

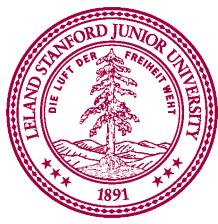
Strings

# Learning Goals

1. Understand chars and Strings
2. Write methods acting on Strings



# Text Applications



How is text  
represented?

# The variable type **String**

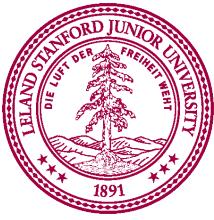
Text is stored using the variable type **String**.  
A **String** is a sequence of characters.

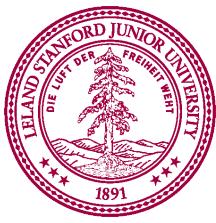
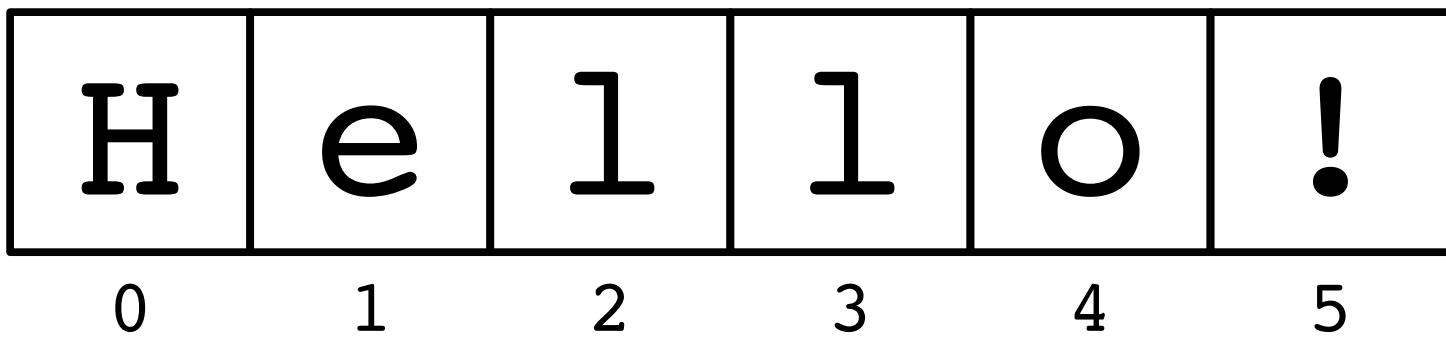
```
public void run() {  
    String text = "hello!";  
    println(text);  
}
```

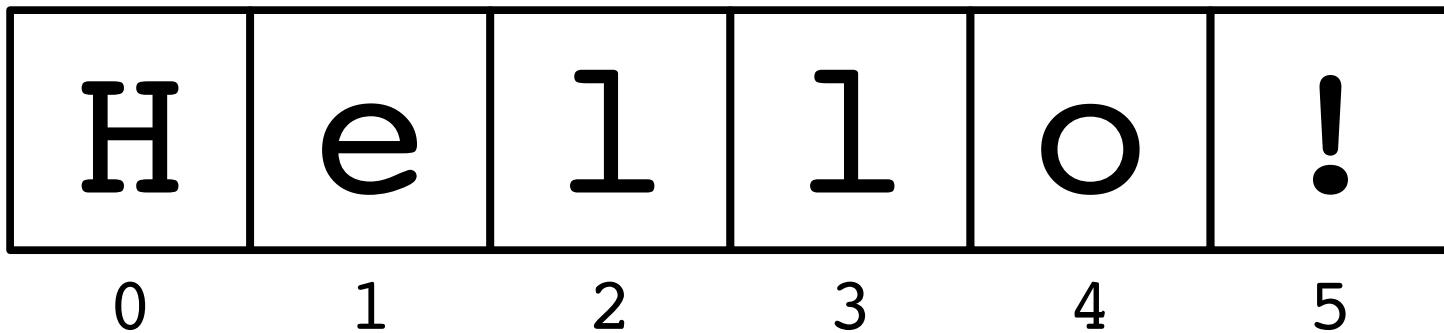


H e l l o !

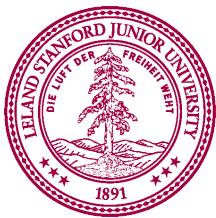
Piech, CS106A, Stanford University







***text.charAt( index )***





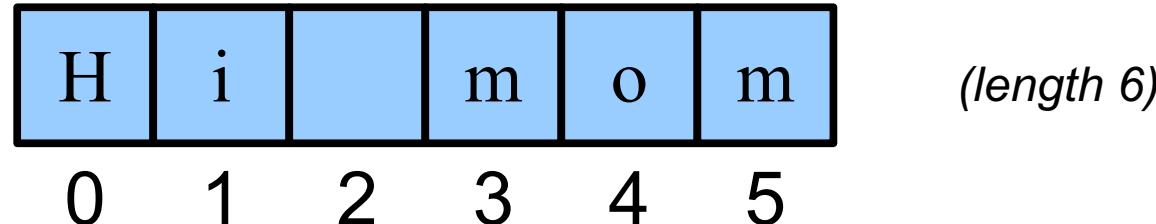
All characters in a string have  
an index.

You can access a character in  
the sequence via its *index*



# String Methods

- The **string.length()** method returns the number of characters in the string. This is one larger than the last valid index in the string.
- the **string.charAt( i )** method returns the character at a given index.



