Capstone反汇编引擎数据类型及API分析及示例(四)

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Capstone反汇编引擎数据类型及API分析及示例(四)

Capstone反汇编引擎数据类型及API分析与示例(一)
Capstone反汇编引擎数据类型及API分析及示例(二)
Capstone反汇编引擎数据类型及API分析及示例(三)

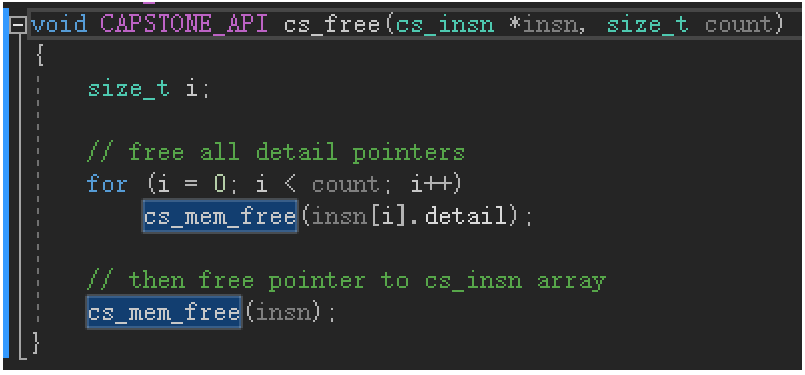
API分析

cs_free

```
void CAPSTONE_API cs_free(cs_insn *insn, size_t count);
```

释放被cs_malloc() 或 cs_disasm()分配的内存(insn参数)
参数
insn: 由cs_disasm()或cs_malloc()中的@insn参数返回的指针
count: 赋值由cs_disasm()返回的cs_insn结构的数量，或赋值为1表示由cs_malloc()分配给空闲内存的数量

代码实现



```
void CAPSTONE_API cs_free(cs_insn *insn, size_t count)
{
    size_t i;

    // free all detail pointers
    for (i = 0; i < count; i++)
        cs_mem_free(insn[i].detail);

    // then free pointer to cs_insn array
    cs_mem_free(insn);
}
```

直接调用cs_mem_free,也就是默认的free

示例(释放cs_disasm申请的内存)，代码片段：

```
count = cs_disasm(handle, (unsigned char*)CODE, sizeof(CODE) - 1, 0x1000, 0, &insn);           //■■■cs_disasm■■■■■
   if (count) {
       size_t j;

       for (j = 0; j < count; j++) {
           printf("0x%""Ix"":\t%s\t\t%s\n", insn[j].address, insn[j].mnemonic, insn[j].op_str);
       }

       cs_free(insn, count);   //■■■■■■■■insn■■■
   }
```

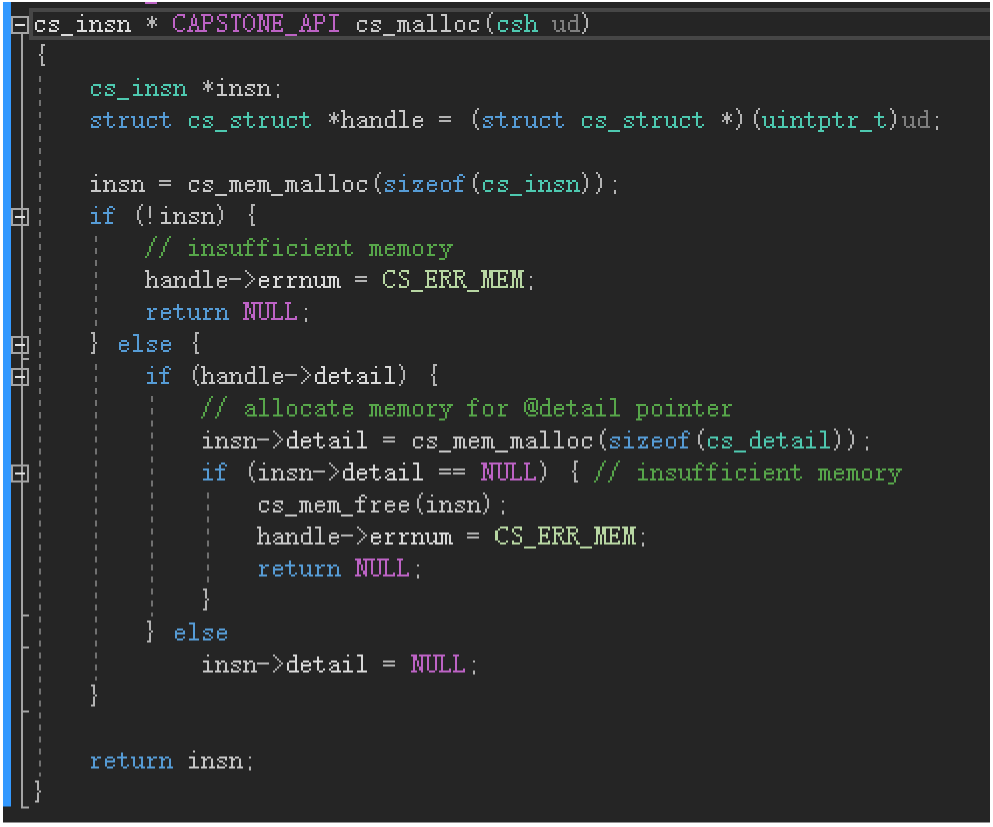
cs_malloc

```
cs_insn * CAPSTONE_API cs_malloc(csh handle);
```

被用于在API cs_disasm_iter()中为一条指令分配内存

参数
handle: cs_open()返回的句柄

代码实现



```
cs_insn * CAPSTONE_API cs_malloc(csh ud)
{
    cs_insn *insn;
    struct cs_struct *handle = (struct cs_struct *)(uintptr_t)ud;

    insn = cs_mem_malloc(sizeof(cs_insn));
    if (!insn) {
        // insufficient memory
        handle->errnum = CS_ERR_MEM;
        return NULL;
    } else {
        if (handle->detail) {
            // allocate memory for @detail pointer
            insn->detail = cs_mem_malloc(sizeof(cs_detail));
            if (insn->detail == NULL) { // insufficient memory
                cs_mem_free(insn);
                handle->errnum = CS_ERR_MEM;
                return NULL;
            }
        } else
            insn->detail = NULL;
    }

    return insn;
}
```

当这条指令所占的内存不再使用时，使用cs_free(insn, 1)释放，示例在下面cs_disasm_iter处

cs_disasm_iter

```
bool CAPSTONE_API cs_disasm_iter(csh handle,
   const uint8_t **code, size_t *size,
   uint64_t *address, cs_insn *insn);
```

给定buff、大小、地址和要解码的指令数，更快速的反汇编机器码，
这个API将生成的指令放入insn中的给定的缓存中。

注意1:
此API将更新code、size和address以指向输入缓冲区中的下一条指令。所以，虽然每次反汇编一条指令可以使用cs_disasm(count=1)来实现，但一些基准测试显示，在循环

注意2:可以使用cs_malloc()创建insn中的缓存。

注意3:对于动态分配内存可能产生内存不足的系统(比如OS内核或固件)，建议使用cs_disasm()这个API, 因为cs_disasm()是根据要分解的指令的数量来分配内存。

参数
handle: cs_open()返回的句柄
code: 要反汇编的机器码所在的缓冲区
size: 机器码缓冲区的大小
address: 所给机器码缓冲区中第一个insn的地址
insn: 指向这个API要填充的指令的指针。
return:如果这个API成功反汇编了一条指令返回true，否则将返回false。

