Project 3:
Parsing

COP 4610 / CGS 5765

Principles of Operating Systems

Misc

- Email me your new team information
- Will **assign** teams if necessary after this Friday

Extract Values from BIOS Parameter Block (BPB)

- Bytes per sector
- Sector per cluster
- Number of FATs
- …

Use Case

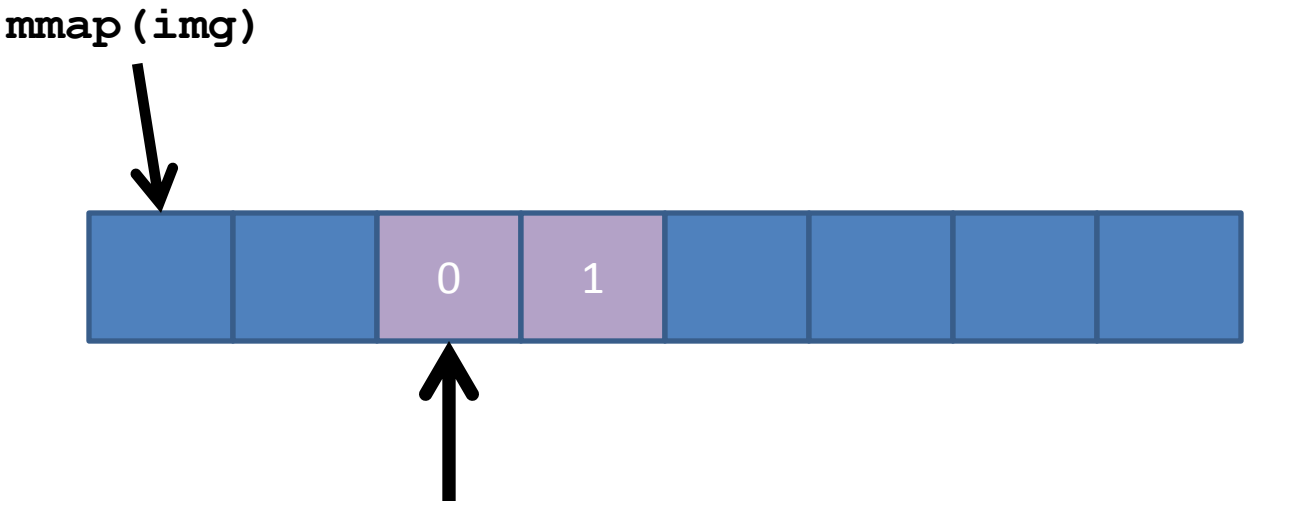
- **`BPB_BytsPerSec`**
  - Offset – 11
  - 2 bytes (little endian)
  - Count of bytes per sector. This value may take on only the following values: 512, 1024, 2048 or 4096.
- Function call?
  - ParseInteger(offset, bytes, [valid values])
    - Returns integer at offset
  - C++
    - ```
      ParseInteger<
      uint16_t,
      512, 1024, 2048, 4096>
      (base_addr+11);
      ```
      ```

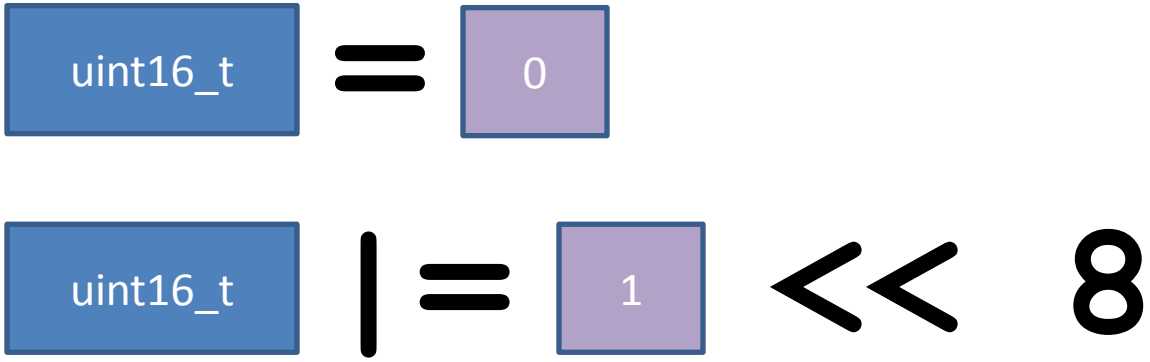
mmap()

```
auto fd = open("fat32.img", O_RDONLY);
if (fd < 0) {
    cerr << "error opening file" << endl;
    exit(EXIT_FAILURE);
}

int offset = 0;
unsigned len = 4096;
auto fdata = (uint8_t*)mmap
   (0, len, PROT_READ, MAP_PRIVATE, fd, offset);
```