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
    int length = example.length();  
    println(length); // prints 6  
  
    // example of getCharAt  
    char first = example.charAt(0);  
    println(first); // prints 'H'  
  
    // loop that prints letters one-by-one  
    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
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    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

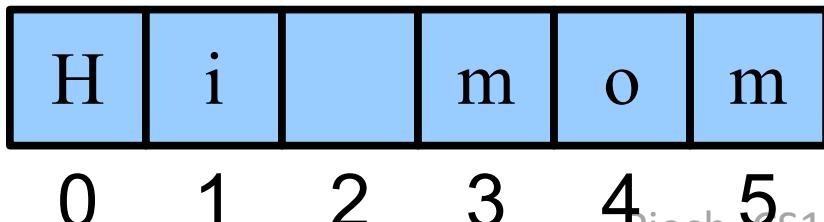


# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
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    int length = example.length();  
    println(length); // prints 6  
  
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    // loop that prints letters one-by-one  
    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

example

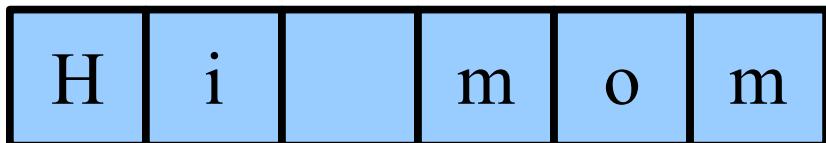


# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
    int length = example.length();  
    println(length), // prints 6  
  
    // example of getCharAt  
    char first = example.charAt(0);  
    println(first); // prints 'H'  
  
    // loop that prints letters one-by-one  
    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

example



length

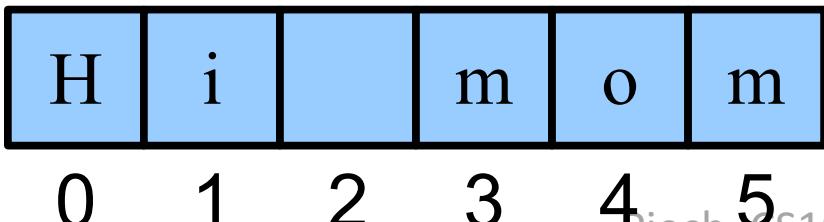
6



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
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    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

example



length

6

Console

6



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
    int length = example.length();  
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    // loop that prints letters one-by-one  
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        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

6

example



length

6

first

'H'



# String Methods

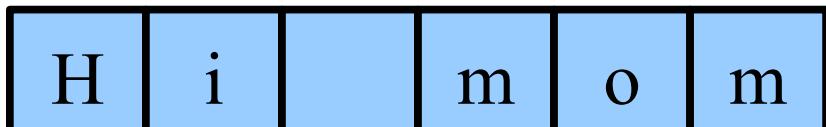
```
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    String example = "Hi mom";  
  
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    }  
}
```

Console

6

H

example



length

6

first

'H'



# String Methods

```
public void run() {  
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        char ch = example.charAt(i);  
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```

Console

6  
H

example



length

6

first

'H'



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```
public void run() {  
    String example = "Hi mom";  
  
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        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

6  
H

example



length

6

first

'H'

i

0



# String Methods

```
public void run() {  
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}
```

Console

6  
H

example



length

6

first

'H'

i

0



# String Methods

```
public void run() {  
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Console

6  
H

example



length

6

first

'H'

i

0



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        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

6  
H

example



length

6

first

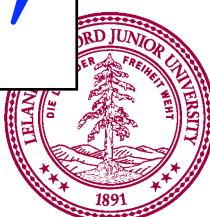
'H'

i

0

ch

'H'



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
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    char firstLetter = example.charAt(0);  
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    // loop that prints letters one-by-one  
    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

6  
H  
H

example

H	i		m	o	m
0	1	2	3	4	5

length

6

first

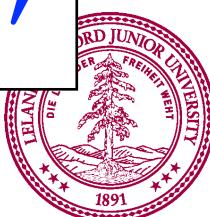
'H'

i

0

ch

'H'



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        println(ch);  
    }  
}
```

Console

6  
H  
H

example



length

6

first

'H'

i

0



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}
```

Console

6  
H  
H

example



length

6

first

'H'

i

1



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```

Console

```
6  
H  
H
```

example



length

6

first

'H'

i

1

0 1 2 3 4 5



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Console

6  
H  
H

example



length

6

first

'H'

i

1



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}
```

Console

6  
H  
H

example



length

6

first

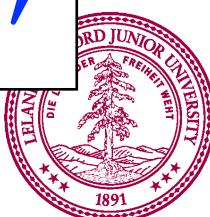
'H'

i

1

ch

'i'



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    }  
}
```

Console

6  
H  
H  
i

example



length

6

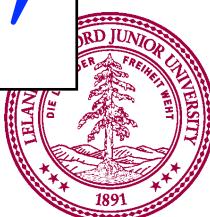
first

'H'

i

ch

'i'



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Console

6  
H  
H  
i

example



length

6

first

'H'

i

1



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```

Console

6  
H  
H  
i

example



length

6

first

'H'

i

2



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```

Console

6  
H  
H  
i

example



length

6

first

'H'

i

2



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```

Console

6  
H  
H  
i

example



length

6

first

'H'

i

2



# String Methods

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    }  
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```

Console

6  
H  
H  
i

example



length

6

first

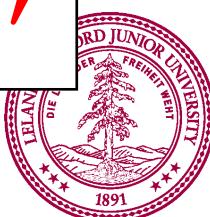
'H'

i

2

ch

' '



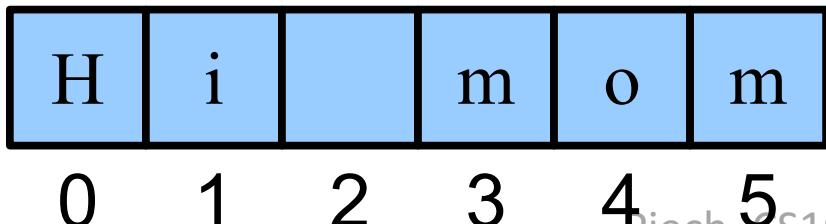
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}
```

Console

6  
H  
H  
i

example



length

6

first

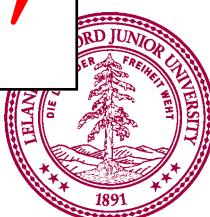
'H'

i

2

ch

' '



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        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

