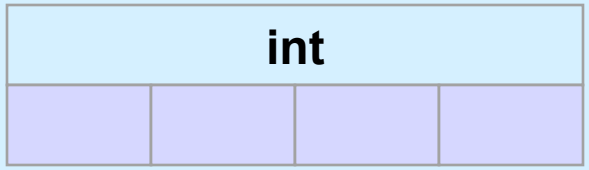
CS 33

Introduction to C
Part 5

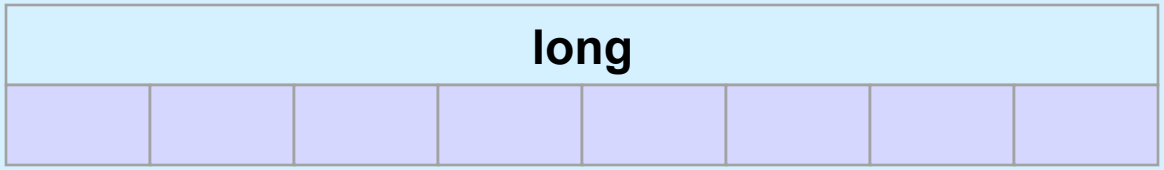
Basic Data Types



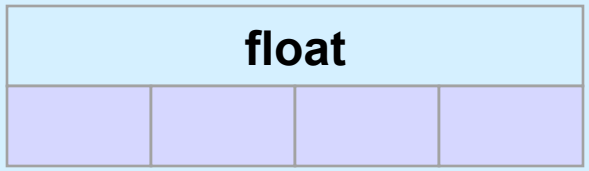
-2,147,483,648 – 2,147,483,647

-32,768 – 32,767

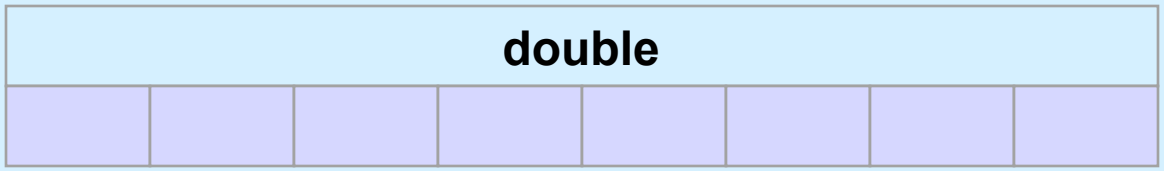
-128 – 127



-9,223,372,036,854,775,808 – 9,223,372,036,854,775,807



$\pm 1.8 \times 10^{-38} - \pm 3.4 \times 10^{38}$, ~7 decimal digits



$\pm 2.23 \times 10^{-308} - \pm 1.8 \times 10^{308}$, ~16 decimal digits

Characters

- **ASCII**
  - **American Standard Code for Information Interchange**

- **works for:**
  - **English**
  - **Swahili**
  - **not much else**

- **doesn't work for:**
  - **French**
  - **Spanish**
  - **German**
  - **Korean**
  - **Arabic**
  - **Sanskrit**
  - **Chinese**
  - **pretty much everything else**

Characters

- Unicode
  - support for the rest of world
  - defines a number of encodings
  - most common is UTF-8
    - » variable-length characters
    - » ASCII is a subset and represented in one byte
    - » larger character sets require an additional one to three bytes
  - not covered in CS 33

ASCII Character Set

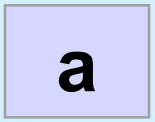
	00	10	20	30	40	50	60	70	80	90	100	110	120
0:	\0	\n			(	2	<	F	P	Z	d	n	x
1:		\v			)	3	=	G	Q	[	e	o	y
2:		\f		sp	*	4	>	H	R	\	f	p	z
3:		\r		!	+	5	?	I	S	]	g	q	{
4:				"	,	6	@	J	T	^	h	r	|
5:				#	-	7	A	K	U	_	i	s	}
6:				$	.	8	B	L	V	`	j	t	~
7:	\a			%	/	9	C	M	W	a	k	u	DEL
8:	\b			&	0	:	D	N	X	b	l	v	
9:	\t			'	1	;	E	O	Y	c	m	w	

