MANCHESTER 1824
The University of Manchester

COMP35112 Chip Multiprocessors

Synchronisation in Parallel Programming - Condition Variables

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Event Signalling

- **Sleeping or busy-waiting for the buffer to be non-full/non-empty is suboptimal**
  - Example with thread trying to deposit in a full buffer:

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- With the `usleep` set to an arbitrary time, may sleep for a much longer time than needed
- Without usleep, keep trying non-stop, monopolising the CPU and wasting cycles

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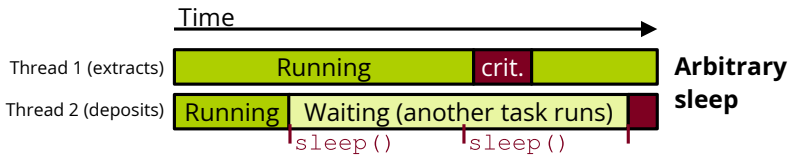

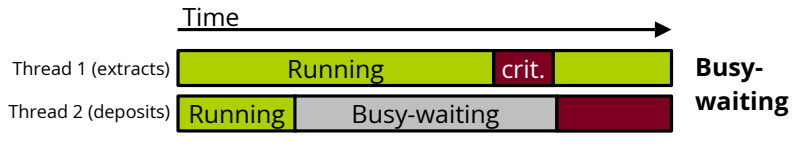

Condition Variables

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  1. **A lock becoming free** and
  2. **An arbitrary event** (e.g. buffer becoming non-full)
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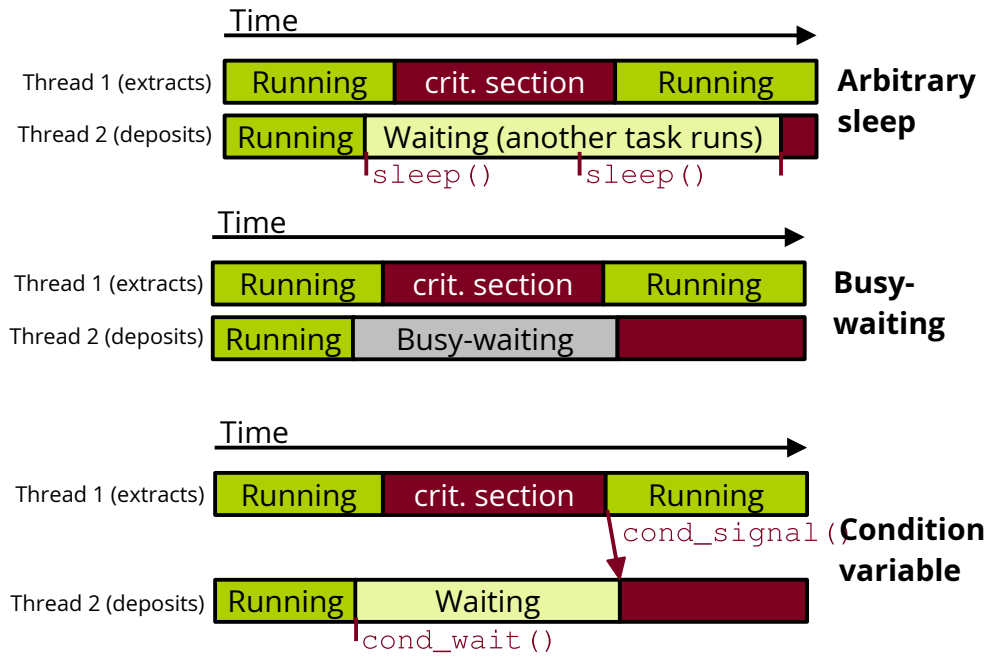
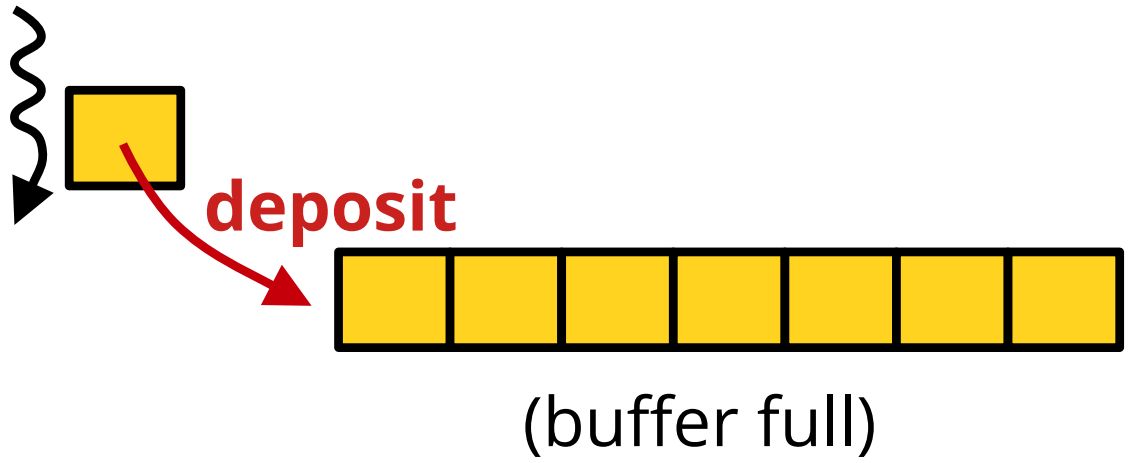