```
6  
H  
H  
i
```

example



length

6

first

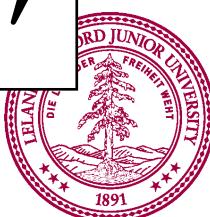
'H'

i

2

ch

' '



# String Methods

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public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
    int length = example.length();  
    println(length); // prints 6  
  
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    char firstLetter = example.charAt(0);  
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    for(int i = 0; i < example.length(); i++) {  
        char ch = example.charAt(i);  
        println(ch);  
    }  
}
```

Console

6  
H  
H  
i  
m  
o  
m

example



length

6

first

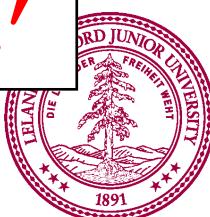
'H'

i

5

ch

'm'



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
    // example of length method  
    int length = example.length();  
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```

Console

6  
H  
H  
i  
m  
o  
m

example



length

6

first

'H'

i

5



# String Methods

```
public void run() {  
    String example = "Hi mom";  
  
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        println(ch);  
    }  
}
```

Console

6  
H  
H  
i  
m  
o  
m

example



length

6

first

'H'

i

6



# String Methods

```
public void run() {  
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    }  
}
```

Console

6  
H  
H  
i  
m  
o  
m

example



length

6

first

'H'

i

6



How are characters  
represented?

# The variable type **char**

- The primitive type **char** represents a single character or glyph.
- Some examples:

```
char letterA = 'A';
```

```
char plus      = '+'
```

```
char zero     = '0';
```

```
char space    = ' ';
```

```
char newLine  = '\n'; // special
```

```
char first   = text.charAt(0);
```



# ASCII

Code	Char	Code	Char	Code	Char	Code	Char	Code	Char	Code	Char
32	[space]	48	0	64	@	80	P	96	*	112	p
33	!	49	1	65	A	81	Q	97	a	113	q
34	"	50	2	66	B	82	R	98	b	114	r
35	#	51	3	67	C	83	S	99	c	115	s
36	\$	52	4	68	D	84	T	100	d	116	t
37	%	53	5	69	E	85	U	101	e	117	u
38	&	54	6	70	F	86	V	102	f	118	v
39	'	55	7	71	G	87	W	103	g	119	w
40	(	56	8	72	H	88	X	104	h	120	x
41	)	57	9	73	I	89	Y	105	i	121	y
42	*	58	:	74	J	90	Z	106	j	122	z
43	+	59	:	75	K	91	[	107	k	123	{
44	,	60	<	76	L	92	\	108	l	124	-
45	-	61	=	77	M	93	]	109	m	125	}
46	.	62	>	78	N	94	^	110	n	126	~
47	/	63	?	79	O	95	_	111	o	127	[backspace]

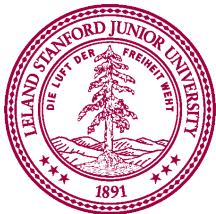
\* This is only the first half of the table

The letter A, for example, has the ASCII value 65





‘A’ -> ‘Z’ are sequential.  
‘a’ -> ‘z’ are sequential.  
‘0’ -> ‘9’ are sequential.

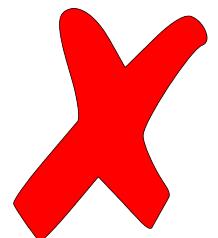


# Useful Character methods

```
public void run() {  
    String str = readLine("Line: ");  
  
    char ch = str.charAt(0);  
    println("Original first char: " + ch);  
  
    ch = Character.toUpperCase(ch);  
    println("Uppercase first char: " + ch);  
  
    if(Character.isLetter(ch)) {  
        println("It's a letter!");  
    }  
}
```



# Character Methods



```
char lowercaseA = 'a';
Character.toUpperCase(lowercaseA); // Does nothing!
println(lowercaseA);           // prints 'a'!
```



```
char uppercaseA =
    Character.toUpperCase(lowercaseA); // OK
println(uppercaseA);           // prints 'A'!
```



# Useful Character methods

**static boolean isDigit(char ch)**

Determines if the specified character is a digit.

**static boolean isLetter(char ch)**

Determines if the specified character is a letter.

**static boolean isLetterOrDigit(char ch)**

Determines if the specified character is a letter or a digit.

**static boolean isLowerCase(char ch)**

Determines if the specified character is a lowercase letter.

**static boolean isUpperCase(char ch)**

Determines if the specified character is an uppercase letter.

**static boolean isWhitespace(char ch)**

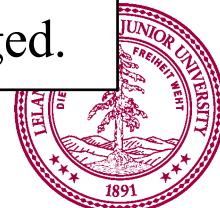
Determines if the specified character is whitespace (spaces and tabs).

**static char toLowerCase(char ch)**

Converts **ch** to its lowercase equivalent, if any. If not, **ch** is returned unchanged.

**static char toUpperCase(char ch)**

Converts **ch** to its uppercase equivalent, if any. If not, **ch** is returned unchanged.



Strings have some unique  
properties

# Strings are Immutable

- Java strings are ***immutable***: once a string has been created **you cannot set characters**.
- To change a string:
  - ***Create a new string*** holding the new value you want it to have via concatenation.
  - Reassigning the String variable (that's allowed).
- ***Important consequence:*** if you pass a String into a method, that method cannot modify that string.