失败时，调用cs_errno()获取错误代码。

代码实现，在cs_disasm基础上使用动态内存分配

```
bool CAPSTONE_API cs_disasm_iter(csh ud, const uint8_t **code, size_t *size,
       uint64_t *address, cs_insn *insn)
{
   struct cs_struct *handle;
   uint16_t insn_size;
   MCInst mci;
   bool r;

   handle = (struct cs_struct *)(uintptr_t)ud;
   if (!handle) {
       return false;
```

```
    }

    handle->errnum = CS_ERR_OK;

    MCInst_Init(&mci);
    mci.csh = handle;

    mci.address = *address;

    // ■■detail■■■■■■■■
    mci.flat_insn = insn;
    mci.flat_insn->address = *address;
#ifdef CAPSTONE_DIET
    mci.flat_insn->mnemonic[0] = '\0';
    mci.flat_insn->op_str[0] = '\0';
#endif

    r = handle->disasm(ud, *code, *size, &mci, &insn_size, *address, handle->getinsn_info);
    if (r) {
        SStream ss;
        SStream_Init(&ss);

        mci.flat_insn->size = insn_size;

        // ■■■■■■■■■■■■■insn ID
        handle->insn_id(handle, insn, mci.Opcode);

        handle->printer(&mci, &ss, handle->printer_info);

        fill_insn(handle, insn, ss.buffer, &mci, handle->post_printer, *code);

        // ■■■■■■(X86)
        if (handle->arch == CS_ARCH_X86)
            insn->id += mci.popcode_adjust;

        *code += insn_size;
        *size -= insn_size;
        *address += insn_size;
    } else {    // ■■■■■■
        size_t skipdata_bytes;

        // ■■■■■■■■■■■■■■■■■■■■■■■■
        if (!handle->skipdata || handle->skipdata_size > *size)
            return false;

        if (handle->skipdata_setup.callback) {
            skipdata_bytes = handle->skipdata_setup.callback(*code, *size,
                    0, handle->skipdata_setup.user_data);
            if (skipdata_bytes > *size)
                // ■■■■■■
                return false;

            if (!skipdata_bytes)
                return false;
        } else
            skipdata_bytes = handle->skipdata_size;

        // ■■■■■■■■■■■■■
        insn->id = 0;   // ■“■■”■■■ID■■
        insn->address = *address;
        insn->size = (uint16_t)skipdata_bytes;
#ifdef CAPSTONE_DIET
        insn->mnemonic[0] = '\0';
        insn->op_str[0] = '\0';
#else
        memcpy(insn->bytes, *code, skipdata_bytes);
        strncpy(insn->mnemonic, handle->skipdata_setup.mnemonic,
                sizeof(insn->mnemonic) - 1);
        skipdata_opstr(insn->op_str, *code, skipdata_bytes);
```

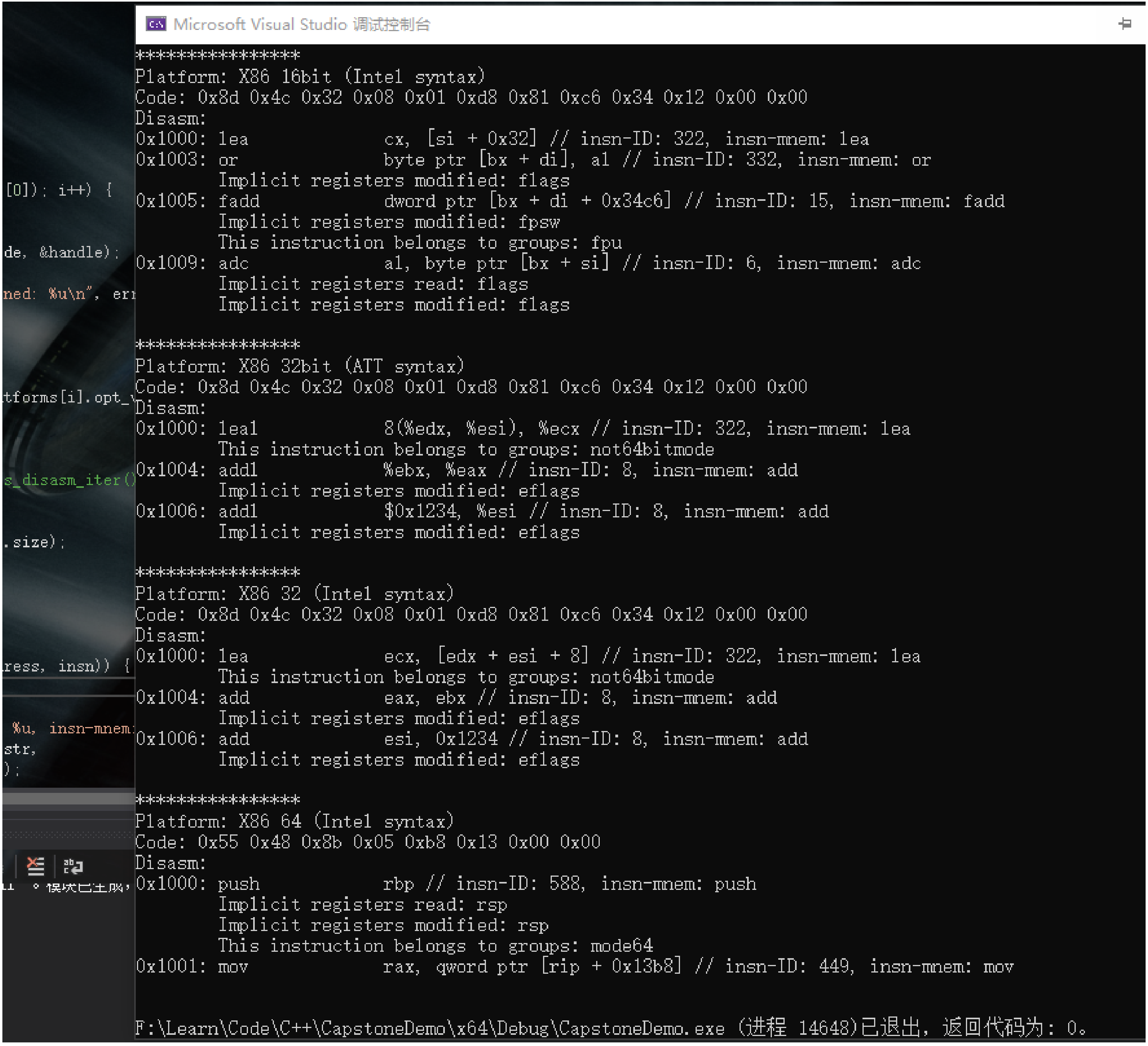
```
#endif

       *code += skipdata_bytes;
       *size -= skipdata_bytes;
       *address += skipdata_bytes;
   }

   return true;
}
```

示例：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
}

static void test()
{
#define X86_CODE16 "\x8d\x4c\x32\x08\x01\xd8\x81\xc6\x34\x12\x00\x00"
#define X86_CODE32 "\x8d\x4c\x32\x08\x01\xd8\x81\xc6\x34\x12\x00\x00"
#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00"

   struct platform platforms[4] = {     //■■■■■
       {
           CS_ARCH_X86,
           CS_MODE_16,
           (unsigned char*)X86_CODE16,
           sizeof(X86_CODE32) - 1,
           "X86 16bit (Intel syntax)"
       },
       {
           CS_ARCH_X86,
           CS_MODE_32,
           (unsigned char*)X86_CODE32,
           sizeof(X86_CODE32) - 1,
           "X86 32bit (ATT syntax)",
           CS_OPT_SYNTAX,
           CS_OPT_SYNTAX_ATT,
       },
       {
           CS_ARCH_X86,
           CS_MODE_32,
           (unsigned char*)X86_CODE32,
           sizeof(X86_CODE32) - 1,
           "X86 32 (Intel syntax)"
       },
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;

   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       // ■cs_disasm_iter()■■■■
       insn = cs_malloc(handle);

       print_string_hex(platforms[i].code, platforms[i].size);   //■■■■
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {   //cs_disasm_iter■■■
           int n;

           printf("0x%" PRIx64 ":\t%s\t\t%s // insn-ID: %u, insn-mnem: %s\n",
               insn->address, insn->mnemonic, insn->op_str,
               insn->id, cs_insn_name(handle, insn->id));

           // ■■■■■■■■■■■■■
           detail = insn->detail;

           if (detail->regs_read_count > 0) {
               printf("\tImplicit registers read: ");
               for (n = 0; n < detail->regs_read_count; n++) {
                   printf("%s ", cs_reg_name(handle, detail->regs_read[n]));
               }
               printf("\n");
           }

           // ■■■■■■■■■■■■■
           if (detail->regs_write_count > 0) {
               printf("\tImplicit registers modified: ");
               for (n = 0; n < detail->regs_write_count; n++) {
                   printf("%s ", cs_reg_name(handle, detail->regs_write[n]));
               }
               printf("\n");
           }
```

```
           // ■■■■■■■■■■
           if (detail->groups_count > 0) {
               printf("\tThis instruction belongs to groups: ");
               for (n = 0; n < detail->groups_count; n++) {
                   printf("%s ", cs_group_name(handle, detail->groups[n]));
               }
               printf("\n");
           }
       }

       printf("\n");

