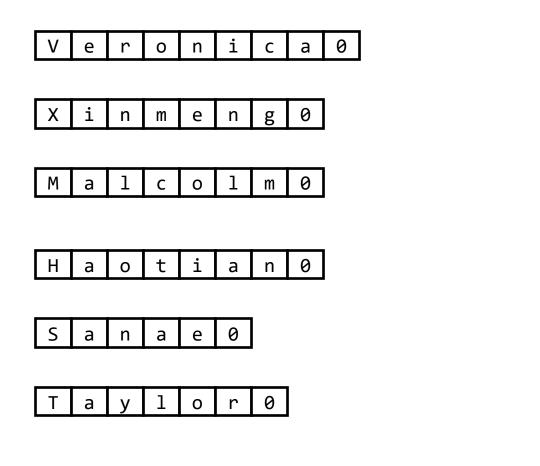
Topic V1A

Examples of String Functions

Reading: (Section 2.9)

Strings



	_				
0x1001	002C	r	0	-	-
0x1001	0028	а	у	1	0
0x1001	0024	а	е	0	Т
0x1001	0020	0	S	а	n
0x1001	001C	t	i	а	n
0x1001	0018	0	Н	а	0
0x1001	0014	С	0	1	m
0x1001	0010	0	М	а	1
0x1001	000C	m	е	n	g
0x1001	8000	0	Χ	i	n
0x1001	0004	n	i	С	а
0x1001	0000	٧	е	r	0

Quiz

Write RISC-V assembly code for the function strlen:

```
Parameter:
```

a0: address of null-terminated string

Return value:

a0: number of characters in string

```
t0 ← a0

nextC: t1 ← M[a0]

if (t1 == 0) goto end

a0 ← a0 + 1

goto nextC

end: a0 ← a0 - t0
```

0x1001	002C	r	0	-	-
0x1001	0028	а	у	1	0
0x1001	0024	а	е	0	Т
0x1001	0020	0	S	а	n
0x1001	001C	t	i	а	n
0x1001	0018	0	Н	а	0
0x1001	0014	С	0	1	m
0x1001	0010	0	М	а	1
0x1001	000C	m	е	n	g
0x1001	0008	0	Χ	i	n
0x1001	0004	n	i	С	а
0×1001	0000	٧	е	r	0

```
strlen:
                                                       t0 ← a0
                 t0, zero, a0 🛑
         add
                                                nextC: t1 ← M[a0]
nextC:
                                                       if (t1 == 0) goto end
         1bu
                 t1, 0(a0)
                                                       a0 ← a0 + 1
         beq
                 t1, zero, end
                                                       goto nextC
         addi
                 a0, a0, 1
                                                       a0 ← a0 - t0
                                                end:
         jal
                 zero, nextC
                                                    0x1001 002C
end:
                                                    0x1001 0028
         sub
                a0, a0, t0
         jalr
                 zero, ra, 0
                                                    0x1001 0024
                                                                    e
                                                    0x1001 0020
                                                                        a
                                                                           n
                                                    0x1001 001C
                                                                        a
                                                                           n
                                                    0x1001 0018
                                                                           0
          a0 0x1001 001A
                                                    0x1001 0014
                                                                           m
                                                    0x1001 0010
          t0 0x1001 0019
                                                                        a
                                                    0x1001 000C
                                                                    e
                                                                        n
          t1 0x0000 0048
                                                    0x1001 0008
                                                                           n
                                                    0x1001 0004
                                                                           a
                                                    0x1001 0000
```

```
strlen:
                                                         t0 ← a0
         add
                  t0, zero, a0
                                                  nextC: t1 \leftarrow M[a0]
nextC:
                                                         if (t1 == 0) goto end
                  t1, 0(a0)
         1bu
                                                         a0 ← a0 + 1
         beq
                  t1, zero, end
                                                         goto nextC
         addi
                  a0, a0, 1
                                                         a0 ← a0 - t0
                                                  end:
         jal
                  zero, nextC
                                                      0x1001 002C
                                                                       0
end:
                                                      0x1001 0028
         sub
                  a0, a0, t0
         jalr
                  zero, ra, 0
                                                      0x1001 0024
                                                                          0
                                                                       e
                                                      0x1001 0020
                                                                          a
                                                                              n
                                                      0x1001 001C
                                                                          a
                                                                              n
                                                      0x1001 0018
                                                                       Η
                                                                          a
                                                                              0
              0x0000 000X
       a0
                                                      0x1001 0014
                                                                              m
                                                      0x1001 0010
              0x1001 0019
       t0
                                                                          a
                                                      0x1001 000C
                                                                       e
                                                                          n
       t1
              0x0000 0000
                                                      0x1001 0008
                                                                              n
                                                      0x1001 0004
                                                                              a
                                                      0x1001 0000
```

