Section 6

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Topics for Today

- Project 1 & 2 Recap
- More Project 3
- Virtual Memory
- Deadlocks
- Midterm

Project 1 & 2 Recap

- Quick recap of design considerations
  - What went well?
  - What should be improved?

Project 1 Designs

OK

```
NtReadFile(…) {
  …
  recordValue(retVal1);
  return retVal1;
  …

  record Value(retVal2);
  return retVal2;
}
```

Better

```
NtReadFile(…) {
  int retVal = _NtReadFile(…);
  recordValue(retVal);
  return retVal;
}

_NtReadFile(…) {
  // Old NtReadFile
  …
}
```

Project 1 Designs

OK

sysinfo.c

```
ULONG readInfo = 0;
ULONG readWarning = 0;
ULONG readSuccess = 0;
…
```

Better

sysinfo.c

```
struct CSE451Info {
  ULONG read[4];
  ULONG write[4];
  ULONG open[4];
  ULONG create[4];
};
```

Project 2 Designs

OK

- Using buffer as a contiguous block and resizing when full.
- Storing entire output string of the history entry into the buffer.

Better

- Using linked list of buffers and removing from front, adding to back.
  - Also used circularly linked list
- Storing enumerations of each history item into the buffer.

Project 2 Designs

- Overall good design decisions
  - Attaching mutex pointers to CSE451Info structs
  - Making critical sections as small as possible
  - Placing header files in `base/ntos/inc/` and modular implementations in `base/ntos/ex/`
  - Placing initialization code in files in `base/ntos/init/`