# Strings are often made through concatenation

```
public void run() {  
    String s1 = "Breakout";  
    String s2 = "it was awesome";  
    String s3 = "I crushed " + s1 + " and " + s2;  
  
    println(s3);  
}
```

I crushed Breakout and it was awesome

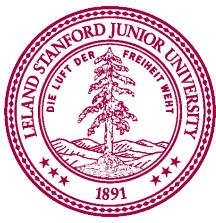
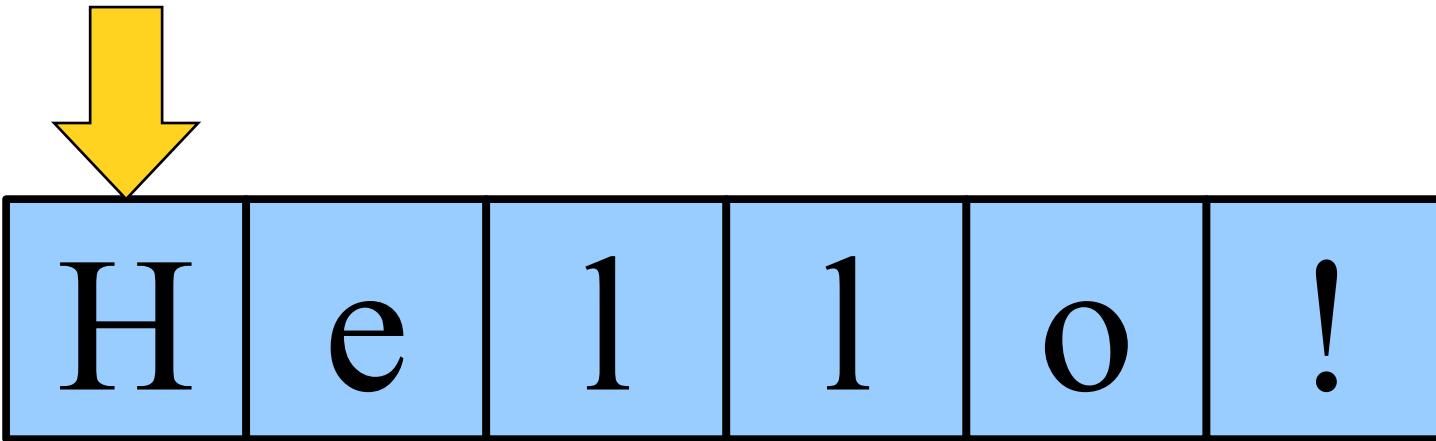




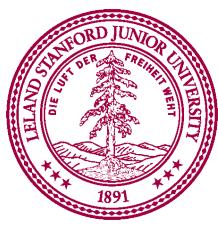
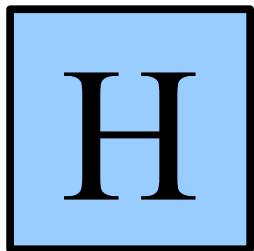
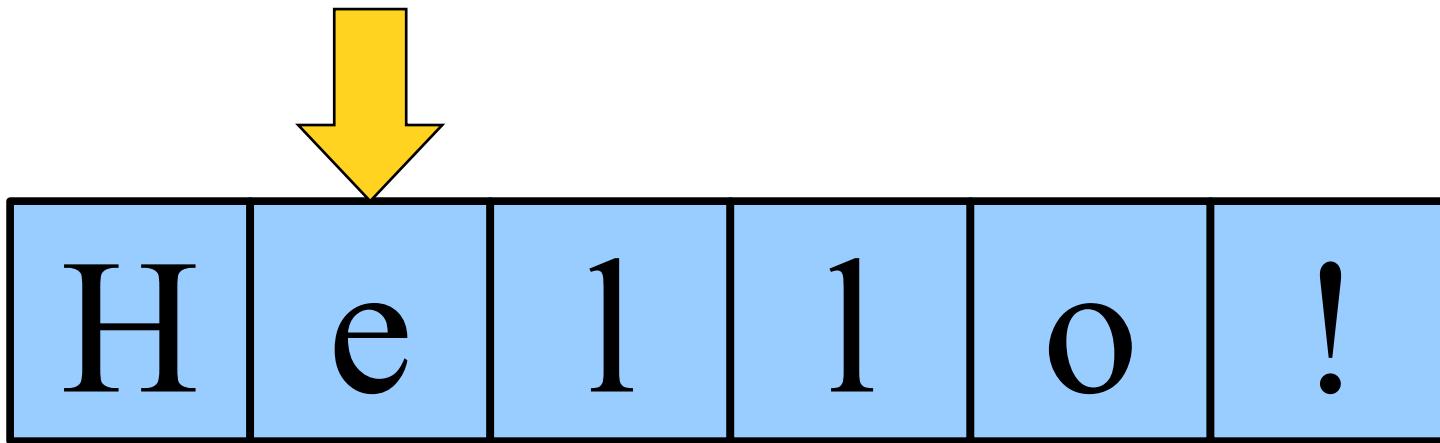
Many string algorithms use  
the “loop and construct”  
pattern.