Little Endian Source





C++ CODE

ParseInteger

```
unsigned int ParseInteger(const uint8_t* const ptr, int nr_bytes)
{
    int val = 0;
    for (size_t i=0; i<nr_bytes; ++i) {
        val |= static_cast<unsigned int>(ptr[i]) << (i*8);
    }
    return val;
}
```

ParseInteger

```
template<typename T>
T ParseInteger(const unit8_t* const ptr)
{
    T val = 0;

    for (size_t i=0; i<sizeof(T); ++i) {
        val |= static_cast<T>(static_cast<T>(ptr[i]) << (i*8));
    }

    return val;
}

ParseInteger<uint16_t>(fdata + 11);
```

ParseInteger

```
ParseInteger<uint16_t, 512, 1024, 2048, 4096>(fdata + 11);

template<typename T, const T...tArgs>
T parseInteger(const char* const ptr)
{
    T val = 0;
    for (size_t i=0; i<sizeof(T); ++i) {
        val |= static_cast<T>(static_cast<T>(ptr[i]) << (i*8));
    }

    constexpr auto valid_vals = initializer_list<T>({tArgs...});

    if (valid_vals.size() == 0) return val;

    for (auto &x: valid_vals)
        if (x == val) return val;

    throw exception();
}
```

ParseInteger

```
parseInteger<uint8_t>(fdata + 13, [](uint8_t v){return v!=0;})

template<typename T, typename...V>
T parseInteger(const char* const ptr, V&&...args)
{
    T val = parseInteger<T>(ptr);

    for (auto j: {args...})
        if (!j(val)) {
            stringstream ss;
            ss << "error parsing value" << val << endl;
            throw runtime_error(ss.str());
        }

    return val;
}
```

FAT32 DATA ARRANGEMENT

Root Directory

- Clusters
  - Numbered starting at 2
- First cluster contains the root directory
  - Locate using BPB values

Root Directory

```
FirstDataSector
    = BPB_ResvdSecCnt + (BPB_NumFATs * BPB_FATSz32);

RootClusterSector
    = ((BPB_RootClus - 2) * BPB_SecPerClus) + FirstDataSector;
```

usually 2

Records

- Describe directory contents (e.g., files/subdirs)
- 32-bytes
- 4 types
  - Unused
    - First byte is **0xE5**
  - End of directory
    - First byte is **0x00**
  - Short filename
  - Long filename text

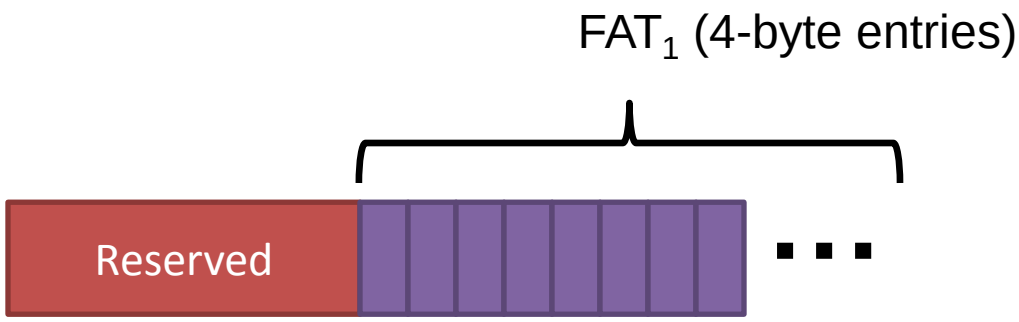
Records

- Short filename
  - **Name** (11-bytes)
  - **Attrib** (1-byte)
    - Is subdirectory, read-only, …
  - **Cluster** (4-bytes)
    - Divided into high and low portions (2 bytes each)
  - **Size** (4-bytes)
- Long filename text
  - Discuss later…

FAT

- Needed if file/dir size is less than one cluster
- Stores location of the next cluster
- Array of 4-byte unsigned integers
  - Index into FAT with valid cluster number
  - Value at index is the next cluster number

Indexing into a FAT




```
N = valid cluster number

FATOffset = N * 4;

ThisFATSecNum = BPB_ResvdSecCnt + (FATOffset / BPB_BytsPerSec);

ThisFATEntOffset = remainder(FATOffset / BPB_BytsPerSec);
```

At This Point

- Read-only access
- You should be able to
  - Traverse directories and list all files
  - Output data in file
  - Use FAT for large directories/files
- Next step
  - Free space (records and clusters)
    - Find
    - Allocate

Getting Started

- Root directory
  - Find using values from BPB
  - List files/dirs in root directory
    - Parse records
- Design
  - BPB
  - Cluster data **uses (requires) a** BPB
  - Cluster **has** records

Next Steps

- Writing
  - Create files/dirs
  - Store data in file
- Allocation
  - Records
  - Clusters

Bonus

- Increase/decrease the number of FATs
- Defragment
- Visualize data layout
- fsck
- Handle bad sectors
  - Mark as bad
  - Copy data
- …