A0B36APO - Computer architectures
Homework 4

LS 2015/2016
Katedra počítačů, FEL, ČVUT v Praze

Homework deadline: your lecture in week starting May 9.
Use only papers given to you, do not add any more papers.

To answer the questions, use a memory program listing on the following sheet(s).

Program was compiled using C compiler for **x86 32-bit** computer and OS GNU/Linux first. Then the same code has been compiled for little-endian variant of MIPS32 architecture.

Program consists of a function called **toplevel_fnc**, which calls a function **subroutine_fnc**. Also there are system calls.

1 System calls (max 1pt)

- Find out which system calls the program uses.

Function code	**System call name**	**Parameter 1**	**Parameter 2**	**Parameter 3**

2 Function/Subroutine calls (max. 2pts)

Function **subrouting_fnc** takes one or two parameters. To make things easier, program uses only integer values and pointers. In our code by integer values we mean data types `char` or `int` and before function call the `char` data type is converted to `int`. We also use only pointers to data types `char` and `int`.

- How many input parameters the **subroutine_fnc** function takes:

- Determine a data type of each parameter of **subroutine_fnc** function:

Parameter	**Data type (int/pointer)**	**Parameter description**
Parameter 1		
Parameter 2		

- Describe meaning of return value of the **subroutine_fnc**:

3 Program (max. 3pts)

- Describe a function of the program and determine a rule for the **toplevel_fcn** return value:

- Describe a function of a whole program on algorithm level. E.g. program calculates an arithmetic average of numbers read from standard input.

Estimate time needed to complete the homework: ....