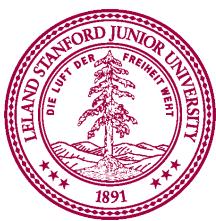
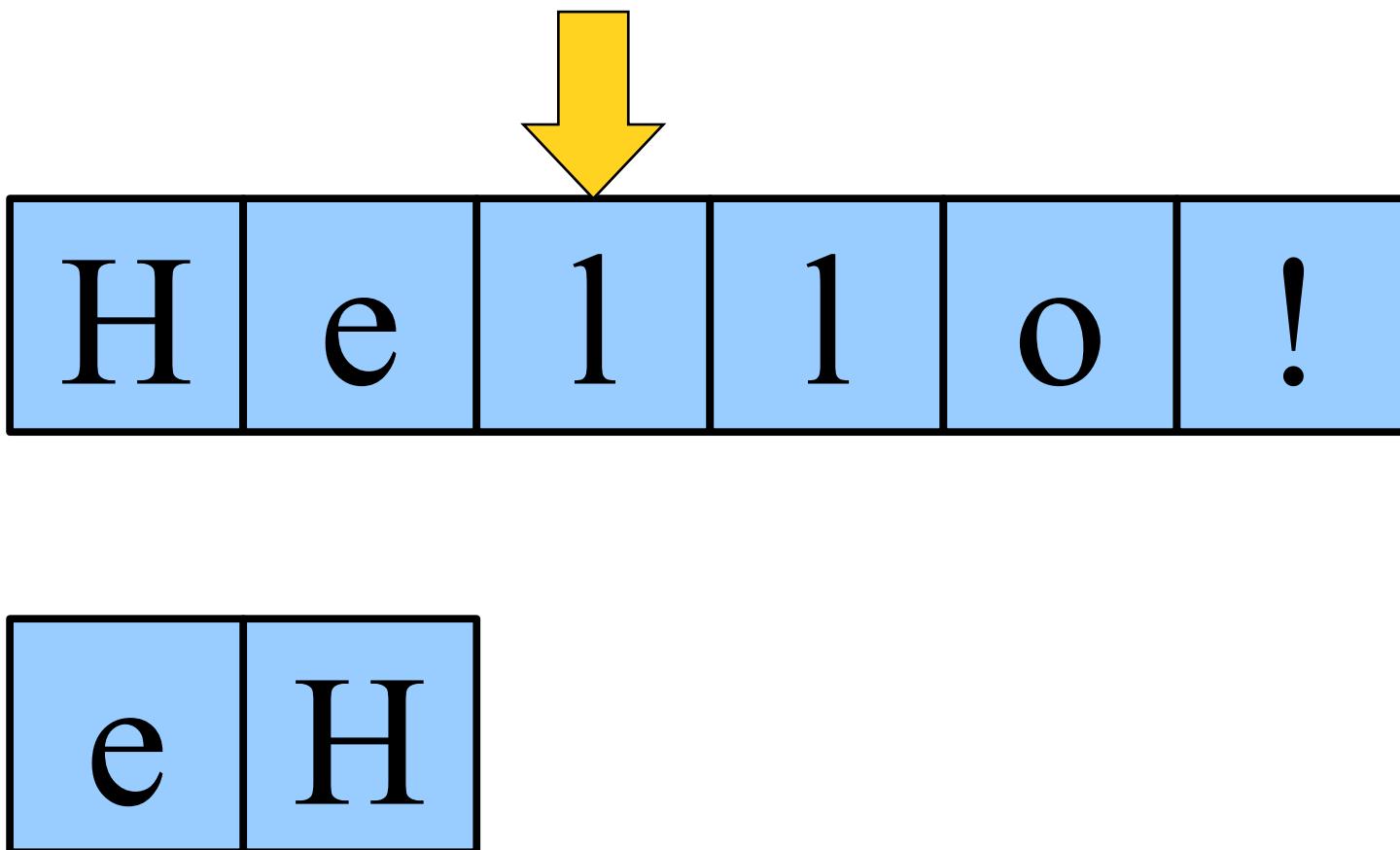
# Reversing a String



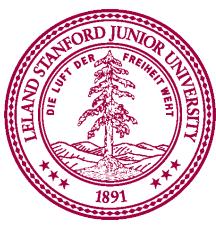
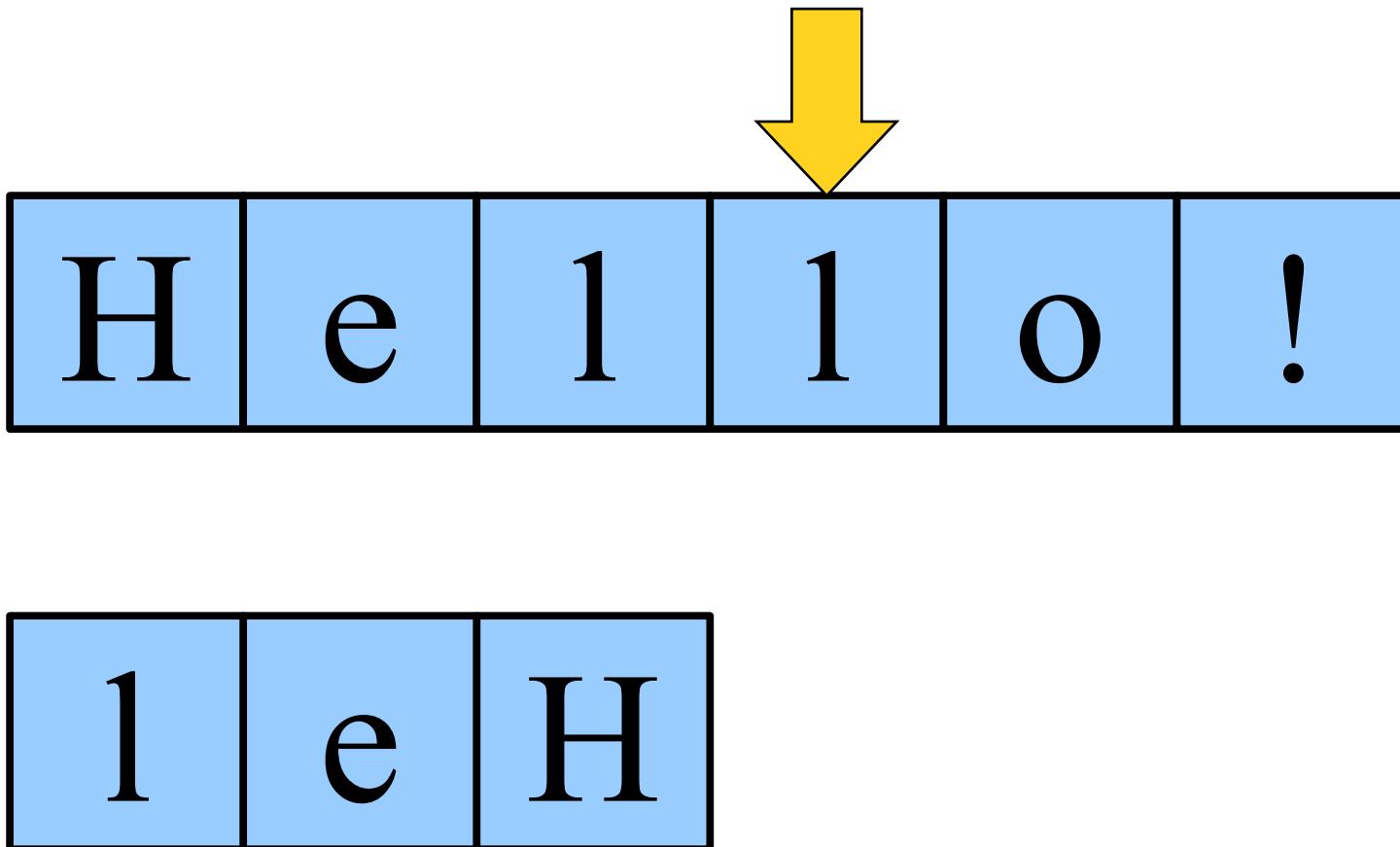
# Reversing a String