       // ■■cs_malloc()■■■■■
       cs_free(insn, 1);

       cs_close(&handle);
   }
}

int main()
{
   test();

   return 0;
}
```

输出



```
****************
Platform: X86 16bit (Intel syntax)
Code: 0x8d 0x4c 0x32 0x08 0x01 0xd8 0x81 0xc6 0x34 0x12 0x00 0x00
Disasm:
0x1000: lea             cx, [si + 0x32] // insn-ID: 322, insn-mnem: lea
0x1003: or              byte ptr [bx + di], al // insn-ID: 332, insn-mnem: or
        Implicit registers modified: flags
0x1005: fadd            dword ptr [bx + di + 0x34c6] // insn-ID: 15, insn-mnem: fadd
        Implicit registers modified: fpsw
        This instruction belongs to groups: fpu
0x1009: adc             al, byte ptr [bx + si] // insn-ID: 6, insn-mnem: adc
        Implicit registers read: flags
        Implicit registers modified: flags

****************
Platform: X86 32bit (ATT syntax)
Code: 0x8d 0x4c 0x32 0x08 0x01 0xd8 0x81 0xc6 0x34 0x12 0x00 0x00
Disasm:
0x1000: leal            8(%edx, %esi), %ecx // insn-ID: 322, insn-mnem: lea
        This instruction belongs to groups: not64bitmode
0x1004: addl            %ebx, %eax // insn-ID: 8, insn-mnem: add
        Implicit registers modified: eflags
0x1006: addl            $0x1234, %esi // insn-ID: 8, insn-mnem: add
        Implicit registers modified: eflags

****************
Platform: X86 32 (Intel syntax)
Code: 0x8d 0x4c 0x32 0x08 0x01 0xd8 0x81 0xc6 0x34 0x12 0x00 0x00
Disasm:
0x1000: lea             ecx, [edx + esi + 8] // insn-ID: 322, insn-mnem: lea
        This instruction belongs to groups: not64bitmode
0x1004: add             eax, ebx // insn-ID: 8, insn-mnem: add
        Implicit registers modified: eflags
0x1006: add             esi, 0x1234 // insn-ID: 8, insn-mnem: add
        Implicit registers modified: eflags

****************
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00
Disasm:
0x1000: push            rbp // insn-ID: 588, insn-mnem: push
        Implicit registers read: rsp
        Implicit registers modified: rsp
        This instruction belongs to groups: mode64
0x1001: mov             rax, qword ptr [rip + 0x13b8] // insn-ID: 449, insn-mnem: mov


F:\Learn\Code\C++\CapstoneDemo\x64\Debug\CapstoneDemo.exe (进程 14648)已退出，返回代码为: 0。
```

cs_reg_name

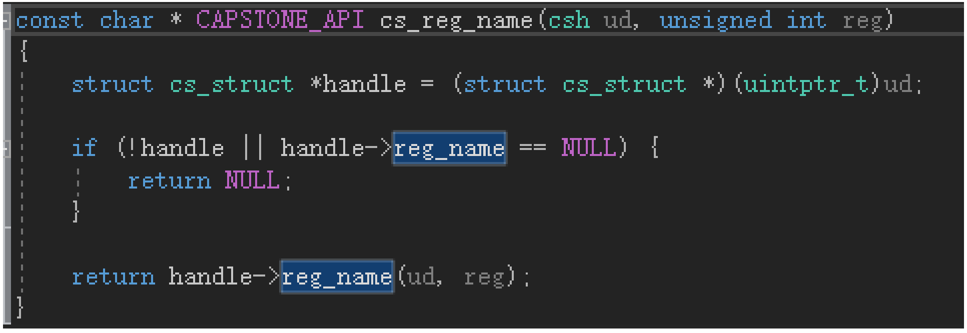
```
const char * CAPSTONE_API cs_reg_name(csh handle, unsigned int reg_id);
```

获取寄存器的名字(string类型)
寄存器id可在相关架构的头文件(建立项目时复制到项目文件夹的那些头文件)内找到

注意： 当处于diet模式时此API不可用，因为引擎不会存储寄存器名

参数
handle: cs_open()返回的句柄
reg_id: 寄存器id
return: 寄存器的字符名, 如果reg_id不可用返回NULL

代码实现

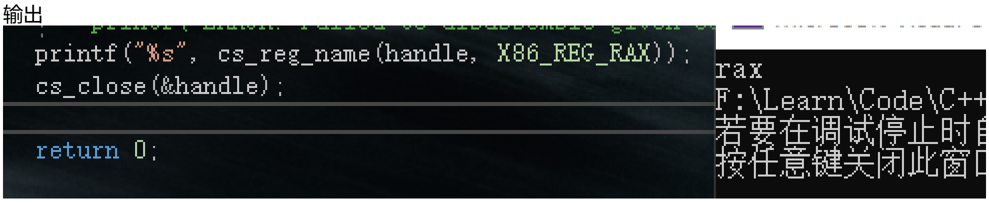


```
const char * CAPSTONE_API cs_reg_name(csh ud, unsigned int reg)
{
    struct cs_struct *handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle || handle->reg_name == NULL) {
        return NULL;
    }

    return handle->reg_name(ud, reg);
}
```

示例(打印RAX)：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

int main(void)
{
   csh handle = 0;
   cs_insn* insn;
   size_t count;

   if (cs_open(CS_ARCH_X86, CS_MODE_64, &handle)) {
       printf("ERROR: Failed to initialize engine!\n");
       return -1;
   }

   printf("%s", cs_reg_name(handle, X86_REG_RAX));
   cs_close(&handle);

   return 0;
}
```

输出



```
    printf("%s", cs_reg_name(handle, X86_REG_RAX));
    cs_close(&handle);

    return 0;
```

```
rax
F:\Learn\Code\C++
若要在调试停止时自
按任意键关闭此窗口
```

cs_insn_name

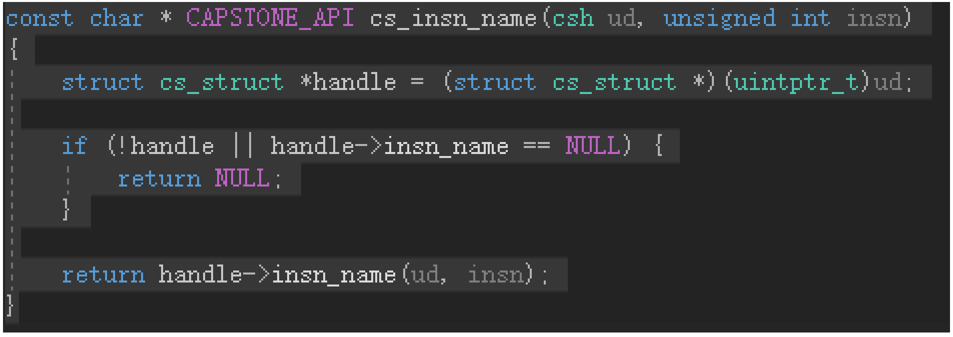
```
const char * CAPSTONE_API cs_insn_name(csh handle, unsigned int insn_id);
```

获取指令的名字(string类型)
指令id可在相关架构的头文件(建立项目时复制到项目文件夹的那些头文件)内找到

注意： 当处于diet模式时此API不可用，因为引擎不会存储寄存器名

参数
handle: cs_open()返回的句柄
insn_id: 指令id
return: 指令的字符名, 如果insn_id不可用返回NULL

代码实现

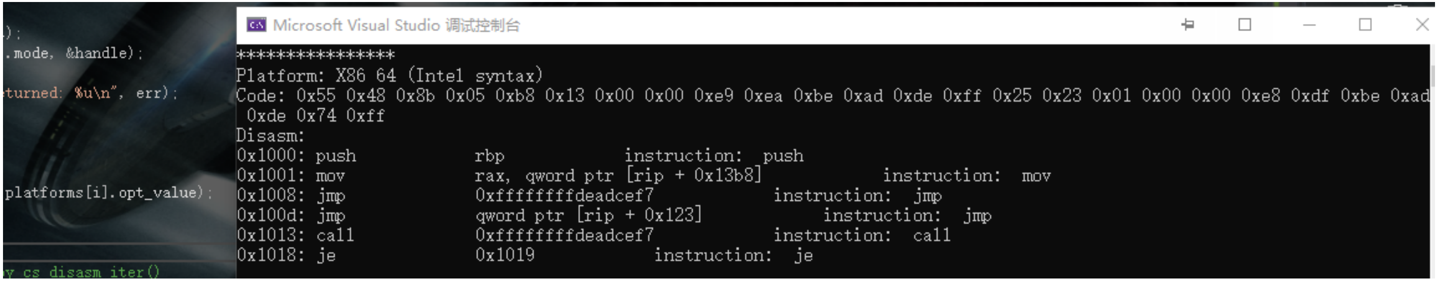


```
const char * CAPSTONE_API cs_insn_name(csh ud, unsigned int insn)
{
    struct cs_struct *handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle || handle->insn_name == NULL) {
        return NULL;
    }

    return handle->insn_name(ud, insn);
}
```

