CEng 140

Strings and Pointers

Strings (and Pointers)

- [As we know] C uses NULL terminated arrays of chars to represent strings
- To create a string variable you must **allocate** sufficient space for the number of characters and the NULL character '\0'.
  - Using arrays
  - Using pointers

Using arrays for strings

```
char robot[5];   // declaration
```

- **Assignment** of a string to an array: two ways
- First way: each array element assigned to a char

```
robot[0] = ‘g’;
robot[1] = ‘o’;
robot[2] = ‘o’;
robot[3] = ‘d’;
robot[4] = ‘\0’;
```

robot[0]	g
robot[1]	o
robot[2]	o
robot[3]	d
robot[4]	\0

Using arrays for strings

char robot[5];   // declaration

- **Assignment** of a string to an array: two ways
- second way: via strcpy func

//strcpy copies the chars one by one from

// source str to destination str

strcpy(robot, "good");

String constant

robot[0]	g
robot[1]	o
robot[2]	o
robot[3]	d
robot[4]	\0

Using arrays for strings

- You can also store a string in an array during the **initialization**

```
char robot[5];   // declaration
char robot[5] = {‘g’, ‘o’, ‘o’, ’d’, ‘\0’};   // or
char robot[5] = "good";
```

robot[0]	g
robot[1]	o
robot[2]	o
robot[3]	d
robot[4]	\0

When a char array is intialized to a string constant:

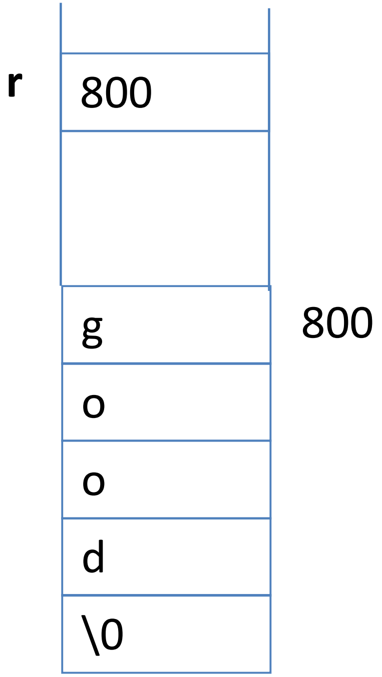
- Same name (robot) always refers to the same storage

- Individual chars can be modified by assignments!

```
robot[0] = ‘w’; // works
```

Using pointers for arrays

```
char *r;  // declaration
              // normally, alloc space for string before assignment
r = (char *) malloc(sizeof(char) * 5);
// Assignment: first way
r[0] = ‘g’;
r[1] = ‘o’;
…                         r[0] = ‘w’; // works
r[4] = ‘\0’;
// Assignment: second way
strcpy(r, "good");
```



Using pointers for arrays

- You can also store a **string constant** in a ptr via **(initialization, or) direct assignment**

```
char *r;  // declaration

char *r = "good";  //or

char *r;

r = "good";
```

Hey! You did not allocate any storage for the string, how is this possible?

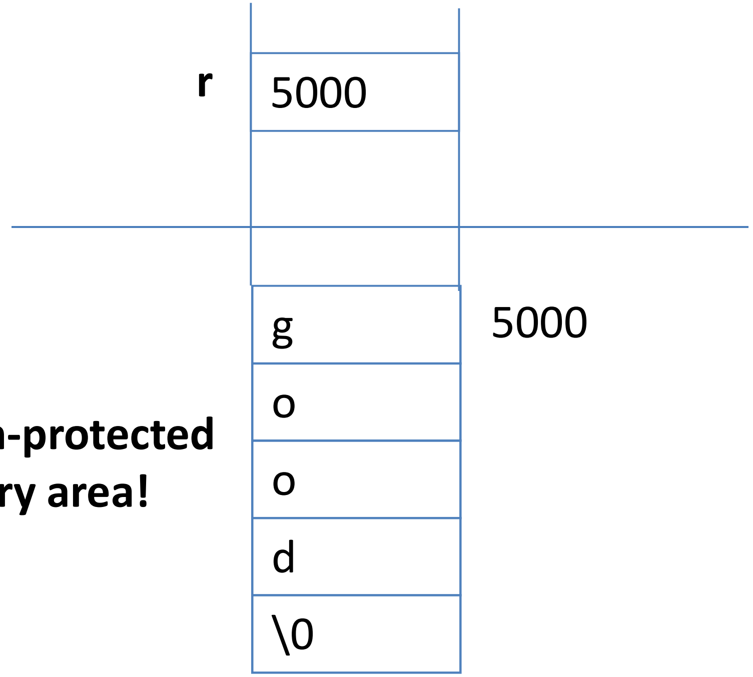
[More about the] String Constants

- A string constant is a sequence of chars in " " and compiler automatically adds NULL character at the end.
- When a string constant appears anywhere (**except** as an initializer of a char array or an argument to the sizeof operator) the chars making up the string (together with NULL) are stored in contiguous memory locations, and **string contant** becomes a **pointer** to the first char of the stored string.
  - Usually stored in a **system-protected memory area!**

Mystery solved!

```
char *r = "good";  //or
char *r;
r = "good";
```

String constant;
a pointer to where "good" is stored!
Both sides are of type **pointer to char**!



system-protected memory area!

