Tutorial 8
Pointers to pointers

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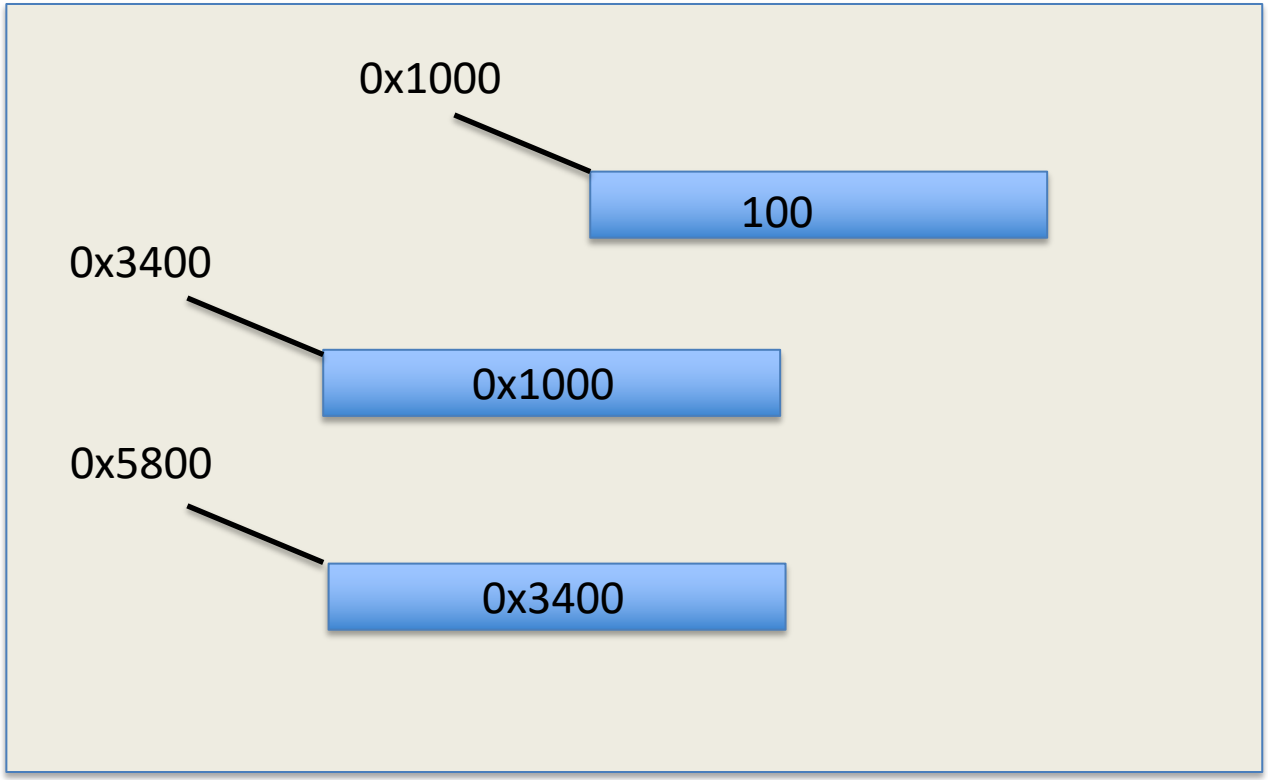
Define a variable

- int a;
- int *p;
- p = &a;
- *p = 100;



- int **ptr;
- ptr=&p;
- **ptr=101;

Declaration vs. dereference

```
int* p1;
int *p2;
int *  p3;
```

```
int* Func1(int a, int* arr);
int *Func2(int a, int* arr);
```