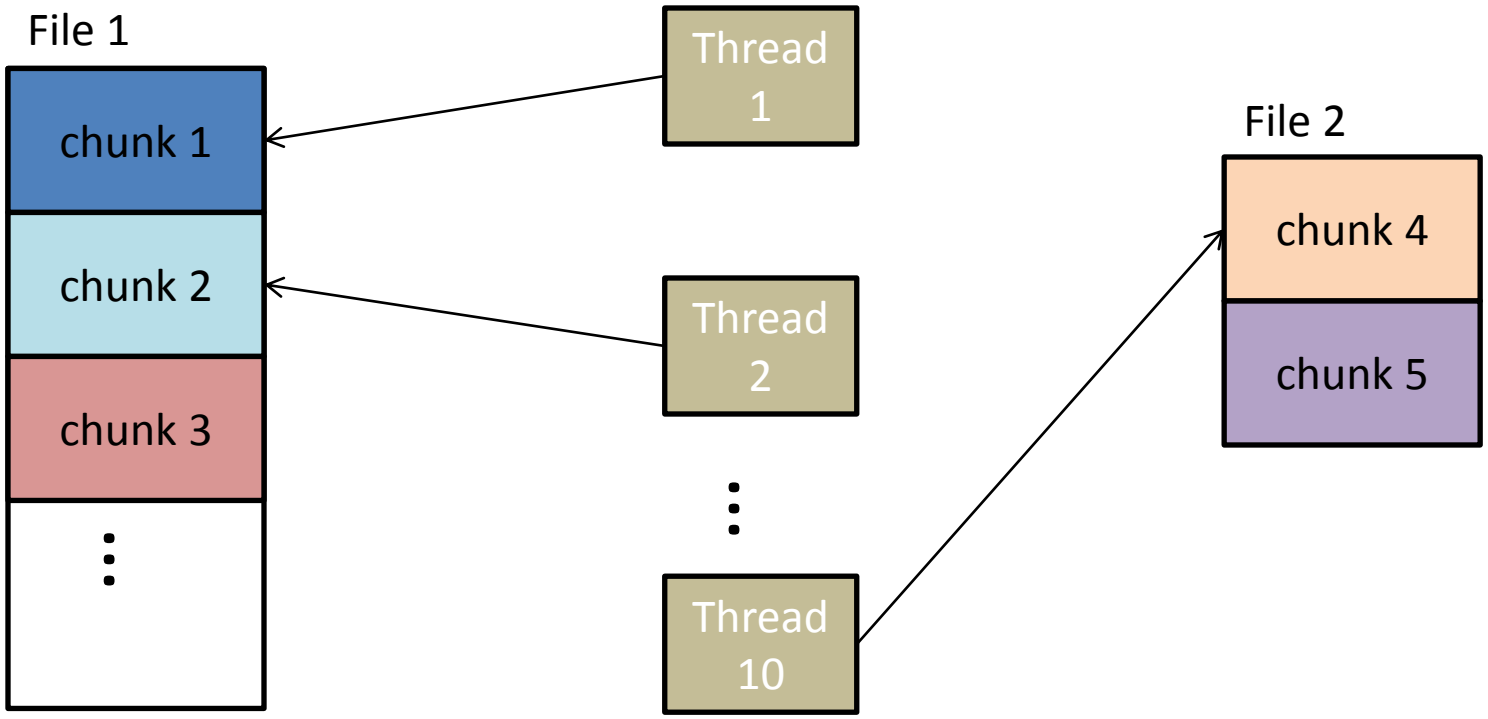
More Project 3

- Due Friday, Feb 17 at 11:59 pm
- If your shared space or SVN has issues, let me know ASAP!
- Please describe your changes in your write up!
  - You can use more than 1 page…if necessary.

More Project 3

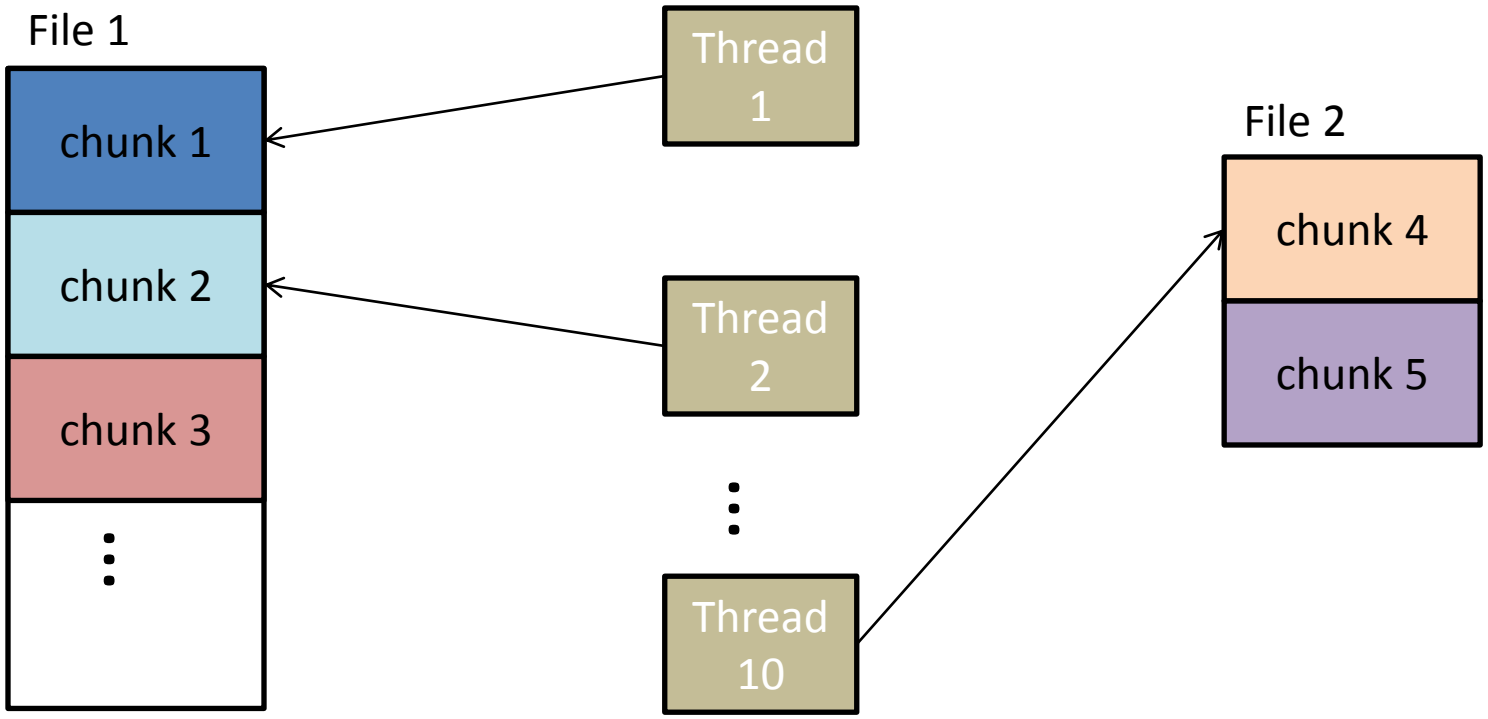
- Check your group membership with the following on attu:
  `group <username>`
  - This is your directory in /projects/instr/12wi/cse451/<dir>
  - E.g. membership to group cse451**x** maps to /projects/instr/12wi/cse451/**x**