Applying Condition Variables to Our Example



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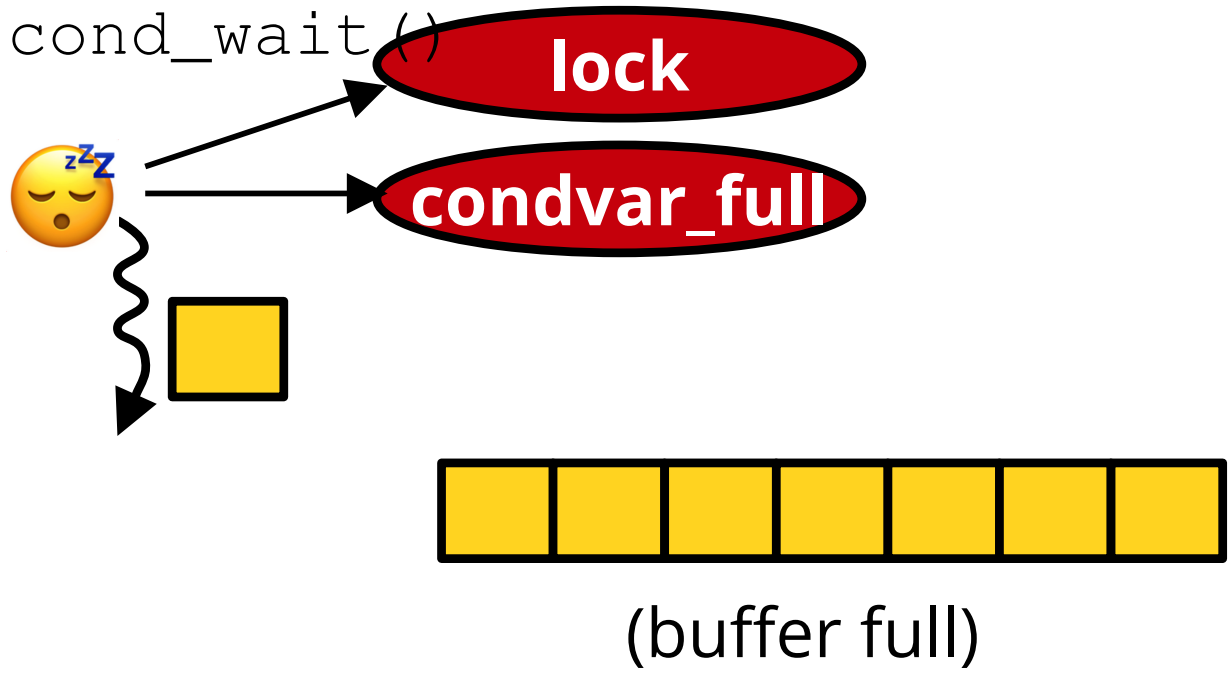