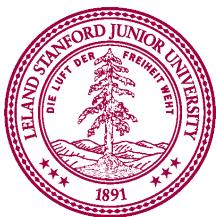
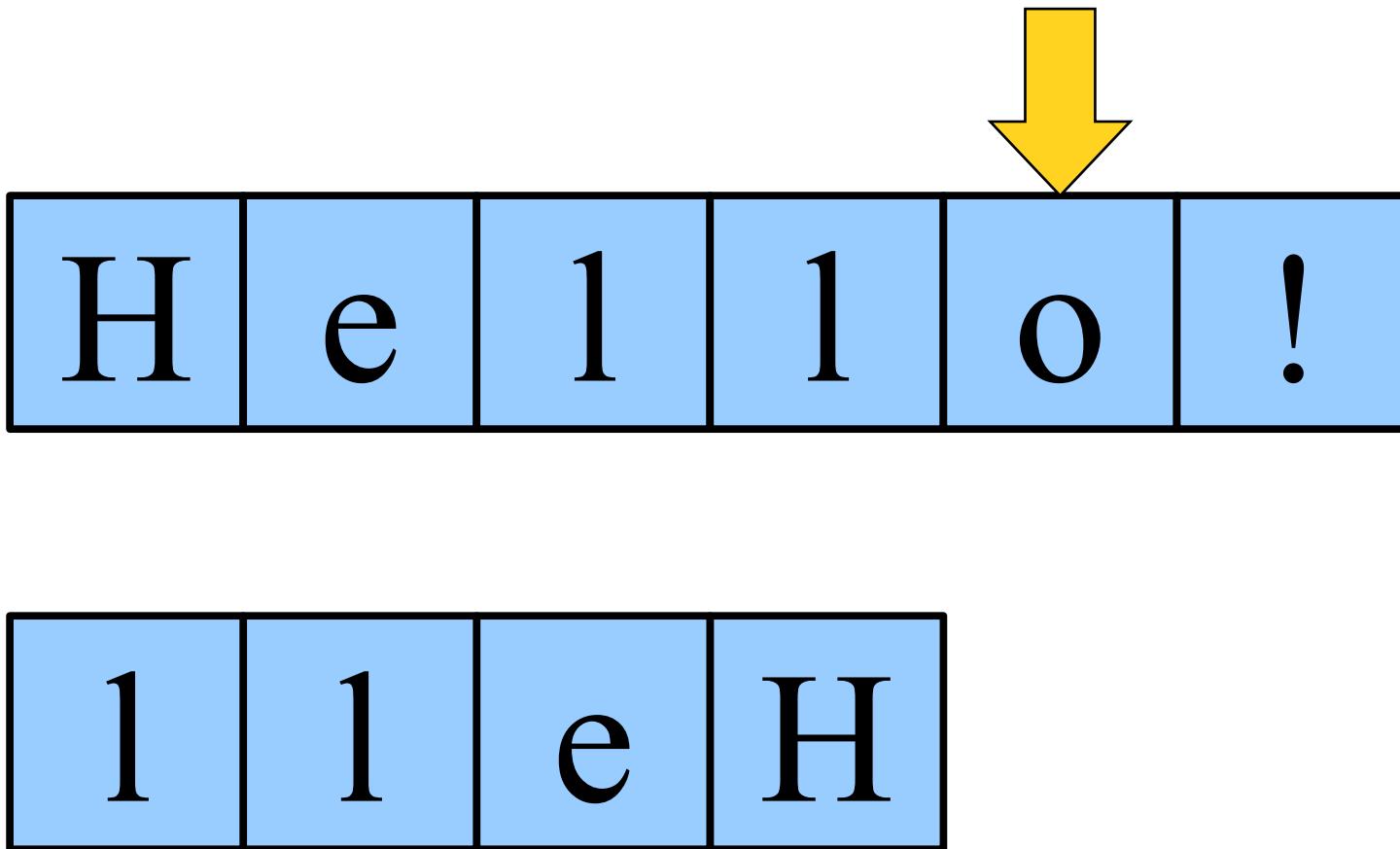
# Reversing a String



