C Programming Tools: Part 3

Building your own Tools

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As in previous weeks, there's a tarball of examples associated with this lecture.

- This lecture's slides and tarballs are available on CATE under Programming III.
- Also at: `http://www.doc.ic.ac.uk/~dcw/c-tools-2018/`

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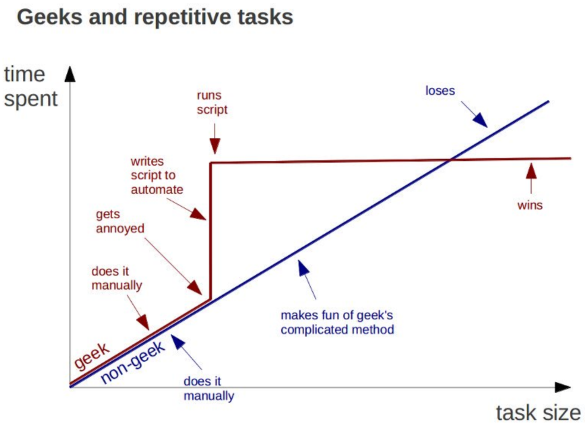
- Let's see an example of those tips together, remembering..



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- Specify input format (as a little language) and corresponding output:

```
INPUT:
  foreach line: F, Op pairs
OUTPUT:
  foreach line: "int <F>( int a, int b ) { return (a <Op> b); }"
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- Don't want to do it in Perl? (weirdo). Then use a different tool!
- I wrote it in C in 15 minutes using standard library function strtok() to split on comma: See 01.tiny-tool/genfuncs1.c.

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- Or, prefix the typename onto function names, eg. `int_plus`:

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perl -nle '($f,$op)=split(/,/); printf "int %-15s( int a, int b ) { return (a${op}b); }\n", "int_${f}"' < input
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- Why not let the user change the type at any point in the input:

```
TYPE,int
plus,+
minus,-
TYPE,double
plus,+
minus,-
```

generates:

```
int    int_plus       ( int a, int b ) { return (a+b); }
int    int_minus      ( int a, int b ) { return (a-b); }
double double_plus    ( double a, double b ) { return (a+b); }
double double_minus   ( double a, double b ) { return (a-b); }
```

- To implement this, change the specification to:

```
INPUT:
  foreach line: F, Op pair (but F=="TYPE" is special)
OUTPUT:
  foreach F, Op pair
      if F=="TYPE" then T=Op
      else print "<T> <T>_<F>( <T> a, <T> b ) { return (a <Op> b); }"
```

- Make our Perl one-liner:

```
perl -nle '($f,$op)=split(/,/); if( $f eq "TYPE" ) { $t=$op; next; }
           printf "${t} %-15s( ${t} a, ${t} b ) { return (a${op}b); }\n", "${t}_${f}"' < input
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- Final thought, instead of hardcoding the output format in the printf, we could replace TYPEs with TEMPLATEs in the input, for example:

```
TEMPLATE,int int_<0>( int a, int b ) { return (a<1>b); }
plus,+
minus,-
TEMPLATE,double double_<0>( double a, double b ) { return (a<1>b); }
plus,+
minus,-
```

- Here, the marker <0> means "replace this marker with the current value of the first field". Our Perl one-liner becomes more powerful but shorter:

```
perl -nle '@f=split(/,/,$_,2); if( $f[0] eq "TEMPLATE" ) { $t=$f[1]; next; }
           $_=$t; s/<(\d+)>/$f[$1]/g; print' < input
```

- This is now a simple macro processor.

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- The problem here is that there's a lot of repetition between the .c file and the .h file. This violates the most important Pragmatic Programmers tip: DRY - Don't Repeat Yourself (tip 11).

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- Note: Reuse can be done without OO or generics, *Make it Easy to Reuse* (PP Tip 12) - just use `void *`.

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  - Then combines them to represent family information, i.e. a mapping from a named parent to set of named children.
  - It's left for you to examine and play with.

- To get you started, **tarball 03.adts** includes a group of half a dozen ADTs (plus unit test programs) that I've written over the years, plus a Makefile to package them as the libADTs.a library.
- Investigate them all at your own leisure - but make install them now so they're installed in your TOOLDIR (`~/c-tools`) directory.
- Next, **tarball 04.hash-set.eg** contains an example application that uses some of those ADTs, specifically:
  - Hashes - (key,value) storage implemented using hash tables, where the keys are strings, and the values are generic void * pointers - yes, it's our old friend hash.c, after Lecture 2's memory-leak fixes and profiling-led optimizations.
  - and Sets of strings.
  - Then combines them to represent family information, i.e. a mapping from a named parent to set of named children.
  - It's left for you to examine and play with.
- C+hashes+sets makes it easy to pretend that you're almost programming in Perl:-)

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- Cost/benefit analysis: a serious tool, a mini-compiler (with parser, lexical analyser, data structures, tree walking code generator): at least a week's work! Think hard!

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- ... change types.in later - suppose you realise that a tree node also needs to store a name (just as the leaves do). Change the type defn, rerun datadec. The `tree_node()` constructor now takes 3 arguments!

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- Then two deconstructor functions which, given a tree of the appropriate shape, breaks it into it's constituent pieces:

```
extern void get_tree_leaf( tree t, string *namep );
extern void get_tree_node( tree t, tree *lp, tree *rp );
```

- These allow you to write tree-walking code like this leaf-counter:

```
int nleaves( tree t )
{
    if( tree_kind(t) == tree_is_leaf )
    {
        string name; get_tree_leaf( t, &name );
        return 1;               // leaf( name ): contains 1 leaf.
    } else
    {
        tree l, r; get_tree_node( t, &l, &r );
        // node( l, r ): process l and r trees.
        return nleaves(l) + nleaves(r);
    }
}
```

- In Haskell, this'd be:

```
nleaves(leaf(name)) = 1
nleaves(node(l,r))  = nleaves(l) + nleaves(r)
```

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- You can read a 3-part article I wrote about how I designed datadec here:

```
http://www.doc.ic.ac.uk/~dcw/PSD/article8/
```

Remember:

(and learn Perl, it's great!)