Mystery solved!

```
char *r = "good";  //or
char *r;
r = "good";
```

String constant;
a pointer to where "good" is stored!
Both sides are of type **pointer to char**!

When a char pointer is intialized/assigned to a string constant:

- Pointer var may be assigned to point somewhere else

- But can **NOT** modify the string pointed by it!

```
  r [0] = ‘w’; // fails! Result is undefined!
```

Let’s recall again cases with a string constant:

- If your variable has its own memory and you copy string constant there, you can modify it as you wish, as in:
  - char robot[5];
    strcpy(robot, "good");
  - char robot[5] = "good";
  - char *r;
    r = (char *) malloc(sizeof(char) * 5);
    strcpy(r, "good");

Otherwise…!

```
char *r;  //
r = (char *) malloc(sizeof(char) * 5);
r = "good";
r [0] = ‘w’; // What will happen?
```

Result is undefined! Bec you are not using the allocated memory but pointing to a string constant, which is not modifiable!

Otherwise…!

char robot[5];

robot = "good"; // What will happen?

RECALL this is not array initialization (where string constant behaves exceptionally), so you are simply trying to change where an array name points to!

→ compile-time error!

strcpy()

- Now that we know what a string constant really is (i.e., a ptr to char)…
- what should be the prototype of strcpy() function?
  - char robot[5];

    strcpy(robot, "good");
  - char *r;

    r = (char *) malloc(sizeof(char) * 5);

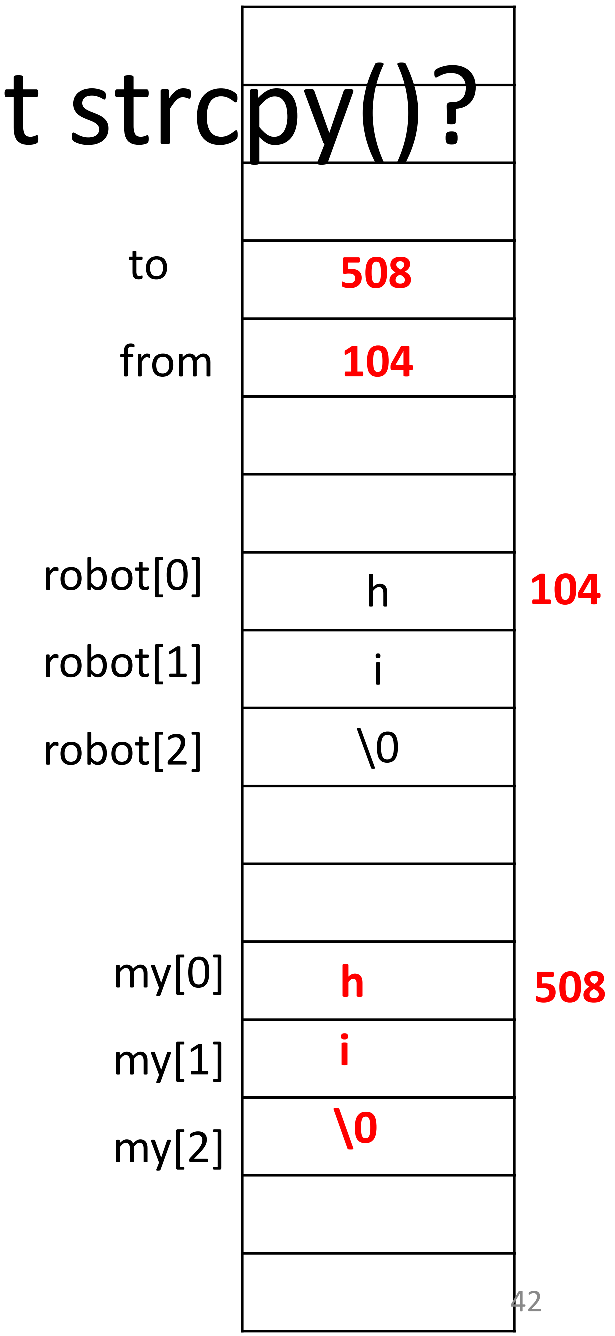
    strcpy(r, "good");

    or, strcpy(r, robot);