*char*s as Integers

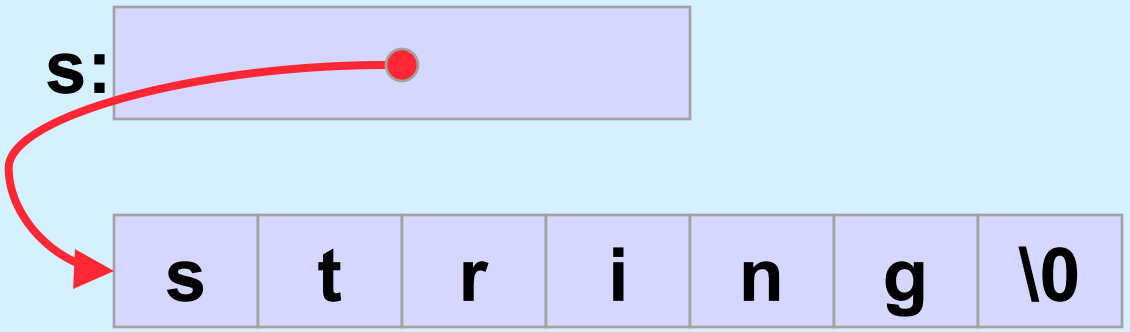
```
char tolower(char c) {
  if (c >= 'A' && c <= 'Z')
      return c + 'a' - 'A';
  else
      return c;
}
```

Character Strings

```
char c = 'a';
```




```
char *s = "string";
```

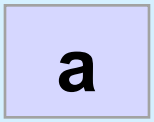


Is there any difference between *c1* and *c2* in the following?

