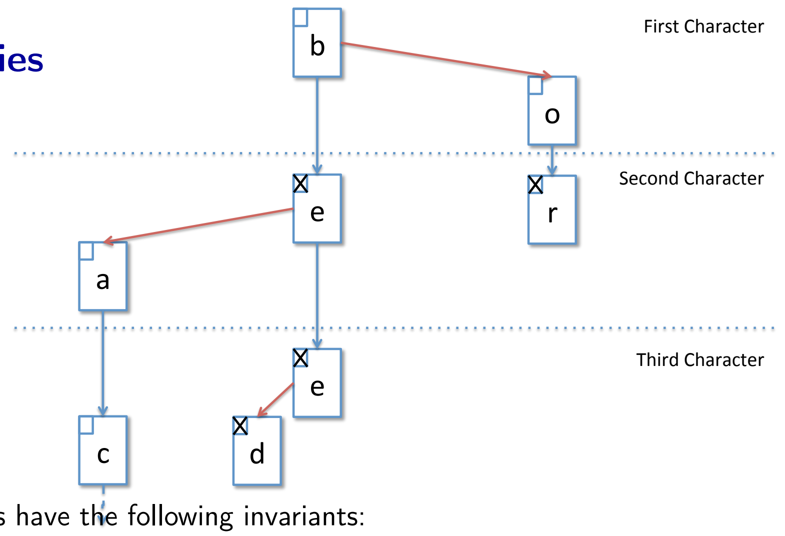
15-122: Principles of Imperative Computation

Recitation 23 **Rob Simmons**

Multi-way tries



Ternary search tries have the following invariants:

- The `left` and `right` of a trie node act as a BST. In other words, for any `tnode T`, IGNORING `middle` pointers, every `tnode` in the `T->left` subtree represents a character whose ASCII value is less than `T->c`, and every `tnode` in the `T->right` subtree represents a character whose ASCII value is greater than `T->c`.
- For any `tnode T`, `T->middle` is a valid `tnode`.
- If, for some `tnode T`, `T->middle == NULL`, then `T->elem` must not be `NULL` (otherwise this trie would not be a prefix for any element!).

The same `tnode_lookup` funciton in the implementation can be used to implement both `trie_member` (the given string is in the trie) and `trie_prefix` (this string is a proper prefix of a string in the trie).

```
tnode *tnode_lookup(tnode *T, char *s, size_t i) {
  REQUIRES(is_tnode_root(T) && s != NULL && i < strlen(s));

  ______________________________________________________________

  ______________________________________________________________

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}

bool trie_member(trie TR, char *s) {
  REQUIRES(is_trie(TR) && s != NULL && strlen(s) > 0);
  tnode *T = tnode_lookup(TR->root, s, 0);
  return T != NULL && T->is_end;
}

bool trie_prefix(trie TR, char *s) {
  REQUIRES(is_trie(TR) && s != NULL && strlen(s) > 0);
  tnode *T = tnode_lookup(TR->root, s, 0);
  return T != NULL && T->middle != NULL;
}
```

Definition-as-use

In C0, all variable declarations were comprised of a *type* and a *variable name*.

```
the type (int pointer)  the variable name (myptr)
vvvv                    vvvvv
int*                    myptr;
```

In C, you have to think about declarations differently: as a *base type* and a *pattern describing how the variable name is used*.

```
the type (int)  it is used by deferencing (myptr)
vvv             vvvvvv
int             *myptr;
```

On one level, this is just a stylistic difference: C isn't that whitespace sensitive. But there are two places where this makes a critical difference.

Checkpoint 0

One one line, declare an integer `i`, a pointer to an integer `p`, and an array of pointers to integers `A`.

`int` ____;

Checkpoint 1

You can define and use a function pointer like this:

```c
typedef int string_hasher(char *s);

int hash_string(char *s) { REQUIRES(s != NULL); ... }

int main() {
  string_hasher *f = &hash_string;
  printf("Hash of 'hello world': %d\n", (*f)("hello world"));
}
```

Using the idea of definition-as-use, declare `f` in the example above without using the intermediate `typedef`.

____ `= &hash_string;`

Checkpoint 2

Consider the following:

```c
typedef int compare(void *x, void *y);
void sort(void **A, int len, compare *F);
// requires A != NULL
// requires \length(A) == len
// requires compare != NULL
```

How would you use this procedure to sort an array of strings? How would you write a generic implementation of `sort` using the selection sort algorithm from earlier in the semester? Which of these preconditions could we actually check in the `sort` function, and how?