Creating arrays of student names

a A1 0 e 0

A2 S a n a e 0

T a y l o r 0

0x1001 002C 0x1001 0028 0x1001 0024 е 0x1001 0020 0x1001 001C n 0x1001 0018 Η a 0 0x1001 0014 0x1001 0010 0x1001 000C е 0x1001 0008 n 0x1001 0004 a 0x1001 0000

Arrays of Pointers to Strings

This is a sentinel value

This is an array of pointers to strings

0x1003 001C 0xFFFF FFFF 0x1003 0018 0x1001 0027 0x1003 0014 0x1001 0021 0x1003 0010 0x1001 0019 0x1003 000C 0xFFFF FFFF 0x1003 0008 0x1001 00011 0x1003 0004 0x1001 0000 0x1003 0000 0x1001 0000

0x1001 002C	r	0	-	-
0x1001 0028	а	у	1	0
0x1001 0024	а	е	0	Т
0x1001 0020	0	S	а	n
0x1001 001C	t	i	а	n
0x1001 0018	0	Н	а	0
0x1001 0014	С	0	1	m
0x1001 0014 0x1001 0010	с 0	0 <u>M</u>	1 a	m 1
		о <u>М</u> е		
0x1001 0010	0	M	а	1
0x1001 0010 0x1001 000C	0 m	M e	a n	1 g

Quiz

Write RISC-V assembly code for the function maxlen:

Parameter:

a0: address of the first pointer to a name in a class

Return value:

a0: number of characters in longest name

```
0x1003 001C 0xFFFF FFFF
0x1003 0018 0x1001 0027
0x1003 0014 0x1001 0021
0x1003 0010 0x1001 0019
0x1003 000C 0xFFFF FFFF
0x1003 0008 0x1001 0011
0x1003 0004 0x1001 0009
0x1003 0000 0x1001 0000
```

```
while (*p != -1){
 t = strlen(*p);
 if (t > max)
         max = t;
 p++;
return max;
    0x1001 0020
                          a
    0x1001 001C
                          a
                              n
    0x1001 0018
                          a
                              0
    0x1001 0014
                              m
    0x1001 0010
                          a
    0x1001 000C
                      e
                          n
    0x1001 0008
                              n
    0x1001 0004
                              a
    0x1001 0000
```

int maxlen(char **p){

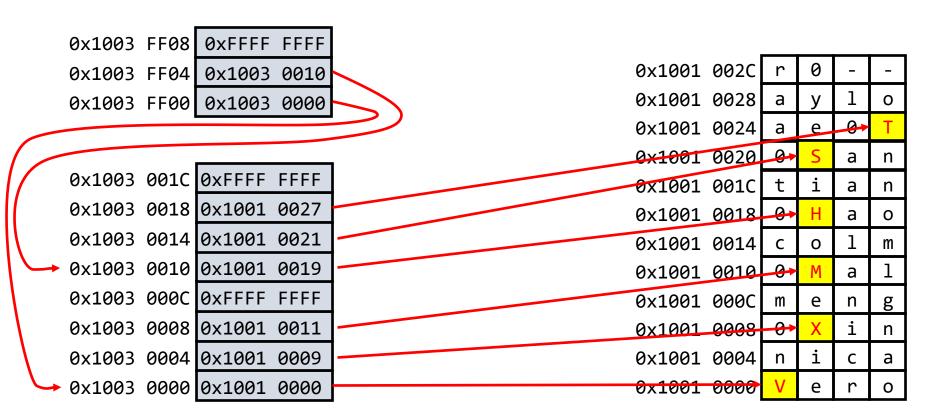
int max = 0;

maxlen:						int maxlen(char	**p){					
	add	s0,	zero, a@	#	s0 ← p	int max = 0;						
	add		zero, ze	ro #	max ← 0	while (*p != -:	L){					
nextS:	li lu	\	-1 0(c0)	#	a0 ← *p	t = strlen(*p	• •					
nexts:	lw beq		0(s0) s2, end		ao ← "p if (*p == -1)	• •	1)					
	jal		strlen		t ← strlen(*p)	if (t > max)						
	addi		s0, 4		p++	ma	x = t;					
	ble	-	s1, next		if (t ≤ max)	p++;						
	add	-	zero, a	#	max ← t							
end:	jal add		o, nextS zero, s1	#	return max	J						
enu.	jalr		o, ra, 0	#	Teturn max	return max;						
	Ju 2.	201	o, .a, o			}						
						OYTOOT	0024	а		V	-	
						0x1001	0020	0	S	а	n	
0x1003	001C	0xFFFF	FFFF			0x1001	001C	t	i	а	n	
0x1003	0018	0×1001	0027	Code to s	ave/restore	e s 0x1001	0018	0	Н	а	0	
0x1003	0014	0×1001	0021	registers	and ra miss	ing 0x1001	0014	С	0	1	m	
0x1003	0010	0×1001	0019			0x1001	0010	0	М	а	1	
0x1003	000C	0xFFFF	FFFF			0x1001	000C	m	е	n	g	
0x1003	0008	0x1001	0011			0x1001	0008	0	Χ	i	n	
0x1003	0004	0x1001	0009			0x1001	0004	n	i	С	а	
0x1003	0000	0×1001	0000			0x1001	0000	٧	е	r	0	