示例：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
}

static void test()
{

#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00\xe9\xea\xbe\xad\xde\xff\x25\x23\x01\x00\x00\xe8\xdf\xbe\xad\xde\x74\xff"

   struct platform platforms[] = {
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },
   };

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;

   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       insn = cs_malloc(handle);

       print_string_hex(platforms[i].code, platforms[i].size);
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {
           int n;

           printf("0x%" PRIx64 ":\t%s\t\t%s",
               insn->address, insn->mnemonic, insn->op_str);
           printf("            instruction:  %s", cs_insn_name(handle, insn->id));   //■■■■■■■■■
           cout << endl;

       printf("\n");
       cs_free(insn, 1);
       cs_close(&handle);
   }
}

int main()
{
   test();

   return 0;
}
```

输出



```
****************
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00 0xe9 0xea 0xbe 0xad 0xde 0xff 0x25 0x23 0x01 0x00 0x00 0xe8 0xdf 0xbe 0xad
 0xde 0x74 0xff
Disasm:
0x1000: push            rbp             instruction:  push
0x1001: mov             rax, qword ptr [rip + 0x13b8]           instruction:  mov
0x1008: jmp             0xffffffffdeadcef7              instruction:  jmp
0x100d: jmp             qword ptr [rip + 0x123]                 instruction:  jmp
0x1013: call            0xffffffffdeadcef7              instruction:  call
0x1018: je              0x1019          instruction:  je
```

cs_group_name

```
const char * CAPSTONE_API cs_group_name(csh handle, unsigned int group_id);
```

输出指令类型名字
指令id可在相关架构的头文件(建立项目时复制到项目文件夹的那些头文件)内找到

注意： 当处于diet模式时此API不可用，因为引擎不会存储寄存器名

参数
handle: cs_open()返回的句柄
insn_id: 指令类型id
return: 指令类型的字符名, 如果insn_id不可用返回NULL

实现代码及示例都与上面类似，略。。

cs_insn_group

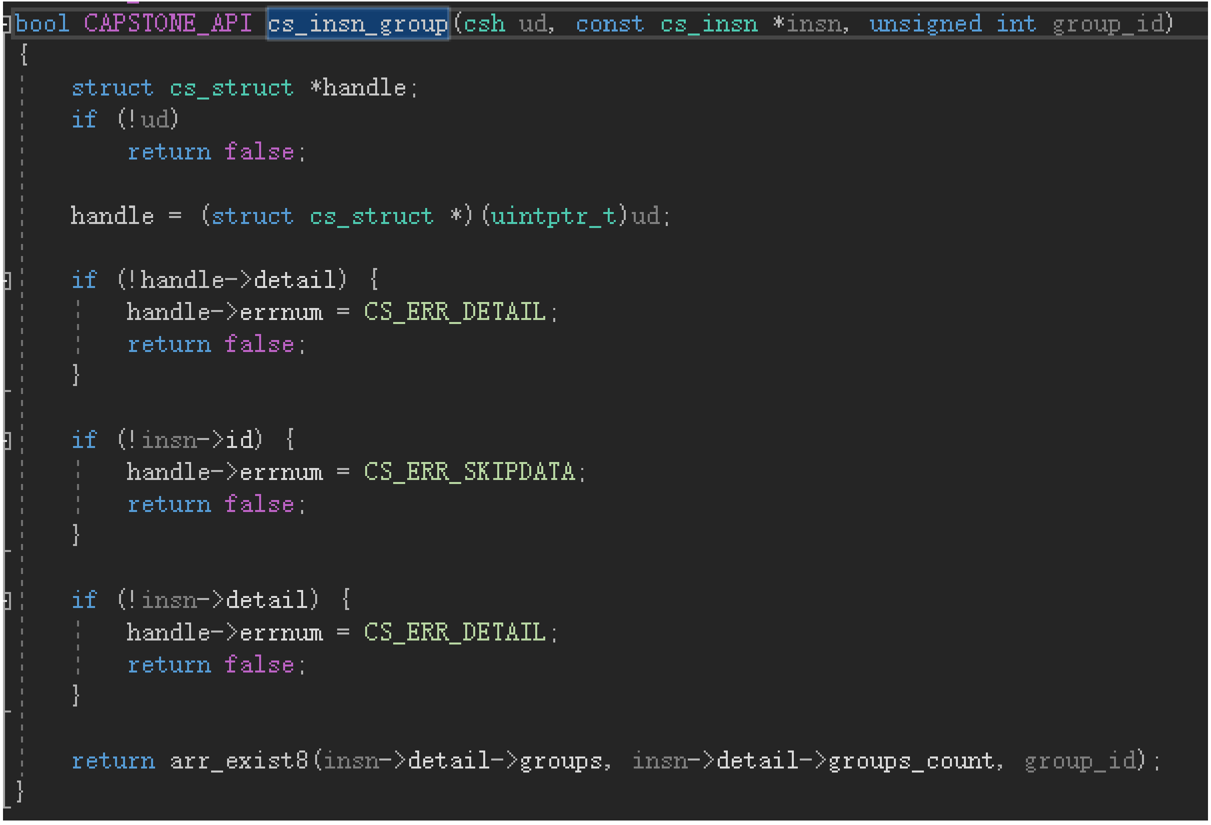
```
bool CAPSTONE_API cs_insn_group(csh handle, const cs_insn *insn, unsigned int group_id);
```

检查反汇编后的指令是否属于某个特定指令类型。

注意：只有当detail选项为ON时这个API可用 (默认OFF).
在"diet"模式下，此API没有用，因为引擎不更新insn->groups数组。

handle: cs_open()返回的句柄
insn: 从cs_disasm()或cs_disasm_iter()接收的反汇编指令结构
group_id: 要检查此指令是否属于的指令类型。
return: 如果该指令确实属于给定的指令类型，则为true，否则为false。

代码实现



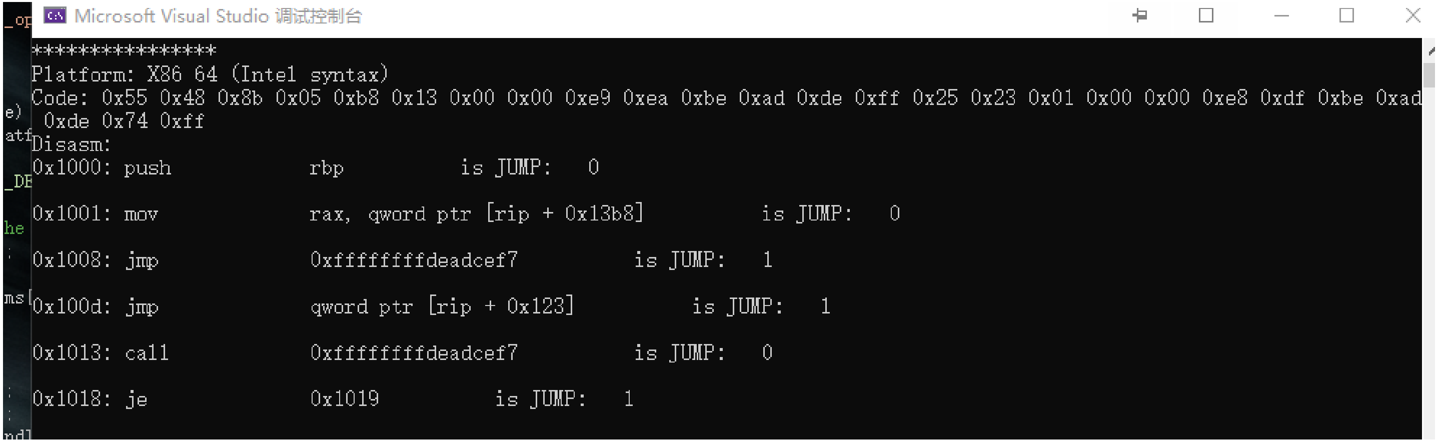
```
bool CAPSTONE_API cs_insn_group(csh ud, const cs_insn *insn, unsigned int group_id)
{
    struct cs_struct *handle;
    if (!ud)
        return false;

    handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    if (!insn->id) {
        handle->errnum = CS_ERR_SKIPDATA;
        return false;
    }

    if (!insn->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    return arr_exist8(insn->detail->groups, insn->detail->groups_count, group_id);
}
```

示例(判断是否属于跳转指令)：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
```

```
}

static void test()
{

#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00\xe9\xea\xbe\xad\xde\xff\x25\x23\x01\x00\x00\xe8\xdf\xbe\xad\xde\x74\xff"

   struct platform platforms[] = {
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },
   };

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;

   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       insn = cs_malloc(handle);

       print_string_hex(platforms[i].code, platforms[i].size);
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {
           int n;

           printf("0x%" PRIx64 ":\t%s\t\t%s          ",
               insn->address, insn->mnemonic, insn->op_str);
           cout << "is JUMP:   " <<cs_insn_group(handle, insn, CS_GRP_JUMP) << endl;   //■■■■■■■■■
           cout << endl;

       printf("\n");
       cs_free(insn, 1);
       cs_close(&handle);
   }
}

int main()
{
   test();

   return 0;
}
```