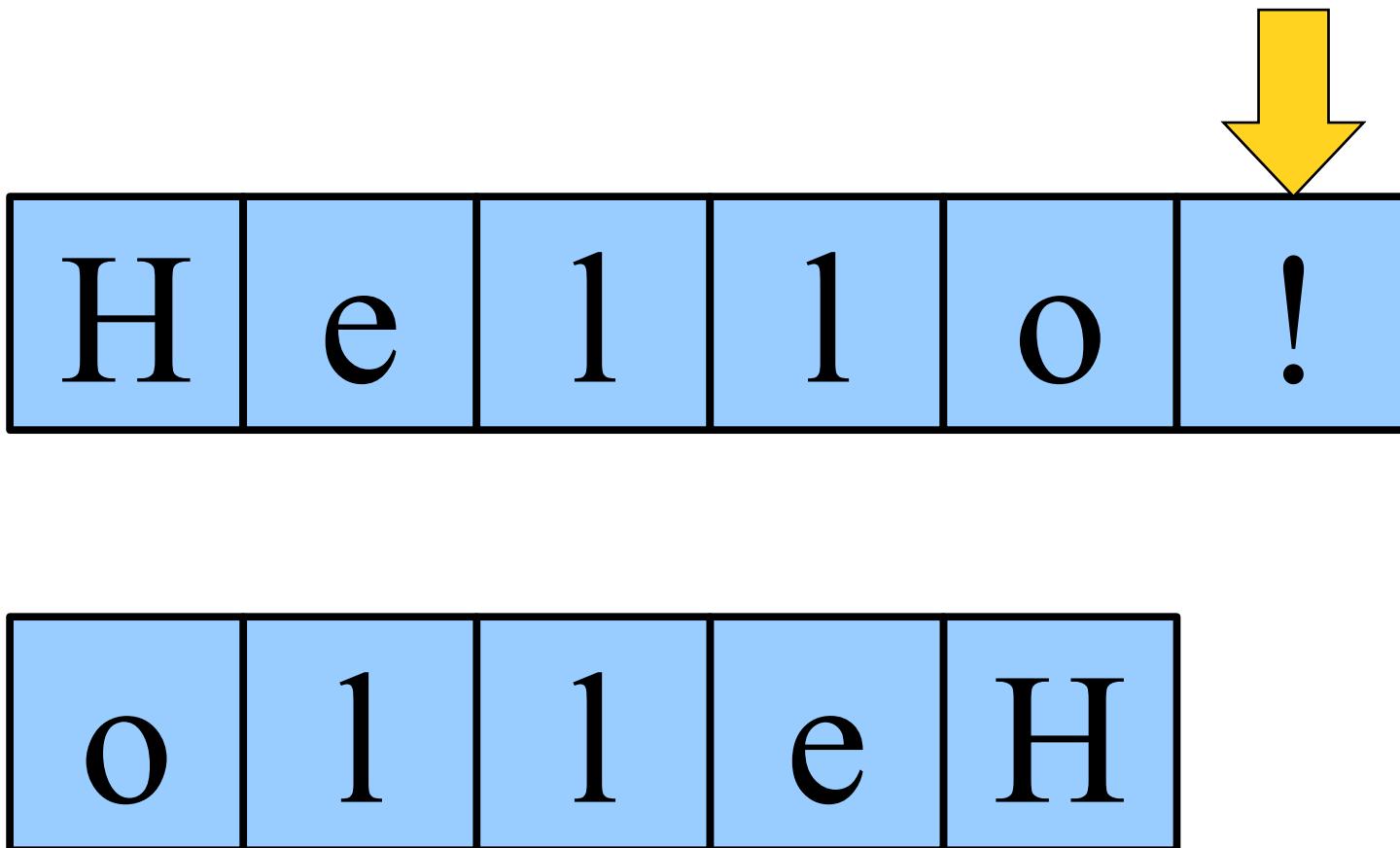
# Reversing a String



# Reversing a String



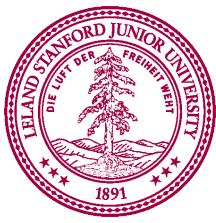
# Reversing a String



# Reversing a String

H	e	l	l	o	!
---	---	---	---	---	---

!	o	l	l	e	H
---	---	---	---	---	---



# reverseString

```
public void run() {  
  
    private String reverseString(String str) {  
        String result = "";  
        for (int i = 0; i < str.length(); i++) {  
            result = str.charAt(i) + result;  
        }  
        return result;  
    }  
}
```

result

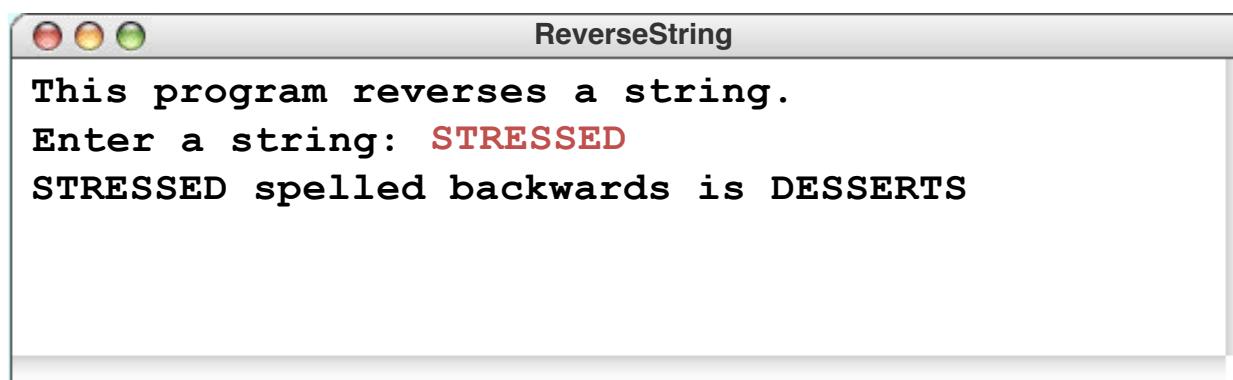
DESSERTS

str

STRESSED

i

8



# Useful String methods

**int length()**

Returns the length of the string

**char charAt(int index)**

Returns the character at the specified index. Note: Strings indexed starting at 0.