maxlen:											
	add add	s0, zero, a s1, zero, z			s0 ← p max ← 0		20	la _v	2 006	9 00	AAA
	li	s2, -1		"	max · o		ae		WOOL) 00	700
nextS:	lw	a0, 0(s0)			a0 ← *p		c 0	O _V	100	2 00	201
	beq	a0, s2, end			if (*p == -1)		Se	ЮΧ	1003	שט פ	104
	jal	ra, strlen			t ← strlen(*p)		_				
	addi ble	s0, s0, 4 a0, s1, nex	t S		p++ if (t ≤ max)		s1	. 0x	0000	90	900
	add	s1, zero, a			max ← t						
	jal	zero, nextS									
end:	add	a0, zero, s		#	return max	0x1001	002C	r	0	-	-
	jalr	zero, ra, 0				0x1001	0028	а	У	1	0
						0×1001	0024	а	е	0	Т
						0×1001	0020	0	S	а	n
0x1003	001C	0xFFFF FFFF				0x1001	001C	t	i	а	n
0x1003	0018	0x1001 0027				0×1001	0018	0	Н	а	0
0x1003	0014	0x1001 0021				0×1001	0014	С	0	1	m
0x1003	0010	0x1001 0019				0×1001	0010	0	М	а	1
0x1003	000C	0xFFFF FFFF				0x1001	000C	m	е	n	g
0x1003	0008	0x1001 0011				0x1001	0008	0	X	i	n
0x1003	0004	0x1001 0009				0×1001	0004	n	i	С	а
0x1003	0000	0x1001 0000				0×1001	0000	V	е	r	0

Creating an Array of Sessions

An Array of Pointers to Pointers to Strings



```
sumax:
                                             int sumax(char ***s){
Parameter:
                                                      int sum = 0;
a0: address of a list of classes
                                                      while (*s != -1){}
                                                               t = maxlen(*s);
Return value:
                                                               sum = sum + t;
a0: sum of longest names in each session
                                                               S++;
    0x1003 FF08 0xFFFF FFFF
                                                      return sum;
    0x1003 FF04 0x1003 0010
    0x1003 FF00 0x1003 0000
                                                          0x1001 0024
                                                                           e
                                                          0x1001 0020
                                                                               a
    0x1003 001C 0xFFFF FFFF
                                                          0x1001 001C
                                                                               a
                                                                                  n
    0x1003 0018 0x1001 0027
                                                          0x1001 0018
                                                                               a
                                                                                  0
    0x1003 0014 0x1001 0021
                                                          0x1001 0014
    0x1003 0010 0x1001 0019
                                                          0x1001 0010
    0x1003 000C 0xFFFF FFFF
                                                          0x1001 000C
                                                                           e
                                                                               n
    0x1003 0008 0x1001 0011
                                                          0x1001 0008
                                                                                  n
    0x1003 0004 0x1001 0009
                                                          0x1001 0004
                                                                                  a
     0x1003 0000 0x1001 0000
                                                          0x1001 0000
```