输出



```
****************
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00 0xe9 0xea 0xbe 0xad 0xde 0xff 0x25 0x23 0x01 0x00 0x00 0xe8 0xdf 0xbe 0xad
 0xde 0x74 0xff
Disasm:
0x1000: push            rbp             is JUMP:    0

0x1001: mov             rax, qword ptr [rip + 0x13b8]           is JUMP:    0

0x1008: jmp             0xffffffffdeadcef7          is JUMP:    1

0x100d: jmp             qword ptr [rip + 0x123]         is JUMP:    1

0x1013: call            0xffffffffdeadcef7          is JUMP:    0

0x1018: je              0x1019          is JUMP:    1
```

cs_reg_read

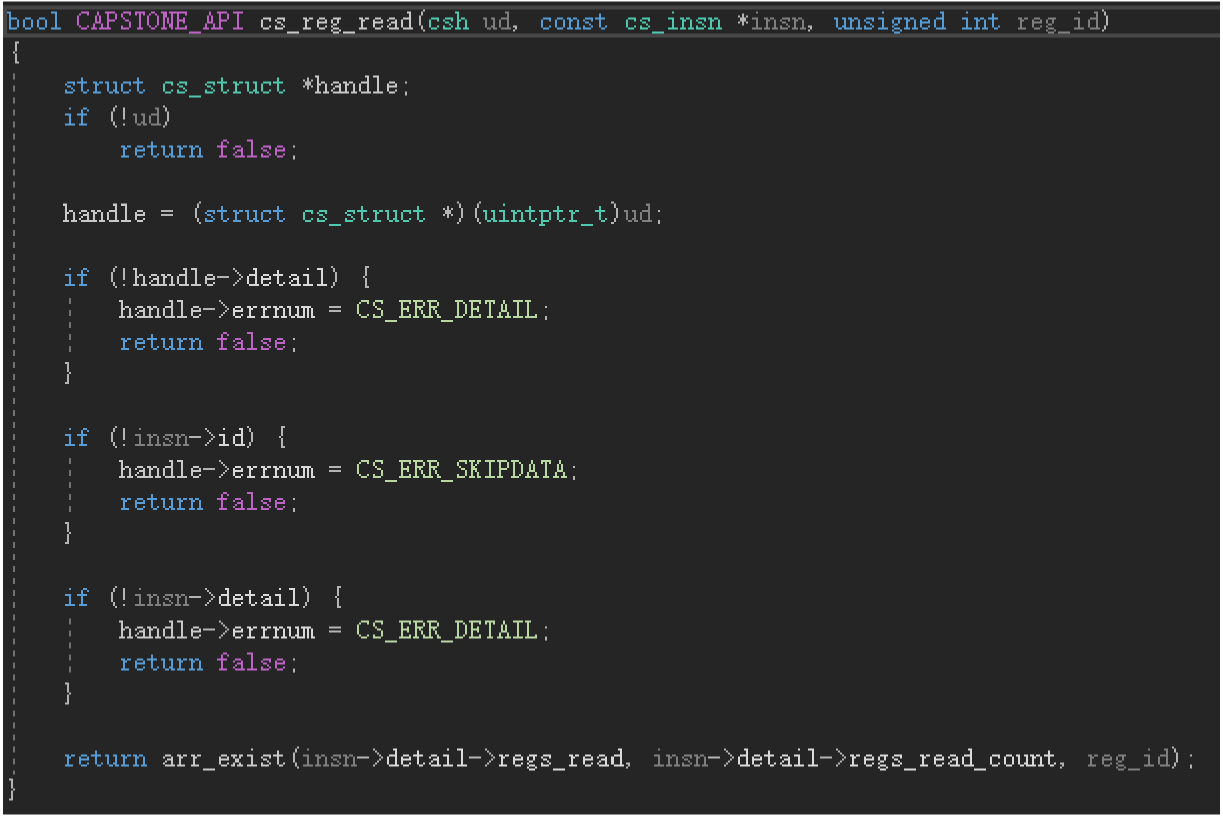
```
bool CAPSTONE_API cs_reg_read(csh handle, const cs_insn *insn, unsigned int reg_id);
```

检查反汇编指令是否隐式使用特定寄存器。

注意:此API仅在启用detail选项时有效(默认为关闭)
在"diet"模式下，此API没有用，因为引擎不更新insn->regs_read数组。

insn: 从cs_disasm()或cs_disasm_iter()接收的反汇编指令结构
reg_id: 标注想要检查的这个指令是否使用了它。
return: 如果该指令确实隐式使用了给定寄存器，则为true，否则为false。

代码实现



```
bool CAPSTONE_API cs_reg_read(csh ud, const cs_insn *insn, unsigned int reg_id)
{
    struct cs_struct *handle;
    if (!ud)
        return false;

    handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    if (!insn->id) {
        handle->errnum = CS_ERR_SKIPDATA;
        return false;
    }

    if (!insn->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    return arr_exist(insn->detail->regs_read, insn->detail->regs_read_count, reg_id);
}
```

示例同API cs_disasm_iter

cs_reg_write

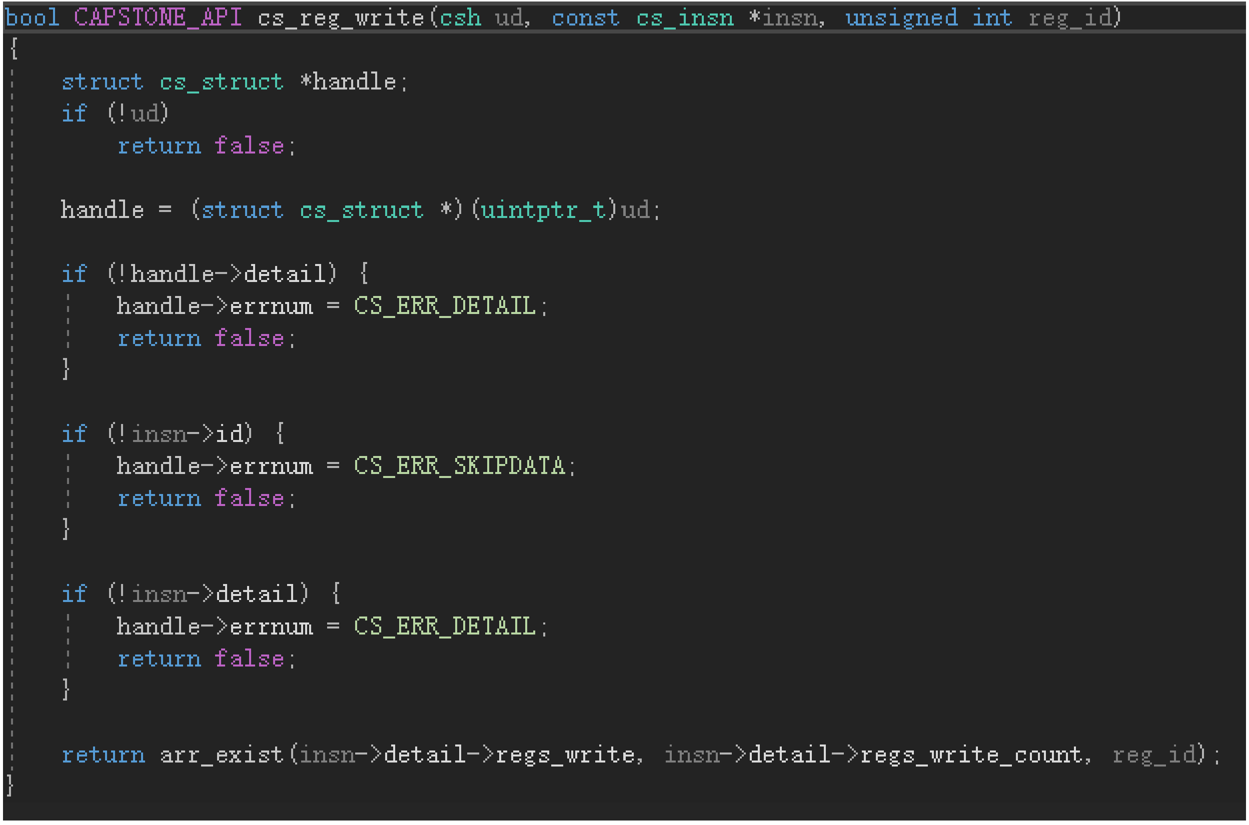
```
bool CAPSTONE_API cs_reg_write(csh handle, const cs_insn *insn, unsigned int reg_id);
```