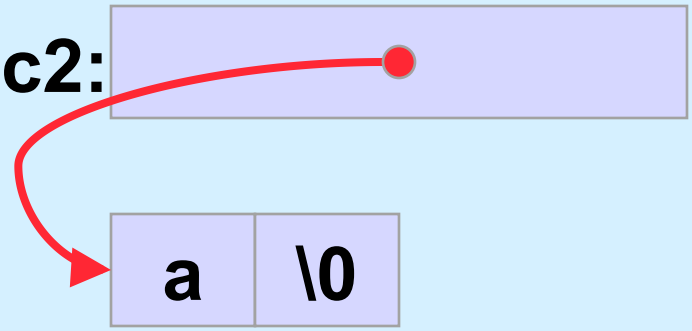
```
char c1 = 'a';
char *c2 = "a";
```

Yes!!

```
char c1 = 'a';
```

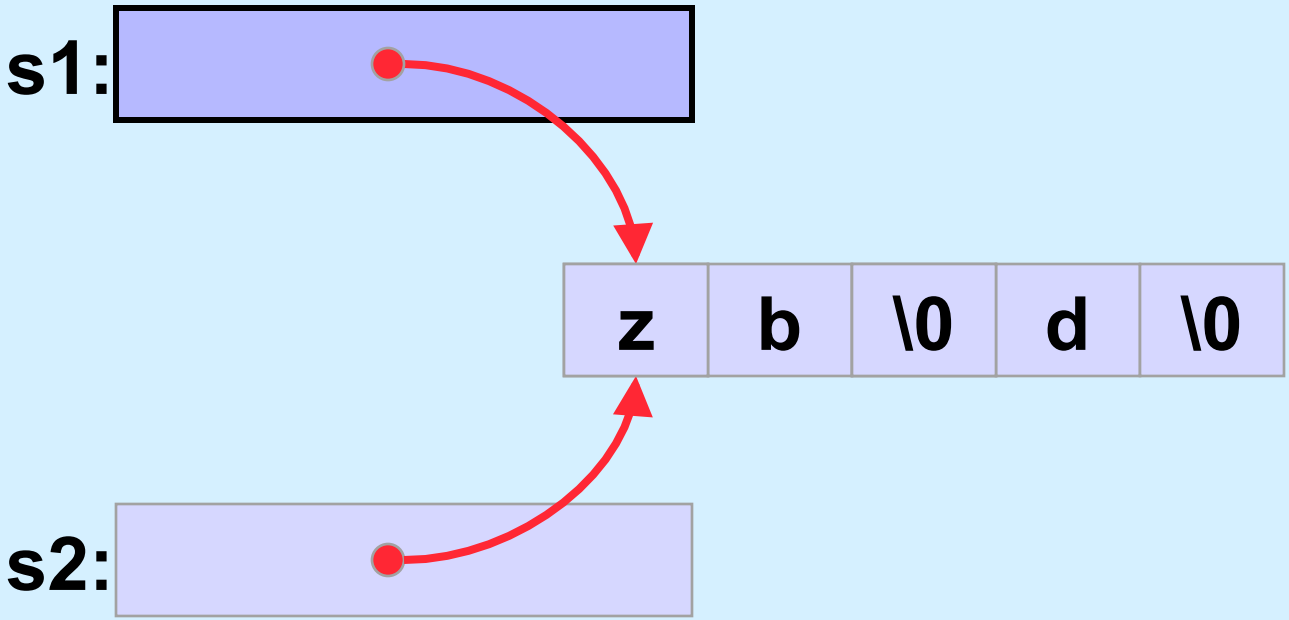



```
char *c2 = "a";
```



What do *s1* and *s2* refer to after the following is executed?

```
char s1[] = "abcd";
char *s2 = s1;
s1[0] = 'z';
s2[2] = '\0';
```



Weird …

Suppose we did it this way:

```
char *s1 = "abcd";
char *s2 = s1;
s1[0] = 'z';
s1[2] = '\0';
```

```
% gcc -o char char.c
% ./char
Segmentation fault
```

Copying Strings (1)

```
char s1[] = "abcd";
char s2[5];

s2 = s1;   // does this do anything useful?

// correct code for copying a string
for (i=0; s1[i] != '\0'; i++)
  s2[i] = s1[i];
s2[i] = '\0';

// would it work if s2 were declared:
char *s2;
// ?
```

Copying Strings (2)

```
char s1[] = "abcdefghijklmnopqrstuvwxyz";
char s2[5];

for (i=0; s1[i] != '\0'; i++)
  s2[i] = s1[i];
s2[i] = '\0';
```

Does this work?

```
for (i=0; (i<4) && (s1[i] != '\0'); i++)
  s2[i] = s1[i];
s2[i] = '\0';
```

Works!

String Length

```
char *s1;

s1 = produce_a_string();
// how long is the string?

sizeof(s1); // doesn't yield the length!!

for (i=0; s1[i] != '\0'; i++)
  ;
// number of characters in s1 is i
```

Size

```
int main() {
    char s[] = "1234";
    printf("%d\n", sizeof(s));
    proc(s, 5);
    return 0;
}

void proc(char s1[], int len) {
    char s2[12];
    printf("%d\n", sizeof(s1));
    printf("%d\n", sizeof(s2));
}
```

```
$ gcc -o size size.c
$ ./size
5
8
12
$
```

Quiz 1

```
void proc(char s[16]) {
    printf("%d\n", sizeof(s));
}
```

What's printed?

a) 8
b) 15
c) 16
d) 17

Comparing Strings (1)

```
char *s1;
char *s2;

s1 = produce_a_string();
s2 = produce_another_string();
// how can we tell if the strings are the same?

if (s1 == s2) {
  // does this mean the strings are the same?
} else {
  // does this mean the strings are different?
}
```

Comparing Strings (2)

```
int strcmp(char *s1, char *s2) {
  int i;
  for (i=0;
       (s1[i] == s2[i]) && (s1[i] != 0) && (s2[i] != 0);
       i++)
    ; // an empty statement
  if (s1[i] == 0) {
    if (s2[i] == 0) return 0; // strings are identical
    else return -1; // s1 < s2
  } else if (s2[i] == 0) return 1; // s2 < s1
  if (s1[i] < s2[i]) return -1; // s1 < s2
  else return 1;  // s2 < s1;
}
```

