C Programming Tools: Part 3

Building and Using your own Toolkit

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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-2017/`

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- Clearly, all that varies from instance to instance is (funcname,operator), eg. `(plus,+)`.
- 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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- 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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- Noticing all those "int"s, let's make it easier to change:

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perl -nle '$t="int"; ($f,$op)=split(/,/);
           printf "${t} %-15s( ${t} a, ${t} b ) { return (a${op}b); }\n", "${t}_${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
       special case: if F=="TYPE" then T=Op
OUTPUT:
  foreach F, Op pair where F!="TYPE":
   "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
```

- See 01.tiny-tool/genfuncs3.c for a C implementation.
- 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
```

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- Unlike C++, the C standard library fails to provide any of the following: So build them yourself as and when you need them, and reuse them at every opportunity.
- Note: Reuse can be done without object orientation! As our friends say (Tip 12): *Make it Easy to Reuse*.

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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.

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- If only there was a tool that reads such type definitions and automatically writes a C module that implements them..
- I looked around, *but I couldn't find one*. Noone seemed to have ever suggested that such a tool could be useful!

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intlist = nil or cons( int head, intlist tail );
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- I'd dearly love to have that ability in C.
- If only there was a tool that reads such type definitions and automatically writes a C module that implements them..
- I looked around, *but I couldn't find one*. Noone seemed to have ever suggested that such a tool could be useful!
- Decision time: do I abandon my brilliant idea, or make the tool?

- Principle: It's often an excellent idea to import cool features from other languages.
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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!)