More Project 3



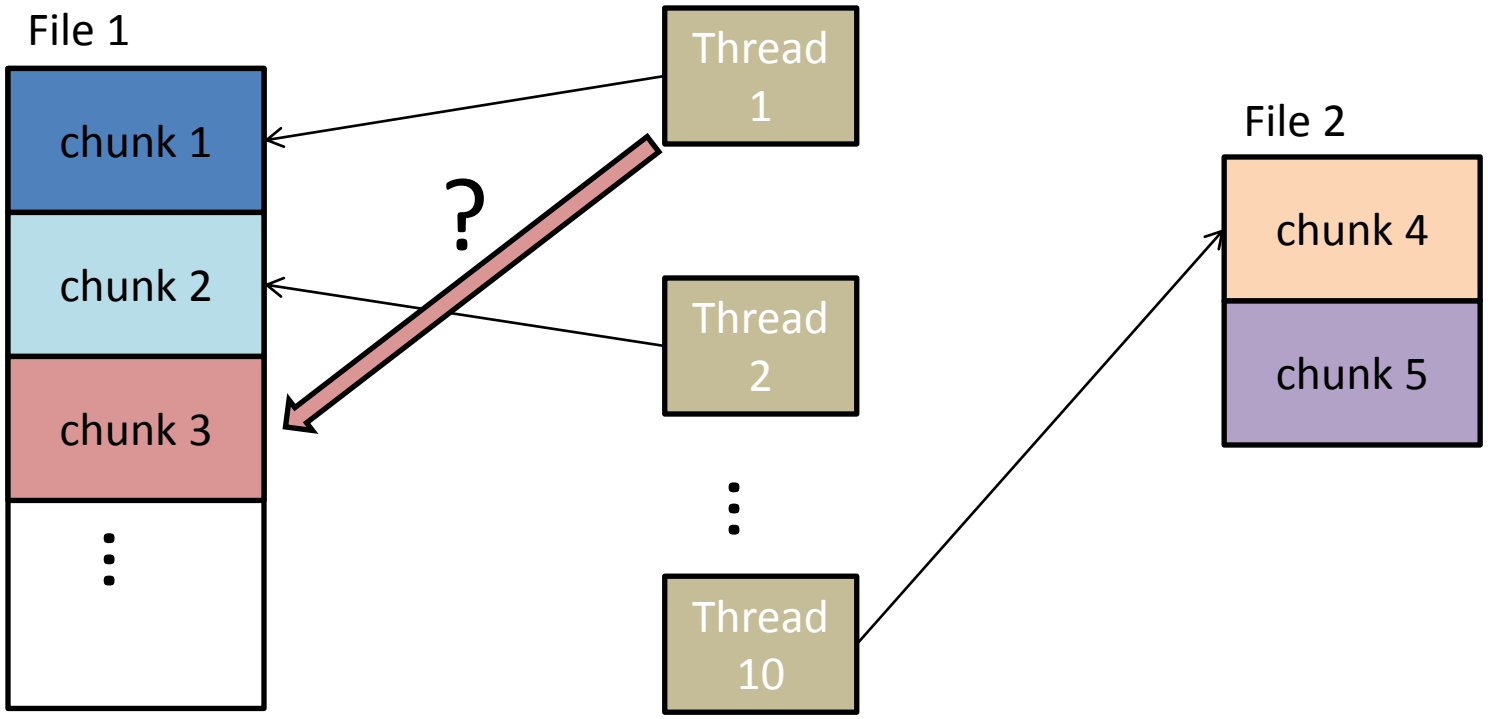
- Copy by multiple chunks, not necessarily multiple files.
  - Break files into chunks of work (use chunkSize == BufferSize)
  - Schedule chunks to threads (each thread copies one chunk at a time)

More Project 3



- Performance?
  - What to do when there is only one small file?
  - What to do when there are multiple large files?