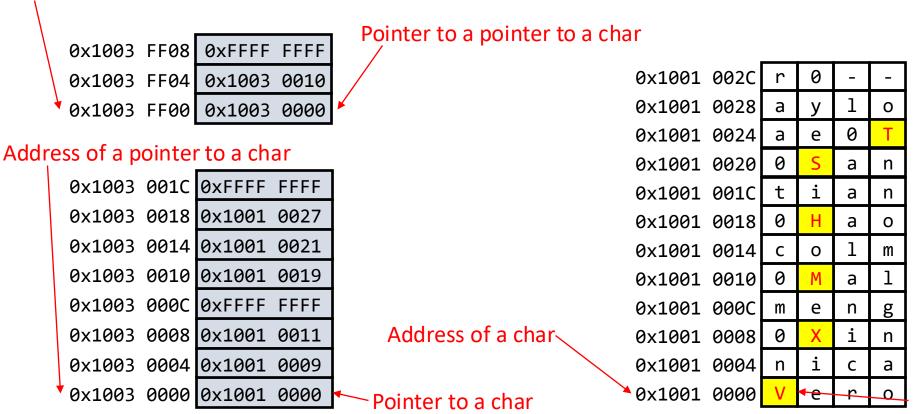
```
int sumax(char ***s){
Parameter:
                                                              int sum = 0;
                                                              while (*s != -1){
a0: address of a list of classes
                                                                         t = maxlen(*s);
Return value:
                                                                         sum = sum + t;
a0: sum of longest names in each session
                                                                         S++;
     0x1003 FF08 0xFFFF FFFF
                                                              return sum;
     0x1003 FF04 0x1003 0010
     0x1003 FF00 0x1003 0000
                                           sumax:
                                                      add
                                                                s0, zero, a0
                                                                                     # s0 ← s
                                                                s1, zero, zero
                                                                                     # sum ← 0
                                                      add
     0x1003 001C 0xFFFF FFFF
                                                                s2, zero, -1
                                                                                     # s2 ← -1
                                                      addi
                                                                                     # a0 ← *s
                                                                a0, 0(s0)
                                                      lw
     0x1003 0018 0x1001 0027
                                                                a0, s2, end
                                                      beq
     0x1003 0014 0x1001 0021
                                                      jal
                                                                ra, maxlen
                                                                                     # t \leftarrow maxlen(*s)
                                           next:
                                                      add
                                                                s1, s1, a0
                                                                                     # sum ← sum + t
     0x1003 0010 0x1001 0019
                                                                s0, s0, 4
                                                      addi
                                                                                     # S++
                                                      lw
                                                                a0, 0(s0)
                                                                                     # a0 ← *s
     0x1003 000C 0xFFFF FFFF
                                                                a0, s2, next
                                                      bne
                                           end:
                                                      add
                                                                a0, zero, s1
     0x1003 0008 0x1001 0011
                                                      jalr zero, ra, 0
                                                                                     # return sum
     0x1003 0004 0x1001 0009
                                    Code to save/restore s
     0x1003 0000 0x1001 0000
```

registers and ra missing

sumax:

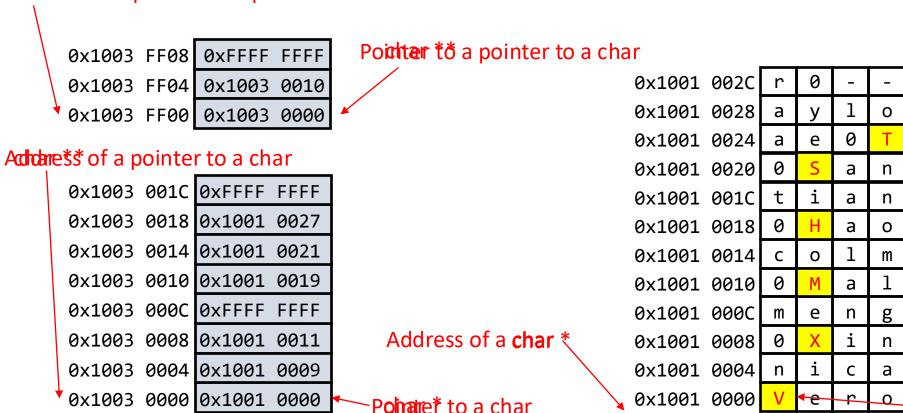
Types

Address of a pointer to a pointer to a char



Types

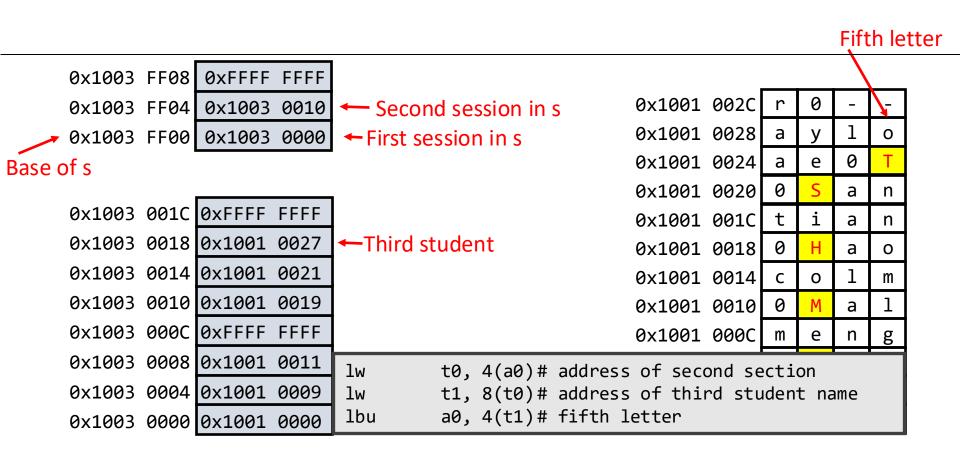




🖁 chai

Quiz

Let s be an array of pointers to lists of students in sessions of a class



What have we learned?

An Array of Pointers to Pointers to Strings