How can we implement strcpy()?

```
void strcpy(char *to, char *from)
{  while (*to = *from)
        to++ , from++ ; }

int main()
{
char my[3], robot[3]="hi";
strcpy(my, robot); }
```



to	508	
from	104	
robot[0]	h	104
robot[1]	i	
robot[2]	\0	
my[0]	h	508
my[1]	i	
my[2]	\0	

How can we implement strcpy()?

```
void strcpy(char *to, char *from)
{  while (*to = *from)
        to++ , from++ ; }
```

Shorter:

```
void strcpy(char *to, char *from)
{  while (*to++ = *from++) ; }
```

```
char robot[5], my[8];
strcpy(robot, "good"); strcpy(my, robot); …
```

How can we implement strlen()?

```
int my_strlen(char str[])
{ int i;
   for (i=0; str[i] != ‘\0’; i++) ;
   return i;
}
```

C Library Functions

Declared in string.h

size_t → unsigned integral type

size_t **strlen**(const char *s); (length of s w.o. NULL)

char ***strcpy**(char *s1, const char *s2);

(copies s2 to s1 including NULL, returns s1)

Sec. 7.4.1:

…strncpy..

…strcat..

…strcmp…

Array of strings

- True 2D, initialized

char robot[5] = {‘g’, ‘o’, ‘o’, ’d’, ‘\0’}; // or
char robot[5] = "good";

char day[7][5] = {"mon",…, "sun"};

// **OR,** I could first declare array and then assign as:

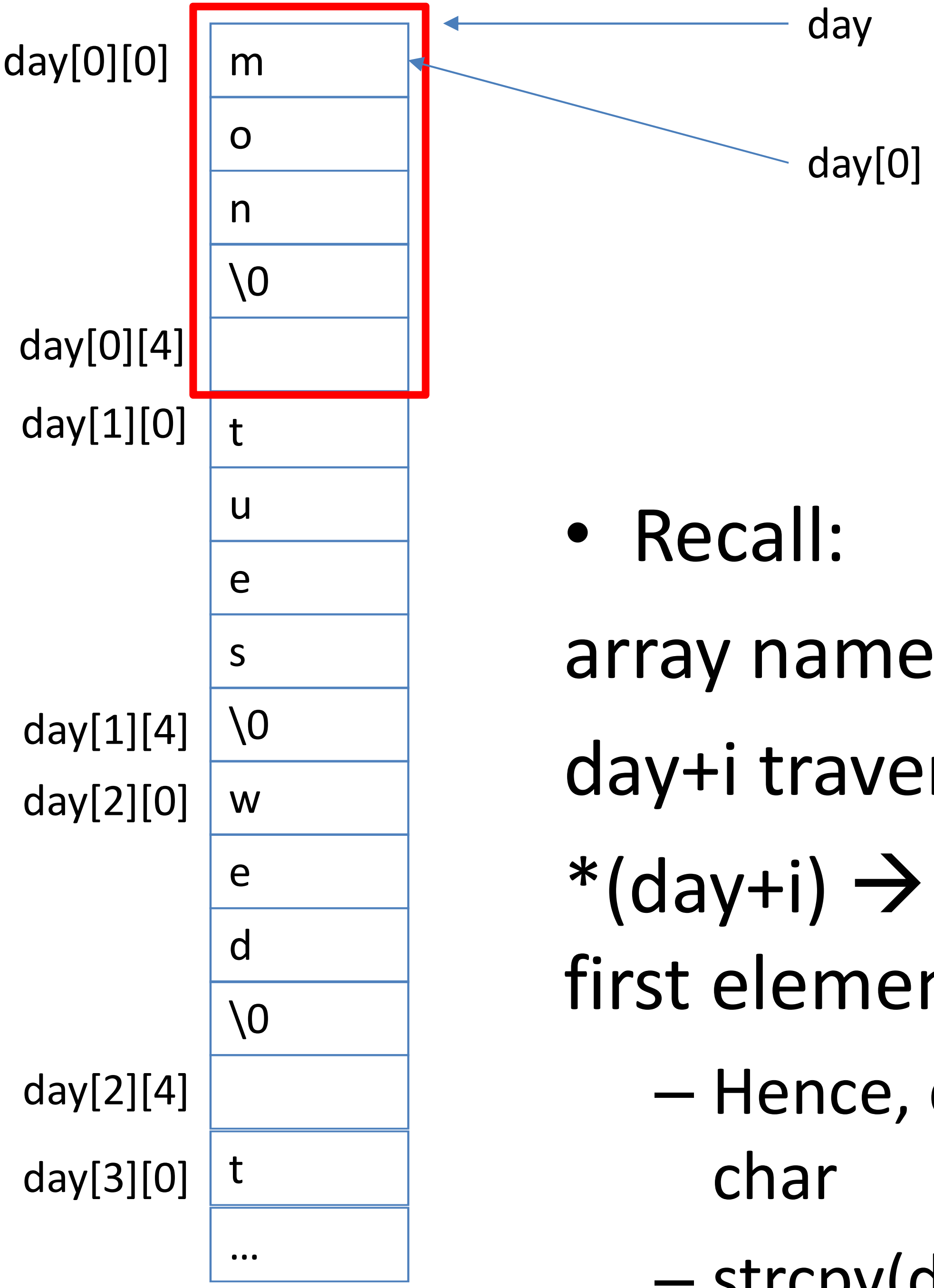
char day[7][5];