Listing x86:

```
program code


build/program-x86:     file format elf32-i386

Disassembly of section my_text:

080a9dfc <subroutine_fnc>:
 80a9dfc: 55                   push   %ebp
 80a9dfd: 89 e5                mov    %esp,%ebp
 80a9dff: 57                   push   %edi
 80a9e00: 56                   push   %esi
 80a9e01: 53                   push   %ebx
 80a9e02: 83 ec 14             sub    $0x14,%esp
 80a9e05: c7 45 e0 00 00 00 00 movl   $0x0,-0x20(%ebp)
 80a9e0c: 8d 7d f3             lea    -0xd(%ebp),%edi
 80a9e0f: 8b 75 0c             mov    0xc(%ebp),%esi
 80a9e12: 83 c6 30             add    $0x30,%esi
 80a9e15: ba 01 00 00 00       mov    $0x1,%edx
 80a9e1a: 8b 5d 08             mov    0x8(%ebp),%ebx
 80a9e1d: 89 f9                mov    %edi,%ecx
 80a9e1f: b8 03 00 00 00       mov    $0x3,%eax
 80a9e24: cd 80                int    $0x80
 80a9e26: 83 f8 01             cmp    $0x1,%eax
 80a9e29: 74 0c                je     80a9e37 <subroutine_fnc+0x3b>
 80a9e2b: bb 01 00 00 00       mov    $0x1,%ebx
 80a9e30: b8 01 00 00 00       mov    $0x1,%eax
 80a9e35: cd 80                int    $0x80
 80a9e37: 0f b6 45 f3          movzbl -0xd(%ebp),%eax
 80a9e3b: 3c 2f                cmp    $0x2f,%al
 80a9e3d: 7e 17                jle    80a9e56 <subroutine_fnc+0x5a>
 80a9e3f: 0f be d0             movsbl %al,%edx
 80a9e42: 39 f2                cmp    %esi,%edx
 80a9e44: 7d 10                jge    80a9e56 <subroutine_fnc+0x5a>
 80a9e46: 8b 45 0c             mov    0xc(%ebp),%eax
 80a9e49: 0f af 45 e0          imul   -0x20(%ebp),%eax
 80a9e4d: 8d 54 10 d0          lea    -0x30(%eax,%edx,1),%edx
 80a9e51: 89 55 e0             mov    %edx,-0x20(%ebp)
 80a9e54: eb bf                jmp    80a9e15 <subroutine_fnc+0x19>
 80a9e56: 8b 45 e0             mov    -0x20(%ebp),%eax
 80a9e59: 83 c4 14             add    $0x14,%esp
 80a9e5c: 5b                   pop    %ebx
 80a9e5d: 5e                   pop    %esi
 80a9e5e: 5f                   pop    %edi
 80a9e5f: 5d                   pop    %ebp
 80a9e60: c3                   ret

080a9e61 <toplevel_fnc>:
 80a9e61: 55                   push   %ebp
 80a9e62: 89 e5                mov    %esp,%ebp
 80a9e64: 57                   push   %edi
 80a9e65: 56                   push   %esi
 80a9e66: 53                   push   %ebx
 80a9e67: 83 ec 20             sub    $0x20,%esp
 80a9e6a: c6 45 f3 41          movb   $0x41,-0xd(%ebp)
 80a9e6e: c7 44 24 04 0a 00 00 movl   $0xa,0x4(%esp)
 80a9e75: 00
 80a9e76: c7 04 24 00 00 00 00 movl   $0x0,(%esp)
 80a9e7d: e8 7a ff ff ff       call   80a9dfc <subroutine_fnc>
 80a9e82: 89 c7                mov    %eax,%edi
 80a9e84: ba 80 01 00 00       mov    $0x180,%edx
 80a9e89: b9 42 02 00 00       mov    $0x242,%ecx
 80a9e8e: be 00 7f 0c 08       mov    $0x80c7f00,%esi
 80a9e93: 89 f3                mov    %esi,%ebx
 80a9e95: b8 05 00 00 00        mov    $0x5,%eax
 80a9e9a: cd 80                 int    $0x80
 80a9e9c: 89 45 dc              mov    %eax,-0x24(%ebp)
 80a9e9f: 85 c0                 test   %eax,%eax
 80a9ea1: 79 0e                 jns    80a9eb1 <toplevel_fnc+0x50>
 80a9ea3: b8 01 00 00 00        mov    $0x1,%eax
 80a9ea8: 89 c3                 mov    %eax,%ebx
 80a9eaa: b8 01 00 00 00        mov    $0x1,%eax
 80a9eaf: cd 80                 int    $0x80
 80a9eb1: 89 7d e0              mov    %edi,-0x20(%ebp)
 80a9eb4: 8d 75 f3              lea    -0xd(%ebp),%esi
 80a9eb7: eb 22                 jmp    80a9edb <toplevel_fnc+0x7a>
 80a9eb9: 8b 5d dc              mov    -0x24(%ebp),%ebx
 80a9ebc: 89 f1                 mov    %esi,%ecx
 80a9ebe: ba 01 00 00 00        mov    $0x1,%edx
 80a9ec3: b8 04 00 00 00        mov    $0x4,%eax
 80a9ec8: cd 80                 int    $0x80
 80a9eca: 85 c0                 test   %eax,%eax
 80a9ecc: 79 09                 jns    80a9ed7 <toplevel_fnc+0x76>
 80a9ece: 89 d3                 mov    %edx,%ebx
 80a9ed0: b8 01 00 00 00        mov    $0x1,%eax
 80a9ed5: cd 80                 int    $0x80
 80a9ed7: 83 6d e0 01           subl   $0x1,-0x20(%ebp)
 80a9edb: 83 7d e0 00           cmpl   $0x0,-0x20(%ebp)
 80a9edf: 75 d8                 jne    80a9eb9 <toplevel_fnc+0x58>
 80a9ee1: 8b 5d dc              mov    -0x24(%ebp),%ebx
 80a9ee4: b8 06 00 00 00        mov    $0x6,%eax
 80a9ee9: cd 80                 int    $0x80
 80a9eeb: 85 c0                 test   %eax,%eax
 80a9eed: 79 0e                 jns    80a9efd <toplevel_fnc+0x9c>
 80a9eef: b8 01 00 00 00        mov    $0x1,%eax
 80a9ef4: 89 c3                 mov    %eax,%ebx
 80a9ef6: b8 01 00 00 00        mov    $0x1,%eax
 80a9efb: cd 80                 int    $0x80
 80a9efd: 89 f8                 mov    %edi,%eax
 80a9eff: 83 c4 20              add    $0x20,%esp
 80a9f02: 5b                    pop    %ebx
 80a9f03: 5e                    pop    %esi
 80a9f04: 5f                    pop    %edi
 80a9f05: 5d                    pop    %ebp
 80a9f06: c3                    ret
```

```
program data


build/program-x86:     file format elf32-i386

Contents of section my_data:
 80c7f00 64617461 00                          data.
```