检查反汇编指令是否隐式修改了特定寄存器。

注意:此API仅在启用detail选项时有效(默认为关闭)
在"diet"模式下，此API没有用，因为引擎不更新insn->regs_read数组。

insn: 从cs_disasm()或cs_disasm_iter()接收的反汇编指令结构
reg_id: 标注想要检查的这个指令是否修改了它。
return: 如果该指令确实隐式修改了给定寄存器，则为true，否则为false。

代码实现



```
bool CAPSTONE_API cs_reg_write(csh ud, const cs_insn *insn, unsigned int reg_id)
{
    struct cs_struct *handle;
    if (!ud)
        return false;

    handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    if (!insn->id) {
        handle->errnum = CS_ERR_SKIPDATA;
        return false;
    }

    if (!insn->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return false;
    }

    return arr_exist(insn->detail->regs_write, insn->detail->regs_write_count, reg_id);
}
```

示例同API cs_disasm_iter

cs_op_count

```
int CAPSTONE_API cs_op_count(csh handle, const cs_insn *insn, unsigned int op_type);
```

计算给定类型的操作数的数量。
注意：只有当detail选项为ON时这个API可用 (默认OFF).

handle: cs_open()返回的句柄
insn: 从cs_disasm()或cs_disasm_iter()接收的反汇编指令结构
op_type: 要找到的操作数类型。
return: 指令insn中给定类型op_type的操作数的数量，返回-1表示查找失败。

代码实现

```
int CAPSTONE_API cs_op_count(csh ud, const cs_insn *insn, unsigned int op_type)
{
   struct cs_struct *handle;
   unsigned int count = 0, i;
   if (!ud)
       return -1;

   handle = (struct cs_struct *)(uintptr_t)ud;

   if (!handle->detail) {
       handle->errnum = CS_ERR_DETAIL;
       return -1;
   }

   if (!insn->id) {
       handle->errnum = CS_ERR_SKIPDATA;
       return -1;
   }

   if (!insn->detail) {
       handle->errnum = CS_ERR_DETAIL;
```

```
        return -1;
    }

    handle->errnum = CS_ERR_OK;

    switch (handle->arch) {
        default:
            handle->errnum = CS_ERR_HANDLE;
            return -1;
        case CS_ARCH_ARM:
            for (i = 0; i < insn->detail->arm.op_count; i++)
                if (insn->detail->arm.operands[i].type == (arm_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_ARM64:
            for (i = 0; i < insn->detail->arm64.op_count; i++)
                if (insn->detail->arm64.operands[i].type == (arm64_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_X86:
            for (i = 0; i < insn->detail->x86.op_count; i++)
                if (insn->detail->x86.operands[i].type == (x86_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_MIPS:
            for (i = 0; i < insn->detail->mips.op_count; i++)
                if (insn->detail->mips.operands[i].type == (mips_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_PPC:
            for (i = 0; i < insn->detail->ppc.op_count; i++)
                if (insn->detail->ppc.operands[i].type == (ppc_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_SPARC:
            for (i = 0; i < insn->detail->sparc.op_count; i++)
                if (insn->detail->sparc.operands[i].type == (sparc_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_SYSZ:
            for (i = 0; i < insn->detail->sysz.op_count; i++)
                if (insn->detail->sysz.operands[i].type == (sysz_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_XCORE:
            for (i = 0; i < insn->detail->xcore.op_count; i++)
                if (insn->detail->xcore.operands[i].type == (xcore_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_M68K:
            for (i = 0; i < insn->detail->m68k.op_count; i++)
                if (insn->detail->m68k.operands[i].type == (m68k_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_TMS320C64X:
            for (i = 0; i < insn->detail->tms320c64x.op_count; i++)
                if (insn->detail->tms320c64x.operands[i].type == (tms320c64x_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_M680X:
            for (i = 0; i < insn->detail->m680x.op_count; i++)
                if (insn->detail->m680x.operands[i].type == (m680x_op_type)op_type)
                    count++;
            break;
        case CS_ARCH_EVM:
#if 0
            for (i = 0; i < insn->detail->evm.op_count; i++)
                if (insn->detail->evm.operands[i].type == (evm_op_type)op_type)
                    count++;
```

```
#endif
            break;
   }

   return count;
}
```

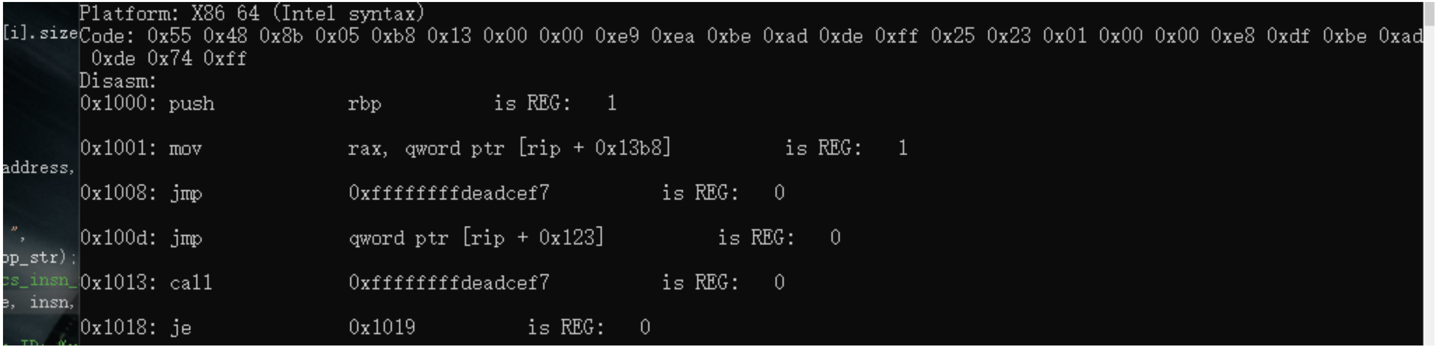
拿x86指令操作码类型举例

```
typedef enum x86_op_type {
   X86_OP_INVALID = 0, ///< = CS_OP_INVALID (■■■■).
   X86_OP_REG, ///< = CS_OP_REG (■■■■■).
   X86_OP_IMM, ///< = CS_OP_IMM (■■■■■).
   X86_OP_MEM, ///< = CS_OP_MEM (■■■■■).
} x86_op_type;
```

示例(判断寄存操作码)：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
}

static void test()
{

#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00\xe9\xea\xbe\xad\xde\xff\x25\x23\x01\x00\x00\xe8\xdf\xbe\xad\xde\x74\xff"

   struct platform platforms[] = {
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },
   };

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;
   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       insn = cs_malloc(handle);

       print_string_hex(platforms[i].code, platforms[i].size);
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {
           int n;

           printf("0x%" PRIx64 ":\t%s\t\t%s          ",
               insn->address, insn->mnemonic, insn->op_str);
           cout << "is REG:   " << cs_op_count(handle, insn, X86_OP_REG) << endl;   //■■■■■■■■■■■
           cout << endl;

       printf("\n");
       cs_free(insn, 1);
       cs_close(&handle);
   }
}

int main()
{
   test();

   return 0;
}
```

输出



```
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00 0xe9 0xea 0xbe 0xad 0xde 0xff 0x25 0x23 0x01 0x00 0x00 0xe8 0xdf 0xbe 0xad
 0xde 0x74 0xff
Disasm:
0x1000: push            rbp           is REG:   1