day[0][0] = ‘m’; …

// **OR,** assign as:

strcpy(day[0], "mon");

// In all cases, strings in the array are **modifiable**!



- Recall:

array name is a ptr to first array!

day+i traverses arrays

*(day+i) → day[i] is a ptr to the first element in the ith array!

  – Hence, day[i] is of type ptr to char
  – strcpy(day[0], "mon"); is OK!

Pop-up quiz

char day[7][5] = {"mon",…, "sun"}; OK

char day[7][5];

day[0]="hey";

day[0][1]= ‘m’; What will happen?

a) Compile-time error

b) Run-time error: string is not modifiable

c) Undefined: string is not modifiable

d) String becomes mey

We have seen

char robot[5] = "good"; OK

char robot[5] ;

robot= "good"; COMPILE ERROR

Array of strings

- True 2D, passing as a parameter:

Rewritten as: **char (*d)[5]**

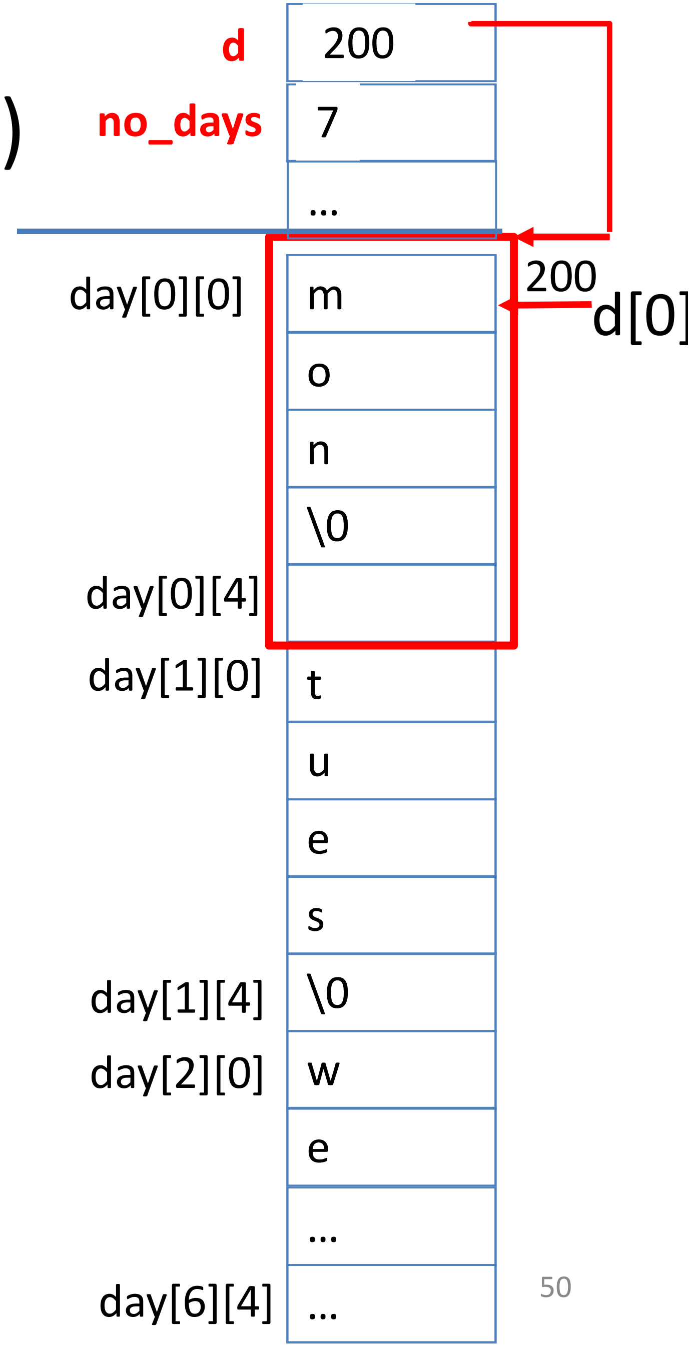
```
void list_days (char d[][5], no_days)
{ int i;
  for (i=0; i<no_days; i++)
     printf("%s\n", d[i]); }
```

No need for second dim length, as each array is ended with NULL!