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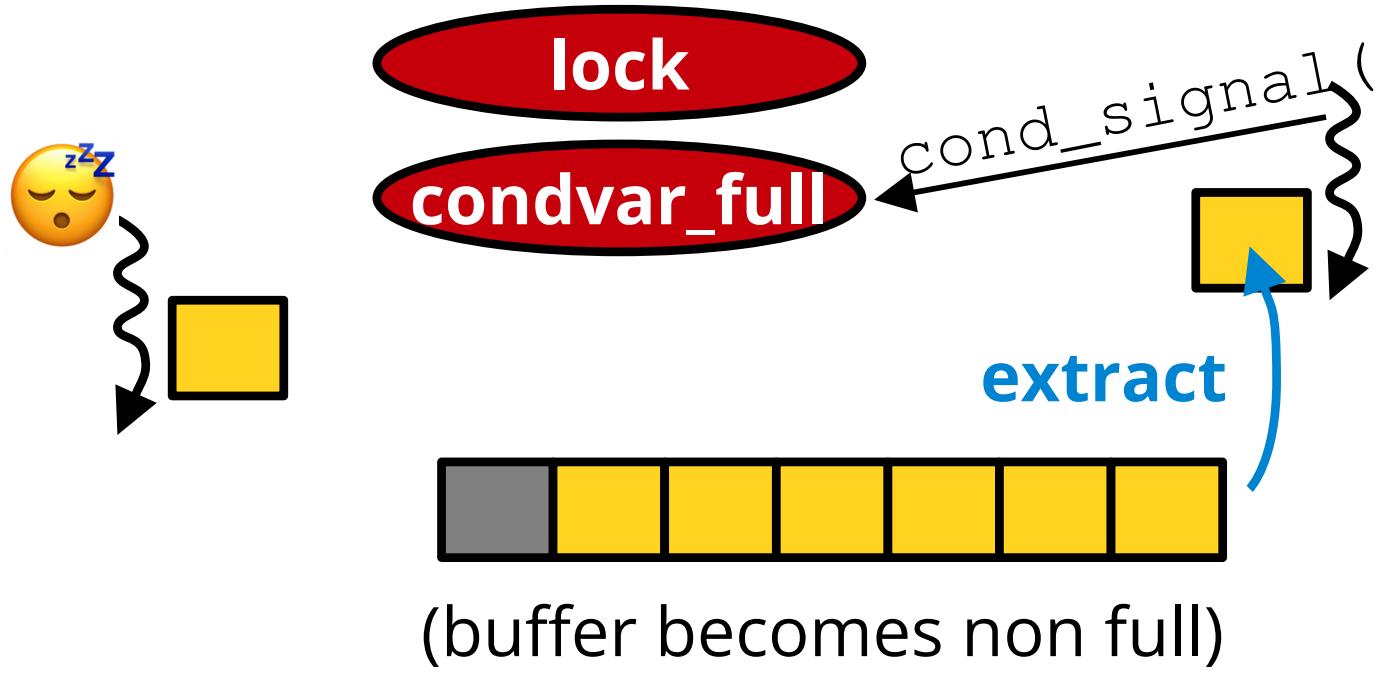

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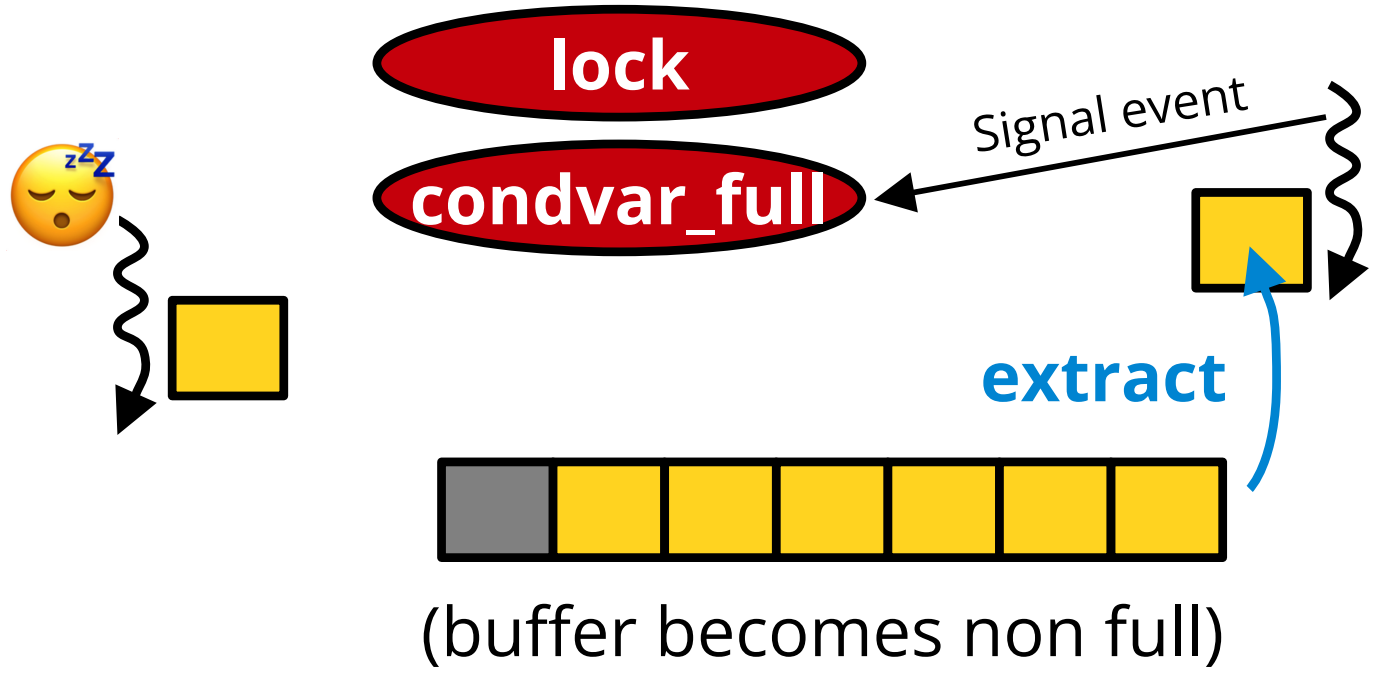