0x1001: mov             rax, qword ptr [rip + 0x13b8]          is REG:   1

0x1008: jmp             0xffffffffdeadcef7          is REG:   0

0x100d: jmp             qword ptr [rip + 0x123]          is REG:   0

0x1013: call            0xffffffffdeadcef7          is REG:   0

0x1018: je              0x1019          is REG:   0
```

cs_op_index

```
int CAPSTONE_API cs_op_index(csh handle, const cs_insn *insn, unsigned int op_type, unsigned int position);
```

检索给定类型的操作数在`<arch>.operands[]`数组中的位置, 使用返回的位置访问操作数。
注意：只有当detail选项为ON时这个API可用 (默认OFF).

handle: cs_open()返回的句柄
insn: 从cs_disasm()或cs_disasm_iter()接收的反汇编指令结构
op_type: 要找到的操作数类型。
position: 要查找的操作数的位置。范围一定在`[1, cs_op_count(handle, insn, op_type)]`内
return: 指令insn的`<arch>.operands[]`数组中给定类型op_type的操作数的索引，失败时返回-1。

代码实现

```
int CAPSTONE_API cs_op_index(csh ud, const cs_insn *insn, unsigned int op_type,
        unsigned int post)
{
    struct cs_struct *handle;
    unsigned int count = 0, i;
    if (!ud)
        return -1;

    handle = (struct cs_struct *)(uintptr_t)ud;

    if (!handle->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return -1;
    }

    if (!insn->id) {
        handle->errnum = CS_ERR_SKIPDATA;
        return -1;
    }

    if (!insn->detail) {
        handle->errnum = CS_ERR_DETAIL;
        return -1;
    }

    handle->errnum = CS_ERR_OK;

    switch (handle->arch) {
        default:
            handle->errnum = CS_ERR_HANDLE;
            return -1;
        case CS_ARCH_ARM:
            for (i = 0; i < insn->detail->arm.op_count; i++) {
                if (insn->detail->arm.operands[i].type == (arm_op_type)op_type)
                    count++;
                if (count == post)
                    return i;
            }
            break;
        case CS_ARCH_ARM64:
            for (i = 0; i < insn->detail->arm64.op_count; i++) {
                if (insn->detail->arm64.operands[i].type == (arm64_op_type)op_type)
                    count++;
                if (count == post)
                    return i;
            }
            break;
        case CS_ARCH_X86:
            for (i = 0; i < insn->detail->x86.op_count; i++) {
                if (insn->detail->x86.operands[i].type == (x86_op_type)op_type)
                    count++;
                if (count == post)
                    return i;
            }
            break;
        case CS_ARCH_MIPS:
            for (i = 0; i < insn->detail->mips.op_count; i++) {
                if (insn->detail->mips.operands[i].type == (mips_op_type)op_type)
                    count++;
                if (count == post)
                    return i;
            }
            break;
        case CS_ARCH_PPC:
            for (i = 0; i < insn->detail->ppc.op_count; i++) {
                if (insn->detail->ppc.operands[i].type == (ppc_op_type)op_type)
                    count++;
```

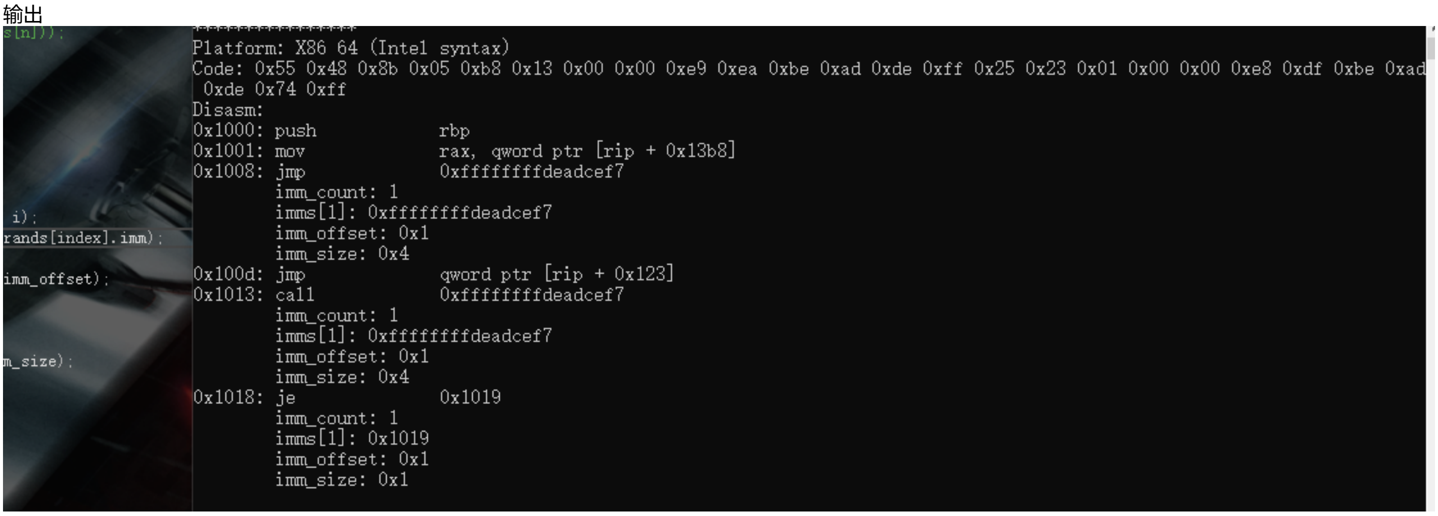
```
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_SPARC:
           for (i = 0; i < insn->detail->sparc.op_count; i++) {
               if (insn->detail->sparc.operands[i].type == (sparc_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_SYSZ:
           for (i = 0; i < insn->detail->sysz.op_count; i++) {
               if (insn->detail->sysz.operands[i].type == (sysz_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_XCORE:
           for (i = 0; i < insn->detail->xcore.op_count; i++) {
               if (insn->detail->xcore.operands[i].type == (xcore_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_M68K:
           for (i = 0; i < insn->detail->m68k.op_count; i++) {
               if (insn->detail->m68k.operands[i].type == (m68k_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_TMS320C64X:
           for (i = 0; i < insn->detail->tms320c64x.op_count; i++) {
               if (insn->detail->tms320c64x.operands[i].type == (tms320c64x_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
       case CS_ARCH_M680X:
           for (i = 0; i < insn->detail->m680x.op_count; i++) {
               if (insn->detail->m680x.operands[i].type == (m680x_op_type)op_type)
                   count++;
               if (count == post)
                   return i;
           }
           break;
   }

   return -1;
}
```

示例

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
}

static void test()
{
#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00\xe9\xea\xbe\xad\xde\xff\x25\x23\x01\x00\x00\xe8\xdf\xbe\xad\xde\x74\xff"
   struct platform platforms[] = {
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },
   };

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;

   cs_x86* x86;

   int count;

   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       insn = cs_malloc(handle);
       x86 = &(insn->detail->x86);
       print_string_hex(platforms[i].code, platforms[i].size);
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {
           int n;
```

```
            printf("0x%" PRIx64 ":\t%s\t\t%s          ",
                insn->address, insn->mnemonic, insn->op_str);
            cout << endl;

            count = cs_op_count(handle, insn, X86_OP_IMM);  //■■■■■
            if (count) {
                printf("\timm_count: %u\n", count);
                for (i = 1; i < count + 1; i++) {
                    int index = cs_op_index(handle, insn, X86_OP_IMM, i);
                    printf("\timms[%u]: 0x%" PRIx64 "\n", i, x86->operands[index].imm);
                    if (x86->encoding.imm_offset != 0) {
                        printf("\timm_offset: 0x%x\n", x86->encoding.imm_offset);
                    }
                    if (x86->encoding.imm_size != 0) {
                        printf("\timm_size: 0x%x\n", x86->encoding.imm_size);
                    }
                }
            }
        }

        printf("\n");
        cs_free(insn, 1);
        cs_close(&handle);
    }
}

int main()
{
   test();
   return 0;
}
```

输出



```
****************
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00 0xe9 0xea 0xbe 0xad 0xde 0xff 0x25 0x23 0x01 0x00 0x00 0xe8 0xdf 0xbe 0xad
 0xde 0x74 0xff
Disasm:
0x1000: push            rbp
0x1001: mov             rax, qword ptr [rip + 0x13b8]
0x1008: jmp             0xffffffffdeadcef7
        imm_count: 1
        imms[1]: 0xffffffffdeadcef7
        imm_offset: 0x1
        imm_size: 0x4
0x100d: jmp             qword ptr [rip + 0x123]
0x1013: call            0xffffffffdeadcef7
        imm_count: 1
        imms[1]: 0xffffffffdeadcef7
        imm_offset: 0x1
        imm_size: 0x4
0x1018: je              0x1019
        imm_count: 1
        imms[1]: 0x1019
        imm_offset: 0x1
        imm_size: 0x1
```

cs_regs_access

```
cs_err CAPSTONE_API cs_regs_access(csh handle, const cs_insn *insn,
       cs_regs regs_read, uint8_t *regs_read_count,
       cs_regs regs_write, uint8_t *regs_write_count);
```