Rewritten as: **char (*d)[5]**

```
void list_days (char d[][5], no_days)
{ int i;
   for (i=0; i<no_days; i++)
      printf("%s\n", d[i]); }

int main(void)
{char day[7][5] = {"mon",..., "sun"};
  list_days(day,7);}
```



d	200
no_days	7
	…
day[0][0]	m
	o
	n
	\0
day[0][4]	
day[1][0]	t
	u
	e
	s
day[1][4]	\0
day[2][0]	w
	e
	…
day[6][4]	…

Array of strings

- Dynamic 2D, iliffe vector, can be:

```
char *day[7] = {"mon",…, "sun"};
```

Not-modifiable

Or:

In what cases,
strings are **modifiable**?

```
char *day[7];
day[0] = "mon";
```

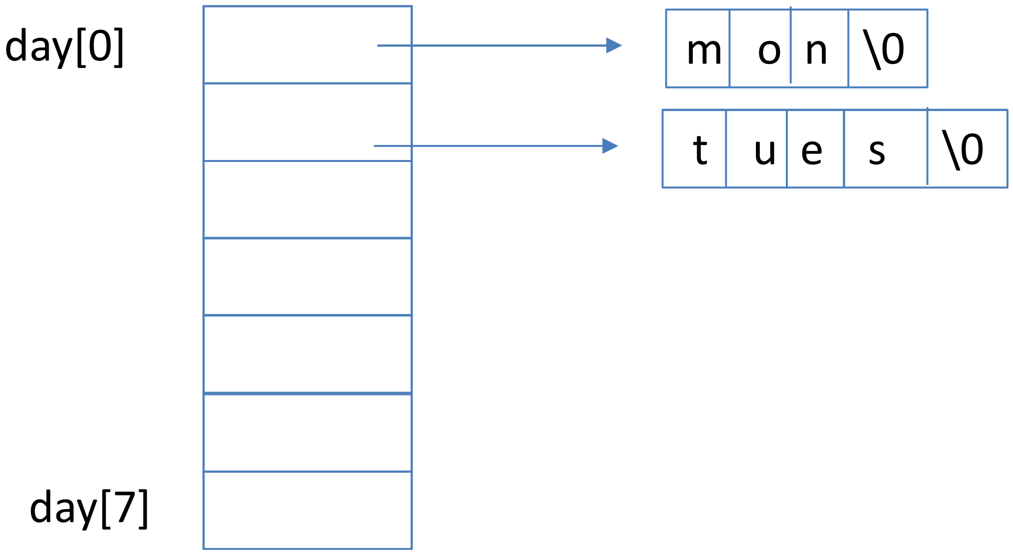
Not-modifiable

Or:

```
char *day[7];
day[0] = (char *) malloc (sizeof("mon"));
strcpy(day[0], "mon"); // or: day[0][0] = ‘m’; …
```

modifiable!

Array of strings



- day[i] is of type ptr to char
- Note that pointed memory space is either explicitly allocated, or system-area (if ptr is assigned to a str constant)

Array of strings

- Dynamic 2D, iliffe vector, passing as a parameter:

Rewritten as: **char **d**

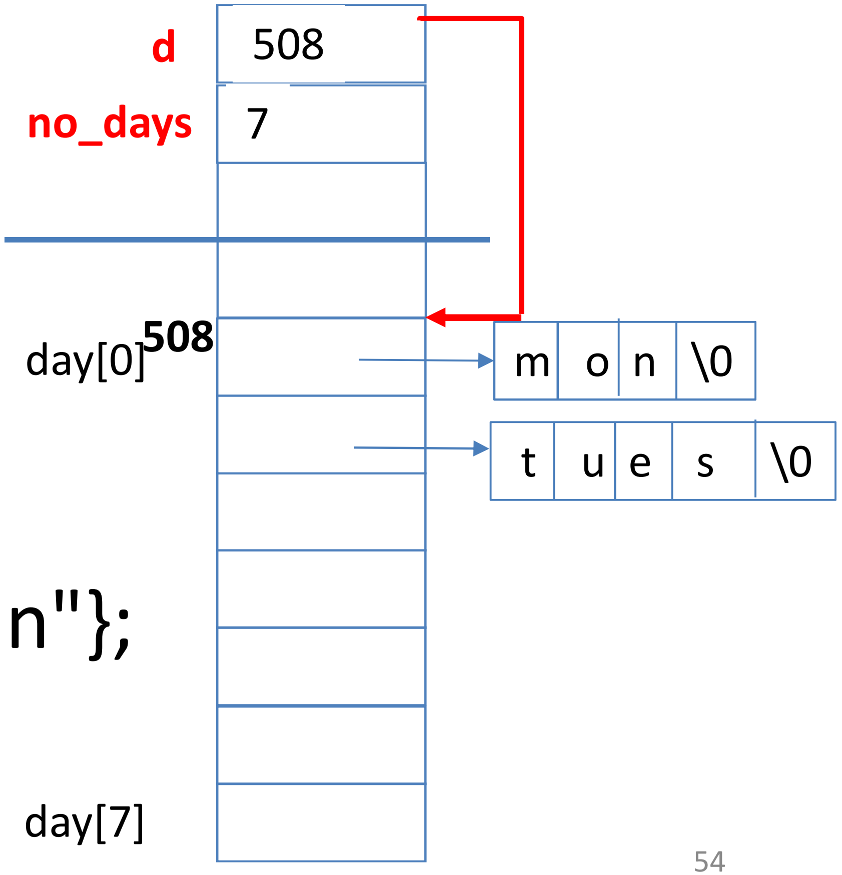
```
void list_days (char *d[], no_days)
{ int i;
   for (i=0; i<no_days; i++)
       printf("%s\n", d[i]); }
```