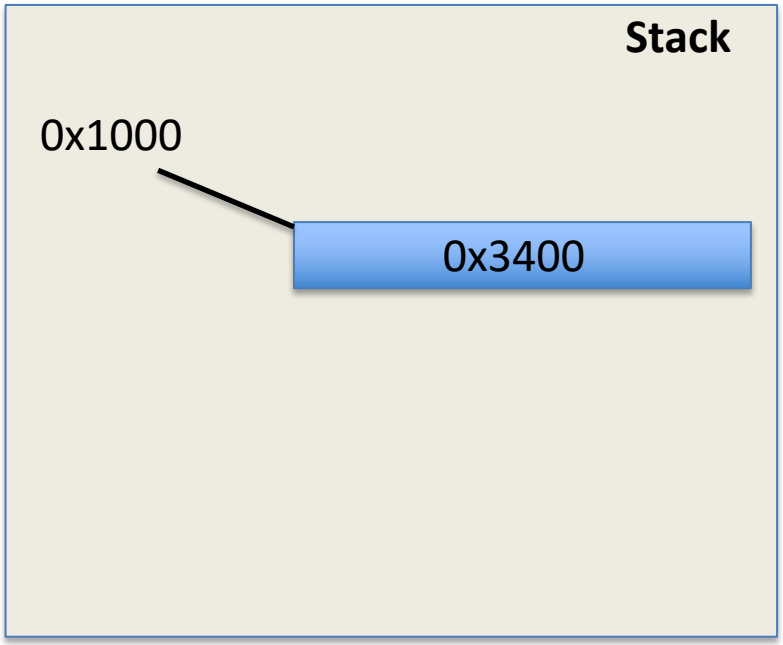
```
int *p;
p = &value;
*p = 5;
```

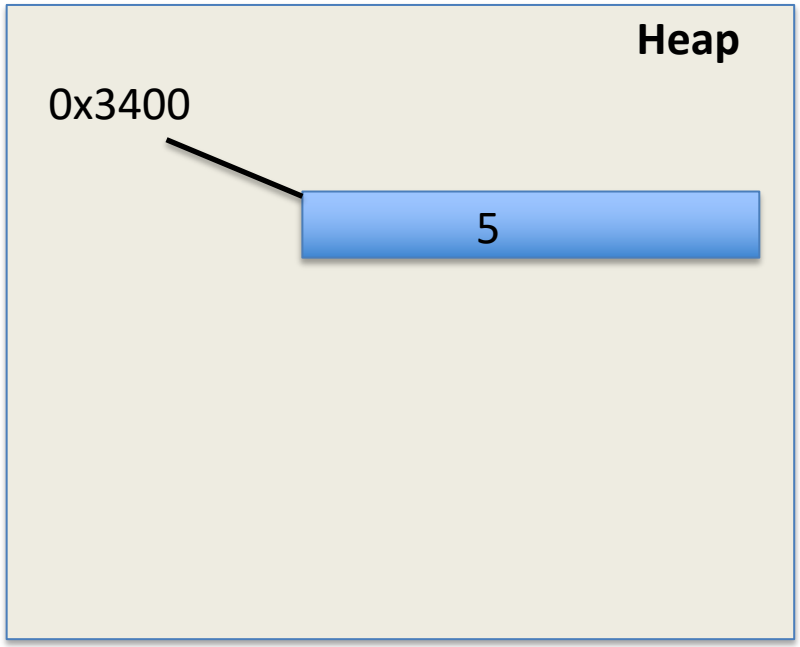
```
int *p = &value;
*p = 5;
```

```
int *p = malloc(sizeof(int));
*p = 5;
```

malloc() and free()

```
int *p;
p = malloc(sizeof(int));
*p = 5;
free(p);
printf("%d",*p);
```





Example 1

```
#include<stdio.h>
int main(int argc, char *argv[])
{
    int a = 1;
    int b = 2;
    int *p1 = &a;
    int *p2 = &b;
    int **pp1 = &p1;
    printf("%d    %p     %p\n", **pp1, *pp1, pp1);

    *pp1 = p2;
    printf("%d    %p     %p\n", **pp1, *pp1, pp1);
    printf("%p    %p\n", &a,  &b);
    printf("%p    %p\n", p1,  p2);

    return 0;
}
```

Why pointers to pointers?

When we use "pass by pointer" to pass a pointer to a function, only a copy of the pointer is passed to the function.

In most cases, this does not present a problem. But problem comes when you modify the pointer inside the function. Instead of modifying the variable, you are only modifying a copy of the pointer and the original pointer remains unmodified, that is, it still points to the old variable.

```
int g_n = 42;

void example_ptr()
{
        int n = 23;
        int* pn = &n;
        printf(“%d”, *pn);
        func_ptr(pn);
        printf(“%d”, *pn);
}
void func_ptr(int* pp)
{
        pp = &g_n;
}
```

How to revise this program?

```
#include<stdio.h>
void swap(int* arg1, int* arg2)
{
	int* value = NULL;
	value = arg1;
	arg1 = arg2;
	arg2 = value;
}

int main()
{
	int a = 1;
	int b = 2;
	int *p1 = &a;
	int *p2 = &b;
	swap(p1, p2);
	printf(%d, %d\n”, *p1, *p2);
}
```

Why pointers to pointers?

When we need to modify a pointer inside a function, we should pass the address of the pointer to the function.

```
void append(IntList **list, int value);

IntList *start;
append(&start, 5);
```

```
int g_n = 42;

void example_ptr()
{
        int n = 23;
        int *pn = &n;
        printf("%d", *pn);
        func_ptr_to_ptr(&pn);
        printf("%d", *pn);
}
void func_ptr_to_ptr(int **pp)
{
        *pp = &g_n;
}
```

Frequent mistakes

- Not assigning memory.

```
int **ptr1;
*ptr1 = malloc(sizeof(int));
```

```
int *ptr2= malloc(sizeof(int));
int **ptr1 = &ptr2;
```

Frequent mistakes

- Misuse pointers in function calls

```
void func( int** ptr)
{
        *ptr = x;   // assume that x is a pointer;
                    // Does this code work?
//      ptr = &x;
                    //  what is the difference?
}

int main()
{
        int *ptr = NULL;
        func(&ptr);

//      int **ptr = NULL;
//      func(ptr);
        …
}
```

Example 2

```
void func1(int *x, int *y);
void func2(int **x, int *y);
int main(void)
{
        int a;
        int *p1 = NULL;

        func1(p1, &a);
        printf("%d   %p\n", a, p1);

        func2(&p1, &a);
        printf("%d   %p\n", a, p1);

        return 0;
}
```

```
void func1(int *x, int *y)
{
        *y = 1;
        x = y;
}

void func2(int **x, int *y)
{
        *y = 2;
        *x = y;
}
```

Task: Complete a Trie

- You are given a partially-completed program which implements a Trie. (trie_incomplete.c in the Tutorial section)
- Your task is to complete the function trie_contains() so that the program print "Test passed" when run.
- The trie_contains function should check if a given string is present in the trie or not.
- assert(expression) is a macro in C. If expression is true, it does nothing. If expression is false, it terminates the program.