Listing mips:

```
program code


build/program-mips:     file format elf32-tradlittlemips

Disassembly of section my_text:

00404e20 <subroutine_fnc>:
  404e20: 3c1c0005  lui gp,0x5
  404e24: 279c95e0  addiu gp,gp,-27168
  404e28: 0399e021  addu gp,gp,t9
  404e2c: 27bdffd8  addiu sp,sp,-40
  404e30: afb40020  sw s4,32(sp)
  404e34: afb3001c  sw s3,28(sp)
  404e38: afb20018  sw s2,24(sp)
  404e3c: afb10014  sw s1,20(sp)
  404e40: afb00010  sw s0,16(sp)
  404e44: 0080a021  move s4,a0
  404e48: 00a09821  move s3,a1
  404e4c: 00008021  move s0,zero
  404e50: 27a50008  addiu a1,sp,8
  404e54: 24060001  li a2,1
  404e58: 24120001  li s2,1
  404e5c: 26710030  addiu s1,s3,48
  404e60: 02802021  move a0,s4
  404e64: 24020fa3  li v0,4003
  404e68: 0000000c  syscall
  404e6c: 10e00002  beqz a3,404e78 <__start_my_text+0x58>
  404e70: 00000000  nop
  404e74: 2402ffff  li v0,-1
  404e78: 10520003  beq v0,s2,404e88 <__start_my_text+0x68>
  404e7c: 24040001  li a0,1
  404e80: 24020fa1  li v0,4001
  404e84: 0000000c  syscall
  404e88: 83a30008  lb v1,8(sp)
  404e8c: 00000000  nop
  404e90: 28620030  slti v0,v1,48
  404e94: 14400007  bnez v0,404eb4 <__start_my_text+0x94>
  404e98: 0071102a  slt v0,v1,s1
  404e9c: 10400005  beqz v0,404eb4 <__start_my_text+0x94>
  404ea0: 02130018  mult s0,s3
  404ea4: 00008012  mflo s0
  404ea8: 00701021  addu v0,v1,s0
  404eac: 1000ffec  b 404e60 <__start_my_text+0x40>
  404eb0: 2450ffd0  addiu s0,v0,-48
  404eb4: 02001021  move v0,s0
  404eb8: 8fb40020  lw s4,32(sp)
  404ebc: 8fb3001c  lw s3,28(sp)
  404ec0: 8fb20018  lw s2,24(sp)
  404ec4: 8fb10014  lw s1,20(sp)
  404ec8: 8fb00010  lw s0,16(sp)
  404ecc: 03e00008  jr ra
  404ed0: 27bd0028  addiu sp,sp,40

00404ed4 <toplevel_fnc>:
  404ed4: 3c1c0005  lui gp,0x5
  404ed8: 279c952c  addiu gp,gp,-27348
  404edc: 0399e021  addu gp,gp,t9
  404ee0: 27bdffc8  addiu sp,sp,-56
  404ee4: afbf0030  sw ra,48(sp)
  404ee8: afb3002c  sw s3,44(sp)
  404eec: afb20028  sw s2,40(sp)
  404ef0: afb10024  sw s1,36(sp)
  404ef4: afb00020  sw s0,32(sp)
  404ef8: afbc0010  sw gp,16(sp)
  404efc: 24020041  li v0,65
  404f00: a3a20018  sb v0,24(sp)
  404f04: 00002021  move a0,zero
  404f08: 2405000a  li a1,10
  404f0c: 8f99809c  lw t9,-32612(gp)
  404f10: 00000000  nop
  404f14: 0320f809  jalr t9
  404f18: 00000000  nop
  404f1c: 8fbc0010  lw gp,16(sp)
  404f20: 00409821  move s3,v0
  404f24: 00408021  move s0,v0
  404f28: 8f8481b4  lw a0,-32332(gp)
  404f2c: 24050302  li a1,770
  404f30: 24060180  li a2,384
  404f34: 24020fa5  li v0,4005
  404f38: 0000000c  syscall
  404f3c: 10e00002  beqz a3,404f48 <toplevel_fnc+0x74>
  404f40: 00000000  nop
  404f44: 2402ffff  li v0,-1
  404f48: 04410004  bgez v0,404f5c <toplevel_fnc+0x88>
  404f4c: 00408821  move s1,v0
  404f50: 24040001  li a0,1
  404f54: 24020fa1  li v0,4001
  404f58: 0000000c  syscall
  404f5c: 2610ffff  addiu s0,s0,-1
  404f60: 2402ffff  li v0,-1
  404f64: 12020010  beq s0,v0,404fa8 <toplevel_fnc+0xd4>
  404f68: 02202021  move a0,s1
  404f6c: 27a50018  addiu a1,sp,24
  404f70: 24060001  li a2,1
  404f74: 2412ffff  li s2,-1
  404f78: 24020fa4  li v0,4004
  404f7c: 0000000c  syscall
  404f80: 10e00002  beqz a3,404f8c <toplevel_fnc+0xb8>
  404f84: 00000000  nop
  404f88: 2402ffff  li v0,-1
  404f8c: 04410003  bgez v0,404f9c <toplevel_fnc+0xc8>
  404f90: 24040001  li a0,1
  404f94: 24020fa1  li v0,4001
  404f98: 0000000c  syscall
  404f9c: 2610ffff  addiu s0,s0,-1
  404fa0: 1612fff5  bne s0,s2,404f78 <toplevel_fnc+0xa4>
  404fa4: 02202021  move a0,s1
  404fa8: 24020fa6  li v0,4006
  404fac: 0000000c  syscall
  404fb0: 10e00002  beqz a3,404fbc <toplevel_fnc+0xe8>
  404fb4: 00000000  nop
  404fb8: 2402ffff  li v0,-1
  404fbc: 04410005  bgez v0,404fd4 <toplevel_fnc+0x100>
  404fc0: 02601021  move v0,s3
  404fc4: 24040001  li a0,1
  404fc8: 24020fa1  li v0,4001
  404fcc: 0000000c  syscall
  404fd0: 02601021  move v0,s3
  404fd4: 8fbf0030  lw ra,48(sp)
  404fd8: 8fb3002c  lw s3,44(sp)
  404fdc: 8fb20028  lw s2,40(sp)
  404fe0: 8fb10024  lw s1,36(sp)
  404fe4: 8fb00020  lw s0,32(sp)
  404fe8: 03e00008  jr ra
  404fec: 27bd0038  addiu sp,sp,56

program data


build/program-mips:     file format elf32-tradlittlemips

Contents of section my_data:
 446400 64617461 00000000                    data....
```