**String substring(int p1, int p2)**

Returns the substring beginning at **p1** and extending up to but not including **p2**

**String substring(int p1)**

Returns substring beginning at **p1** and extending through end of string.

**boolean equals(String s2)**

Returns true if string **s2** is equal to the receiver string. This is case sensitive.

**int compareTo(String s2)**

Returns integer whose sign indicates how strings compare in lexicographic order

**int indexOf(char ch) or int indexOf(String s)**

Returns index of first occurrence of the character or the string, or -1 if not found

**String toLowerCase() or String toUpperCase()**

Returns a lowercase or uppercase version of the receiver string

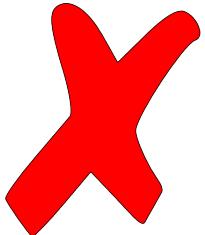


# Palindrome

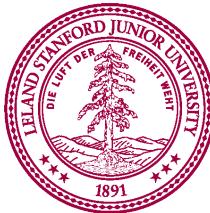
- A **palindrome** is a string that reads the same forwards and backwards.
- For example:
  - Abba
  - Racecar
  - Kayak
  - Mr. Owl ate my metal worm.
  - Go hang a salami! I'm a lasagna hog.
  - Elu par cette crapule



Let's Code it!

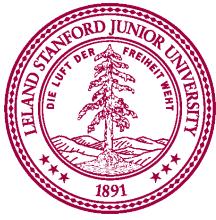


```
private boolean isPalindrome(String original) {  
    String reversed = reverse(original);  
    return reversed == original;  
}
```





Use `.equals` to compare  
strings, not `==`





```
private boolean isPalindrome(String original) {  
    String reversed = reverse(original);  
    return reversed.equals(original);  
}
```



# Some test cases

- Let's test our program on some examples:
  - Racecar
  - Kayak
  - Mr. Owl ate my metal worm.
  - Go hang a salami! I'm a lasagna hog.
- Will it work?



# More Palindromes

Here are some palindromes in other languages:

- بلح تعلق تحت قلعة حلب (Dates hang underneath a castle in Halab)
- 여보, 안경 안보여 (Honey, I can't see my glasses)
- কড়ক (a loud thunderous sound)
- 上海自來水來自海上 (Shanghai tap water originates from "above" the ocean)

The comedian Dmitri Martin also has a routine about palindromes; check it out at  
<https://www.youtube.com/watch?v=0hUHDIOazlU>



# Stress Test

A man, a plan, a caret, a ban, a myriad, a sum, a lac, a liar, a hoop, a pint, a catalpa, a gas, an oil, a bird, a yell, a vat, a caw, a pax, a wag, a tax, a nay, a ram, a cap, a yam, a gay, a tsar, a wall, a car, a luger, a ward, a bin, a woman, a vassal, a wolf, a tuna, a nit, a pall, a fret, a watt, a bay, a daub, a tan, a cab, a datum, a gall, a hat, a tag, a zap, a say, a jaw, a lay, a wet, a gallop, a tug, a trot, a trap, a tram, a torr, a caper, a top, a tonk, a toll, a ball, a fair, a sax, a minim, a tenor, a bass, a passer, a capital, a rut, an amen, a ted, a cabal, a tang, a sun, an ass, a maw, a sag, a jam, a dam, a sub, a salt, an axon, a sail, an ad, a wadi, a radian, a room, a rood, a rip, a tad, a pariah, a revel, a reel, a reed, a pool, a plug, a pin, a peek, a parabola, a dog, a pat, a cud, a nu, a fan, a pal, a rum, a nod, an eta, a lag, an eel, a batik, a mug, a mot, a nap, a maxim, a mood, a leek, a grub, a gob, a gel, a drab, a citadel, a total, a cedar, a tap, a gag, a rat, a manor, a bar, a gal, a cola, a pap, a yaw, a tab, a raj, a gab, a nag, a pagan, a bag, a jar, a bat, a way, a papa, a local, a gar, a baron, a mat, a rag, a gap, a tar, a decal, a tot, a led, a tic, a bard, a leg, a bog, a burg, a keel, a doom, a mix, a map, an atom, a gum, a kit, a baleen, a gala, a ten, a don, a mural, a pan, a faun, a ducat, a pagoda, a lob, a rap, a keep, a nip, a gulp, a loop, a deer, a leer, a lever, a hair, a pad, a tapir, a door, a moor, an aid, a raid, a wad, an alias, an ox, an atlas, a bus, a madam, a jag, a saw, a mass, an anus, a gnat, a lab, a cadet, an em, a natural, a tip, a caress, a pass, a baronet, a minimax, a sari, a fall, a ballot, a knot, a pot, a rep, a carrot, a mart, a part, a tort, a gut, a poll, a gateway, a law, a jay, a sap, a zag, a tat, a hall, a gamut, a dab, a can, a tabu, a day, a batt, a waterfall, a patina, a nut, a flow, a lass, a van, a mow, a nib, a draw, a regular, a call, a war, a stay, a gam, a yap, a cam, a ray, an ax, a tag, a wax, a paw, a cat, a valley, a drib, a lion, a saga, a plat, a catnip, a pooh, a rail, a calamus, a dairyman, a bater, a canal – Panama!