检索由一条指令显式或隐式访问的所有寄存器。

注意： 在“diet”模式下，此API不可用，因为引擎不存储寄存器。

handle: cs_open()返回的句柄
insn: 从cs_disasm()或cs_disasm_iter()返回的反汇编指令结构
regs_read:返回时，这个数组包含所有按指令读取的寄存器。
regs_read_count:保存在regs_read数组中的寄存器数。
regs_write:返回时，这个数组包含所有由指令修改的寄存器。
regs_write_count:保存在regs_write数组中的寄存器数。
成功时返回CS_ERR_OK，失败时返回其他值(详细错误请参阅cs_err enum)。

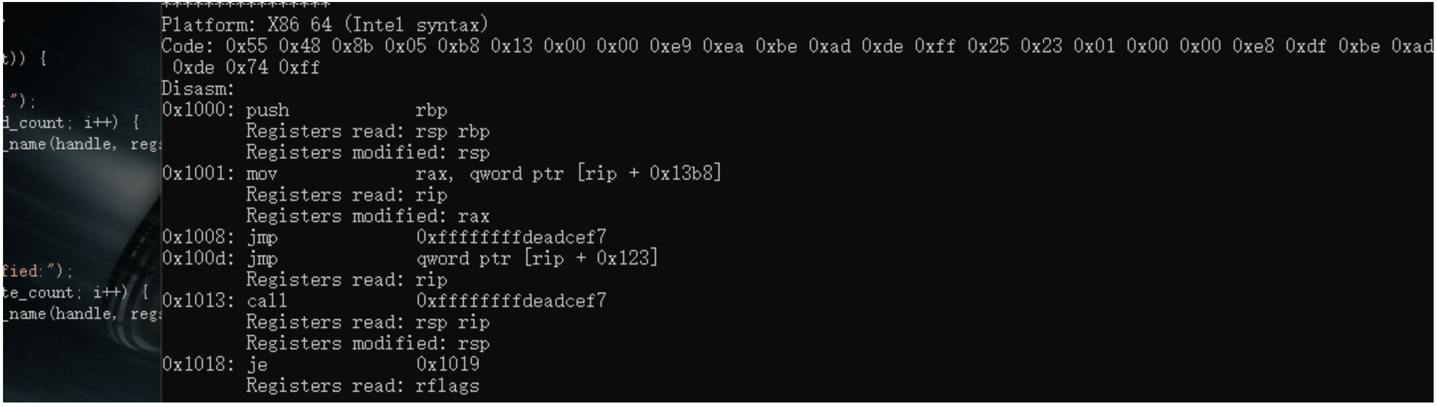
代码实现

```
cs_err CAPSTONE_API cs_regs_access(csh ud, const cs_insn *insn,
       cs_regs regs_read, uint8_t *regs_read_count,
       cs_regs regs_write, uint8_t *regs_write_count)
{
   struct cs_struct *handle;

   if (!ud)
       return -1;

   handle = (struct cs_struct *)(uintptr_t)ud;

#ifdef CAPSTONE_DIET
   // This API does not work in DIET mode
   handle->errnum = CS_ERR_DIET;
   return CS_ERR_DIET;
#else
   if (!handle->detail) {
       handle->errnum = CS_ERR_DETAIL;
       return CS_ERR_DETAIL;
   }

   if (!insn->id) {
       handle->errnum = CS_ERR_SKIPDATA;
       return CS_ERR_SKIPDATA;
   }

   if (!insn->detail) {
       handle->errnum = CS_ERR_DETAIL;
       return CS_ERR_DETAIL;
   }

   if (handle->reg_access) {
       handle->reg_access(insn, regs_read, regs_read_count, regs_write, regs_write_count);
   } else {
       // this arch is unsupported yet
       handle->errnum = CS_ERR_ARCH;
       return CS_ERR_ARCH;
   }

   return CS_ERR_OK;
#endif
}
```

示例：

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

#include "capstone.h"
#include "platform.h"

using namespace std;

struct platform {
   cs_arch arch;
   cs_mode mode;
   unsigned char* code;
   size_t size;
   const char* comment;
   cs_opt_type opt_type;
   cs_opt_value opt_value;
};

static void print_string_hex(unsigned char* str, size_t len)
{
   unsigned char* c;

   printf("Code: ");
   for (c = str; c < str + len; c++) {
       printf("0x%02x ", *c & 0xff);
   }
   printf("\n");
}

static void test()
{
#define X86_CODE64 "\x55\x48\x8b\x05\xb8\x13\x00\x00\xe9\xea\xbe\xad\xde\xff\x25\x23\x01\x00\x00\xe8\xdf\xbe\xad\xde\x74\xff"
   struct platform platforms[] = {
       {
           CS_ARCH_X86,
           CS_MODE_64,
           (unsigned char*)X86_CODE64,
           sizeof(X86_CODE64) - 1,
           "X86 64 (Intel syntax)"
       },
   };

   csh handle;
   uint64_t address;
   cs_insn* insn;
   cs_detail* detail;
   int i;
   cs_err err;
   const uint8_t* code;
   size_t size;

   cs_x86* x86;
   cs_regs regs_read, regs_write;
   uint8_t regs_read_count, regs_write_count;

   int count;

   for (i = 0; i < sizeof(platforms) / sizeof(platforms[0]); i++) {
       printf("****************\n");
       printf("Platform: %s\n", platforms[i].comment);
       err = cs_open(platforms[i].arch, platforms[i].mode, &handle);
       if (err) {
           printf("Failed on cs_open() with error returned: %u\n", err);
           abort();
       }

       if (platforms[i].opt_type)
           cs_option(handle, platforms[i].opt_type, platforms[i].opt_value);

       cs_option(handle, CS_OPT_DETAIL, CS_OPT_ON);

       insn = cs_malloc(handle);
       x86 = &(insn->detail->x86);
       print_string_hex(platforms[i].code, platforms[i].size);
       printf("Disasm:\n");

       address = 0x1000;
       code = platforms[i].code;
       size = platforms[i].size;
       while (cs_disasm_iter(handle, &code, &size, &address, insn)) {
           int n;

           printf("0x%" PRIx64 ":\t%s\t\t%s          ",
               insn->address, insn->mnemonic, insn->op_str);
           cout << endl;

           if (!cs_regs_access(handle, insn,       //■■■■■■■■■■■■■■■
               regs_read, &regs_read_count,
               regs_write, &regs_write_count)) {
               if (regs_read_count) {
                   printf("\tRegisters read:");
                   for (i = 0; i < regs_read_count; i++) {
                       printf(" %s", cs_reg_name(handle, regs_read[i]));
                   }
                   printf("\n");
               }

               if (regs_write_count) {
                   printf("\tRegisters modified:");
                   for (i = 0; i < regs_write_count; i++) {
                       printf(" %s", cs_reg_name(handle, regs_write[i]));
                   }
                   printf("\n");
               }
           }
       }

       printf("\n");
       cs_free(insn, 1);
       cs_close(&handle);
   }
}

int main()
{
   test();
   return 0;
}
```

输出



```
****************
Platform: X86 64 (Intel syntax)
Code: 0x55 0x48 0x8b 0x05 0xb8 0x13 0x00 0x00 0xe9 0xea 0xbe 0xad 0xde 0xff 0x25 0x23 0x01 0x00 0x00 0xe8 0xdf 0xbe 0xad
 0xde 0x74 0xff
Disasm:
0x1000: push            rbp
        Registers read: rsp rbp
        Registers modified: rsp
0x1001: mov             rax, qword ptr [rip + 0x13b8]
        Registers read: rip
        Registers modified: rax
0x1008: jmp             0xffffffffdeadcef7
0x100d: jmp             qword ptr [rip + 0x123]
        Registers read: rip
0x1013: call            0xffffffffdeadcef7
        Registers read: rsp rip
        Registers modified: rsp
0x1018: je              0x1019
        Registers read: rflags
```

结语

对Capstone API的分析到这里也就结束了，希望能对大家的二进制学习产生一定的帮助~

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