Array of strings

Rewritten as: **char **d**

```
void list_days (char *d[], no_days)
{ int i;
   for (i=0; i<no_days; i++)
       printf("%s\n", d[i]); }

int main(void)
{char *day[7] = {"mon",..., "sun"};
  list_days(day,7);}
```



d 508

no_days 7

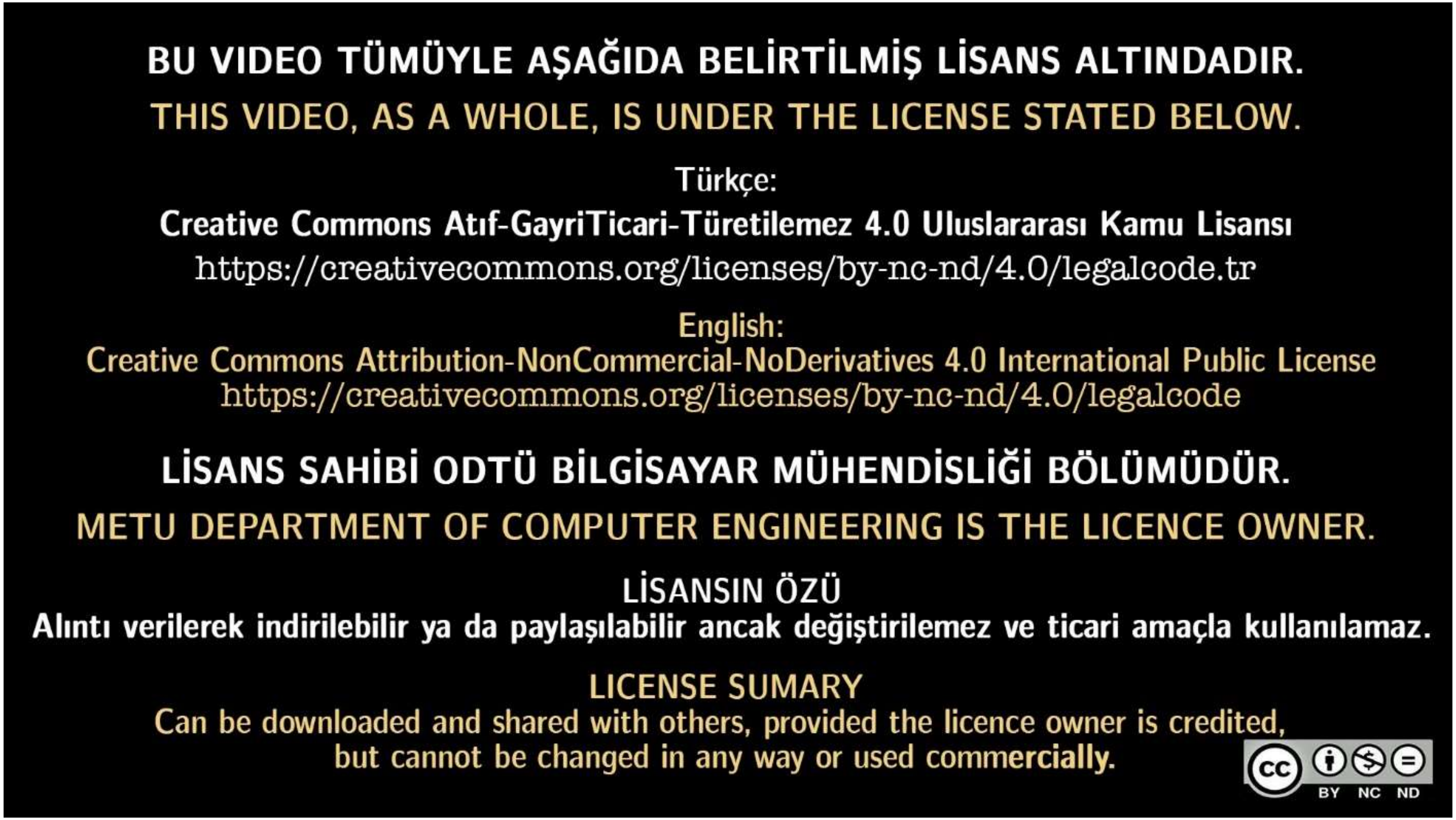
day[0] **508**

m o n \0

t u e s \0

day[7]

Warning



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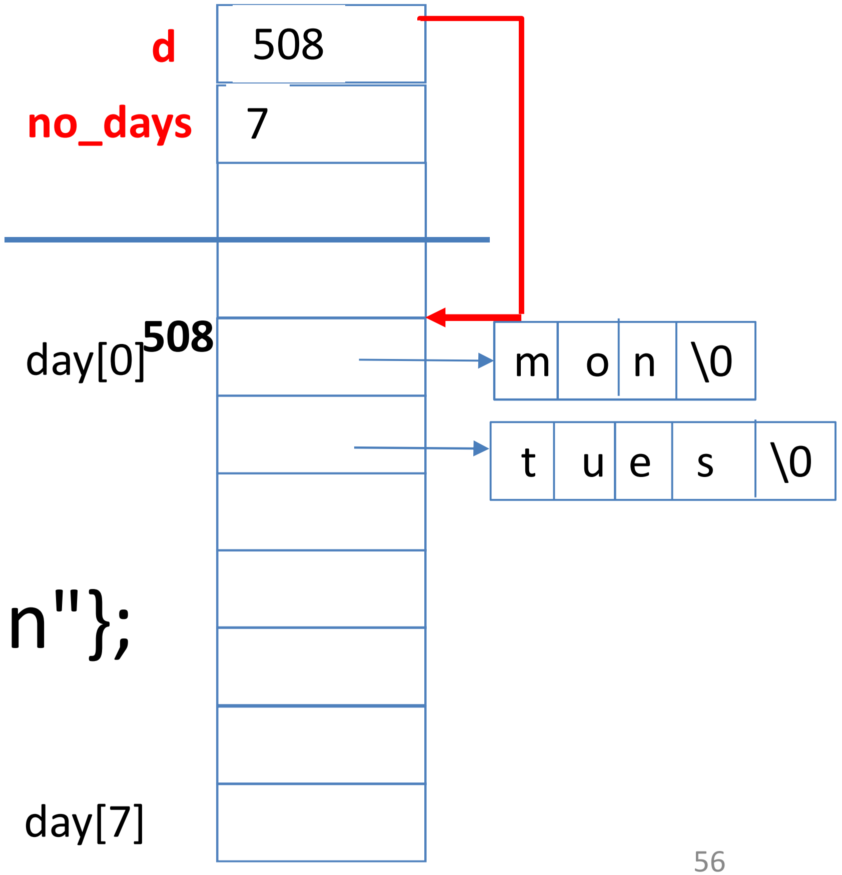
Recap: Array of strings