More Project 3



- Task scheduling approaches?
  - Place chunks in a FIFO queue
  - Work stealing (Google it!)

More Project 3 (Hints)

- Asynchronous I/O needs to keep track of status of operations.
  - E.g. open file, read file, write file, close file
  - State tables may be helpful
- Remember that threads run single functions.
  - Threads terminate after function returns, so figure out how to keep threads alive (if necessary)
- Think carefully about what needs to be locked.
  - Reading and writing a file requires disk seeks.

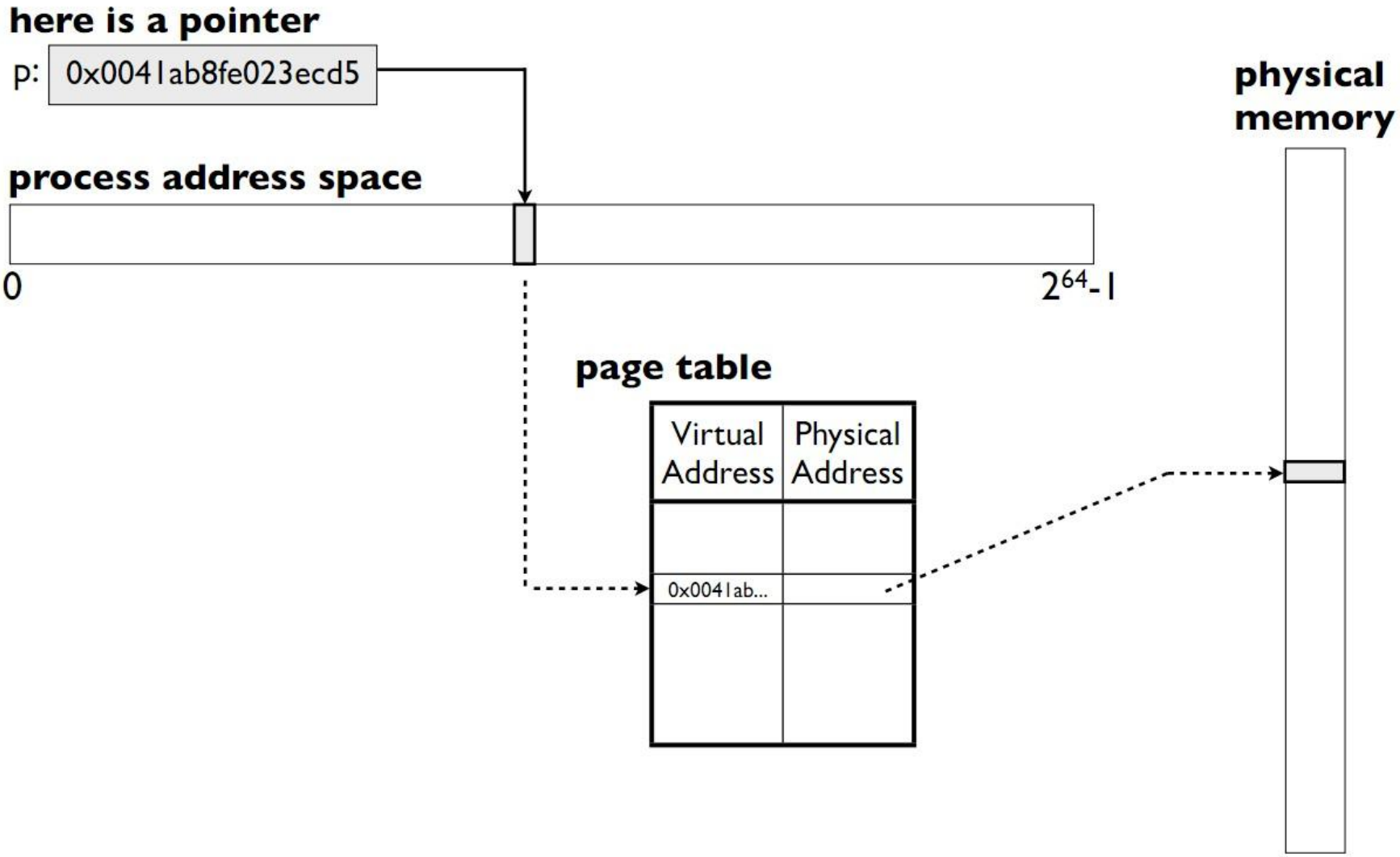
More Project 3 (Testing)

