path around the bases of a baseball field. Often referred to as the father of modern base theory, Lenny theory laid the groundwork for the more general "graph theory," in which any base can be connected to any other base.

Nevertheless, success quickly got the better of Lenny, who became a hard partying, crack loving junkie. His addiction consumed him, and his theoretical work was relegated to that of the obscure traveling dealer problem (i.e., If one has to sell smack in the South Bronx, 125th and 8th, etc, what is the shortest path to visit all potential buyers)

Fortunately, the story has a happy ending. After years of running from the law, Lenny finally hit rock bottom and was forced into rehab by the 18th District Superior Court. Soon thereafter, Lenny returned to academia, where he triumphantly proved by induction that all your base are belong to us.

Currently, Lenny is working at Cambridge on his Grand Unified Theory, which will prove that baseball and cricket are actually manifestations of the same fundamental force.

- a) Explain how you can compute a lower bound on the number of cycles a basic block will take to execute by using Dijkstra's algorithm and the instruction dependency graph.
- b) Sketch the inductive proof mentioned in the text. You may make use of the lemma that "setting up someone the bomb" ensures that their first base belongs to you.

6 Language Features

Consider the following famous parody lyrics by Bob Kanefsky.

01: I was taught assembler in my second year of school.
02: It's kind of like construction work – with a toothpick for a tool.
03: So when I made my senior year, I threw my code away,
04: And learned the way to program that I still prefer today.
05: Now, some folks on the Internet put their faith in C++.
06: They swear that it's so powerful, it's what God used for us.
07: And maybe it lets mortals dredge their objects from the C.
08: But I think that explains why only God can make a tree.
09: For God wrote in Lisp code
10: When he filled the leaves with green.
11: The fractal flowers and recursive roots:
12: The most lovely hack I've seen.
13: And when I ponder snowflakes, never finding two the same,
14: I know God likes a language with its own four-letter name.
15: Now, I've used a SUN under Unix, so I've seen what C can hold.
16: I've surfed for Perls, found what Fortran's for,
17: Got that Java stuff down cold.
18: Though the chance that I'd write COBOL code
19: is a SNOBOL's chance in Hell.
20: And I basically hate hieroglyphs, so I won't use APL.
21: Now, God must know all these languages, and a few I haven't named.
22: But the Lord made sure, when each sparrow falls, that its flesh will be reclaimed.
23: And the Lord could not count grains of sand with a 32-bit word.
24: Who knows where we would goto if Lisp weren't what he preferred?
25: And God wrote in Lisp code
26: Every creature great and small.
27: Don't search the disk drive for man.c,
28: When the listing's on the wall.
29: And when I watch the lightning
30: Burn unbelievers to a crisp,
31: I know God had six days to work,
32: So he wrote it all in Lisp.
33: Yes, God had a deadline.
34: So he wrote it all in Lisp.

- a) According to the author, which Lisp feature resulted in it being chosen?
- b) What language feature is being discussed in line 22?
- c) What language feature is being discussed in line 23? How would your implementation of PA5 change if Cool had that feature? How would the operational semantics of Cool change?

7 Real Life Extra Credit

Too often we find that the extra credit options offered are disjoint from reality. Give yourself one point if you can ...

- a) Explain how to obtain steel from iron.
- b) Take apart an internal combustion engine, put it back together, and have it work.
- c) Translate the paragraph starting “In 1066, the shortstop” from the Algorithms problem into at least two other languages.
- d) Build a dovetail joint.
- e) Dance the Waltz or East-Coast Swing without embarrassing yourself.
- f) Explain (using electrodynamics) how a microphone and a speaker work.
- g) Explain how a battery works (using classical chemistry).
- h) Defend or refute the thesis that Kant’s notion of morality is well-aligned with Confucian doctrines.
- i) Describe the structure of scientific revolutions using at least two examples from last century.
- j) Pick a lock, obtain root access or hot-wire a car.
- k) Climb fifty feet up a tree or rappel down a cliff.
- l) Care for a newborn child.
- m) Explain (in detail) how to use small-claims court to right minor wrongs.
- n) Sew an entire garment.
- o) Cope with death.
- p) Cook a gourmet meal.
- q) Explain how the city’s plumbing and sewer system works.
- r) Explain how to obtain energy from fossil fuels, hydrodynamics and nuclear power.
- s) Perform CPR, rescue breathing and make a simple splint.
- t) Explain the second World War.
- u) Make glass and then fashion ornaments or vessels from it.
- v) Explain how we gather information about things outside our solar system.
- w) Be happy without interfering with others.

Good luck. Hopefully you won’t need it.