The String Library

```
#include <string.h>

char *strcpy(char *dest, char *src);
  // copy src to dest, returns ptr to dest
char *strncpy(char *dest, char *src, int n);
  // copy at most n bytes from src to dest
int strlen(char *s);
  // return the length of s (not counting the null)
int strcmp(char *s1, char *s2);
  // returns -1, 0, or 1 depending on whether s1 is
  // less than, the same as, or greater than s2
int strncmp(char *s1, char *s2, int n);
  // do the same, but for at most n bytes
```

The String Library (more)

```
size_t strspn(const char *s, const char *accept);
      // returns length of initial portion of s
      // consisting entirely of bytes from accept

size_t strcspn(const char *s, const char *reject);
      // returns length of initial portion of s
      // consisting entirely of bytes not from
      // reject
```

Quiz 2

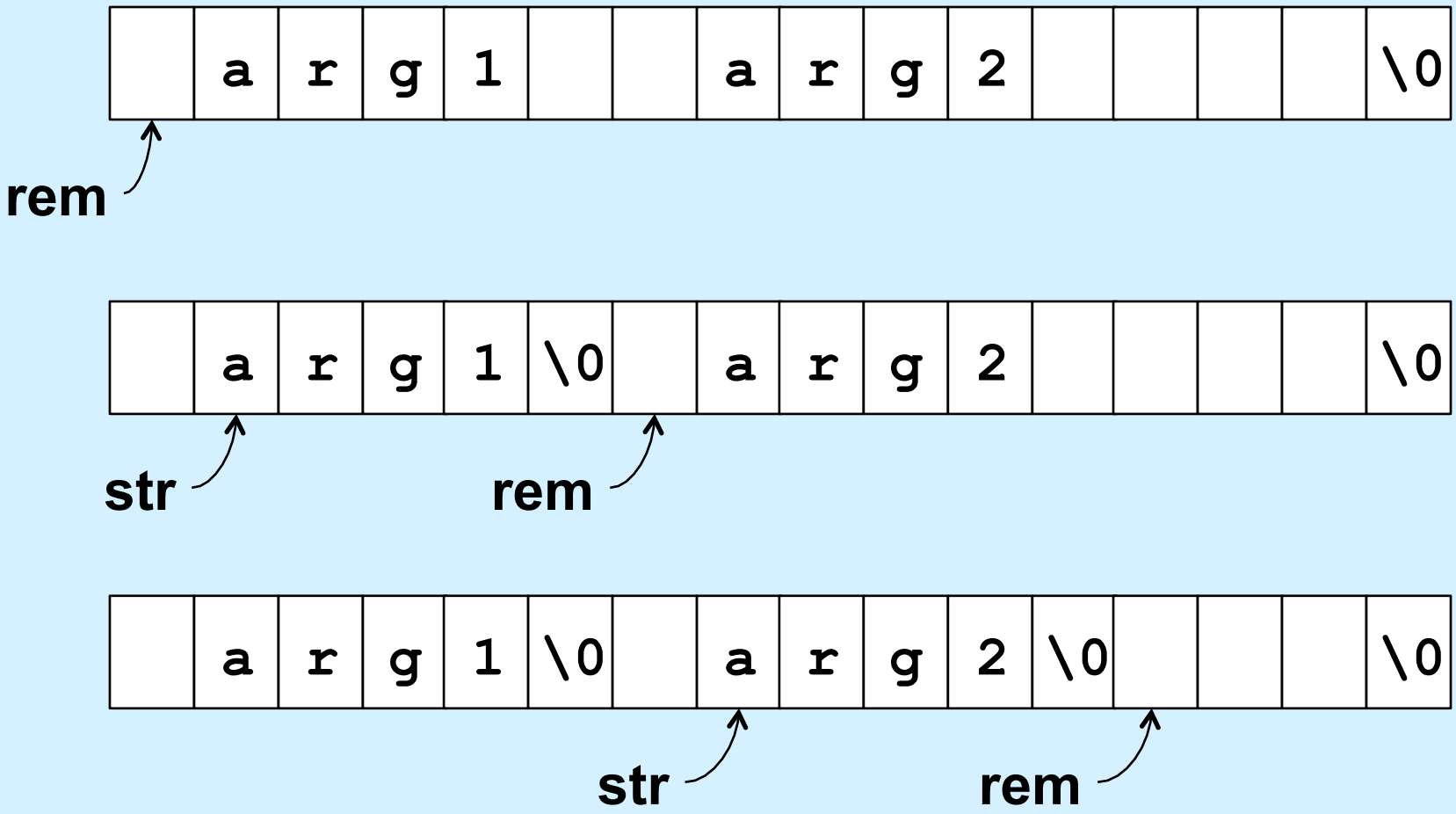
```
#include <stdio.h>
#include <string.h>

int main() {
  char s1[] = "Hello World!\n";
  char *s2;
  strcpy(s2, s1);
  printf("%s", s2);
  return 0;
}
```