Rewritten as: **char **d**

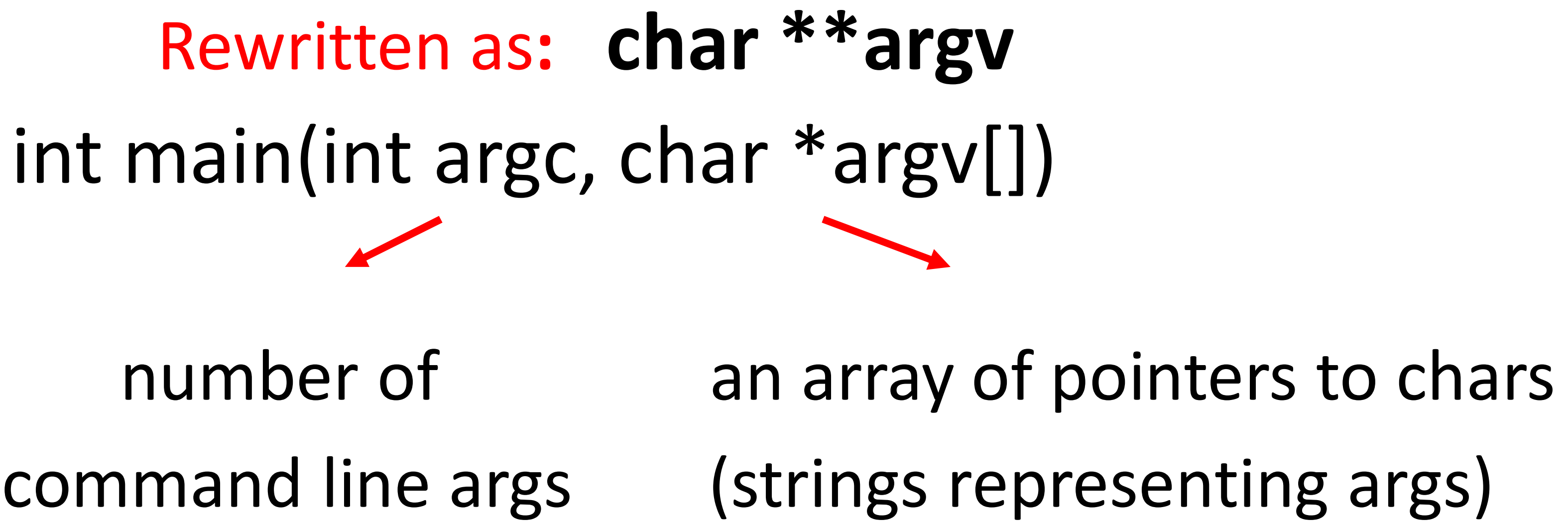
```
void list_days (char *d[], no_days)
{ int i;
   for (i=0; i<no_days; i++)
      printf("%s\n", d[i]); }

int main(void)
{char *day[7] = {"mon",..., "sun"};
  list_days(day,7);}
```



Parameters of main()

- main can be defined with formal parameters so that it can accept command-line arguments
  - main defined as having two parameters, typically called as argc and argv, as follows:



Rewritten as: **char **argv**

int main(int argc, char *argv[])

number of command line args

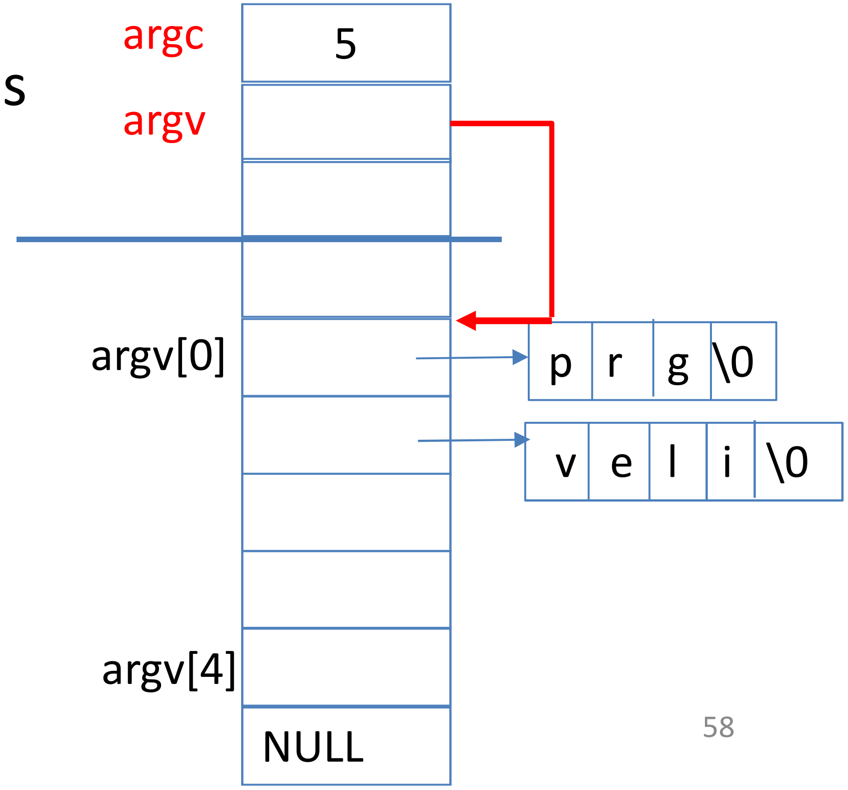
an array of pointers to chars (strings representing args)

Parameters of main()

- Compile your prg.c as executable prg

  ./prg veli ali ayse fatma

- argc: 5, argv is as shown in figure:
  - argv[0] points to the name of the program
  - argv[1] to argv[argc-1] point to args
  - argv[argc] is NULL by convention



Parameters of main()

- So, the command line arguments are strings
  - if needed you can convert them to other types
  - long int atoi(char *) → string to int
  - more functions in Section Appendix A.6 of the textbook