- Single small file
- Multiple small files
- Single large file
- Multiple large files
- Files in different directories
- Be creative!

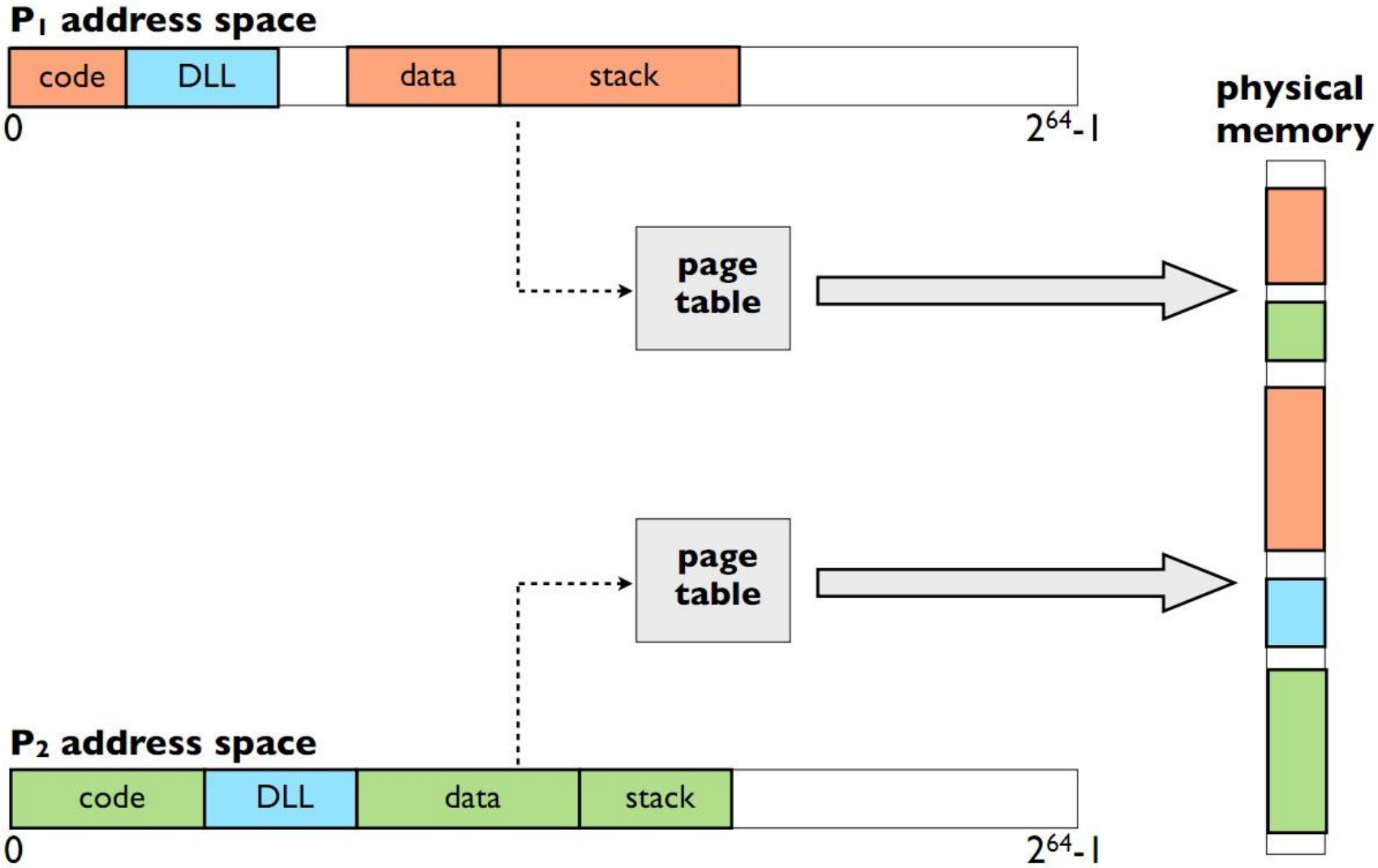
Virtual Memory

- Recap
  - Abstracts physical memory
  - Uses a page table and offset to find a real address.
  - Addresses seen in code are actually virtual memory addresses.