This code:

a) is a great example of well written C code
b) has syntax problems
c) might seg fault

Parsing a String

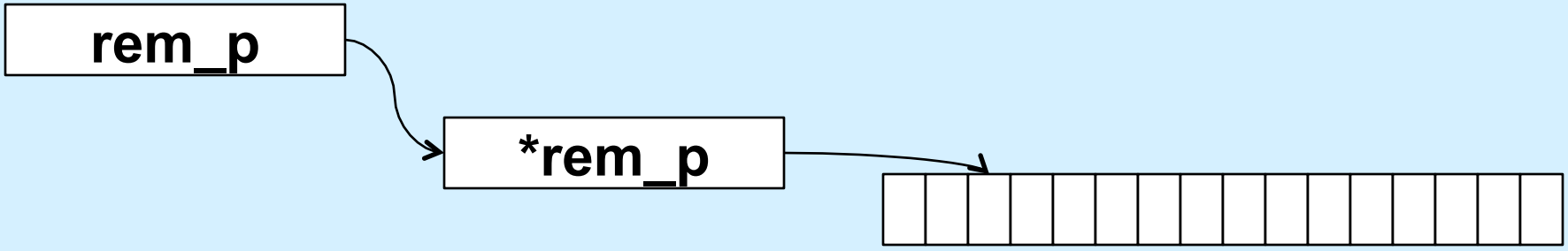


Design of *getfirstword*

- char *getfirstword(char **rem_p)
  - returns
    - » pointer to null-terminated first word in *rem_p

    or
    - » NULL, if *rem_p is a string entirely of whitespace
  - *rem_p modified to
    - » point to character following first word in *rem_p if within bounds of string

    or
    - » NULL if next character not within bounds



Using *getfirstword*

```
int main() {
  char line[] = "  arg0   arg1 arg2   arg3   ";
  char *rem = line;
  char *str;
  while ((str = getfirstword(&rem)) != NULL) {
    printf("%s\n", str);
  }
  return 0;
}
```

Output:

```
arg0
arg1
arg2
arg3
```

Code

```
char *getfirstword(char **rem_p) {
  char *str = *rem_p;
  if (str == NULL)
    return NULL;
  int len = strlen(str);
  int wslen =
    strspn(str, " \t\n");
      // initial whitespace
  if (wslen == len) {
    // string is all whitespace
    return NULL;
  }
  str = &str[wslen];
    // skip over whitespace
  len -= wslen;
  int wlen =
    strcspn(str, " \t\n");
      // length of first word
  if (wlen < len) {
    // word ends before end of
    // string: terminate
    // it with null
    str[wlen] = '\0';
    *rem_p = &str[wlen+1];
  } else {
    // no more words
    *rem_p = NULL;
  }
  return str;
}
```