Virtual Memory



Virtual Memory



Virtual Memory

- Processes are protected from each other via virtual memory
- But, how is the kernel memory protected?

Virtual Memory

- Processes are protected from each other via virtual memory
- But, how is the kernel memory protected?
  - Kernel memory is part of the process memory!

Deadlocks

- What is it?

Deadlocks

- What is it?
  - An irreducible circular dependence.

http://library.thinkquest.org/08aug/01033/deadlock.jpg

Spot the deadlock!

```
foo(x, y) {
  lock( &x );
  lock( &y );
  …
  unlock( &y );
  unlock( &x );
  …
}
```

Spot the deadlock!

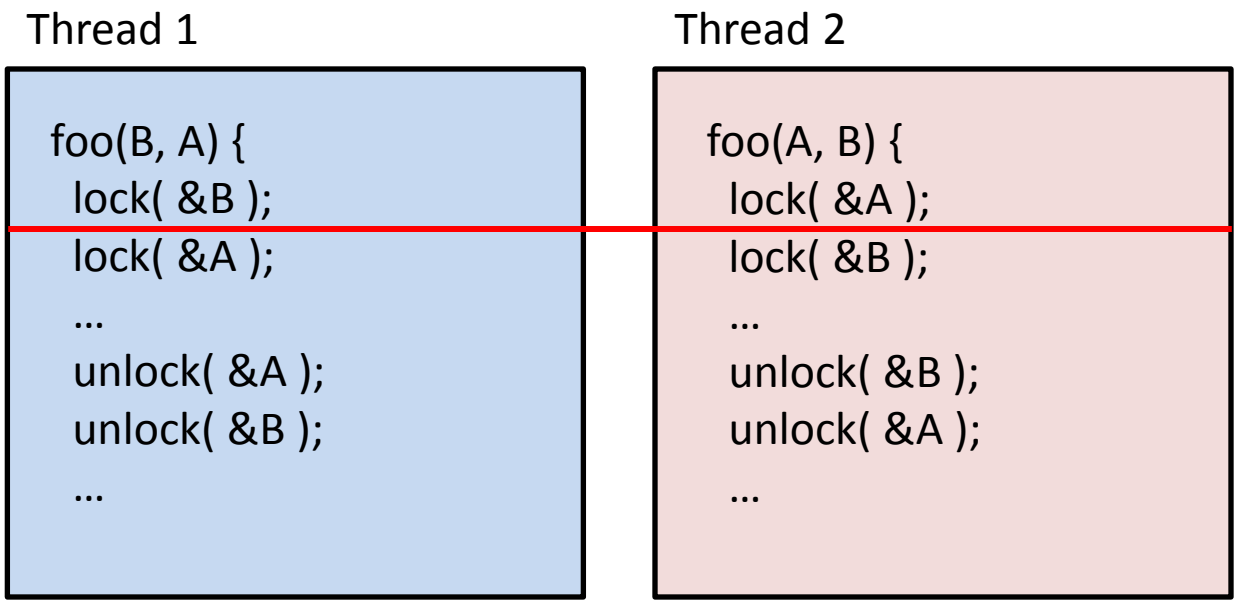
Thread 1

```
foo(B, A) {
  lock( &B );
  lock( &A );
  …
  unlock( &A );
  unlock( &B );
  …
```

Thread 2

```
foo(A, B) {
  lock( &A );
  lock( &B );
  …
  unlock( &B );
  unlock( &A );
  …
```

Spot the deadlock!



Midterm

- Anything up to Wednesday's lecture (Feb. 8th)
- Conceptual questions
  - Not much computation or math required
- Questions?