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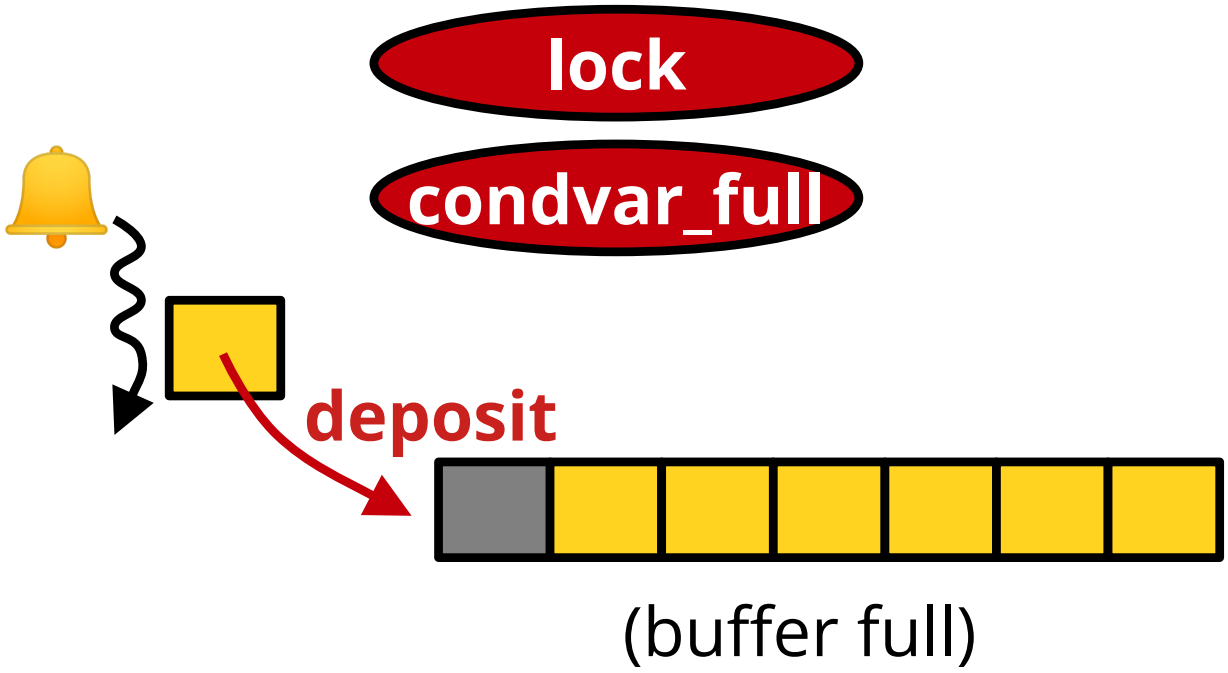

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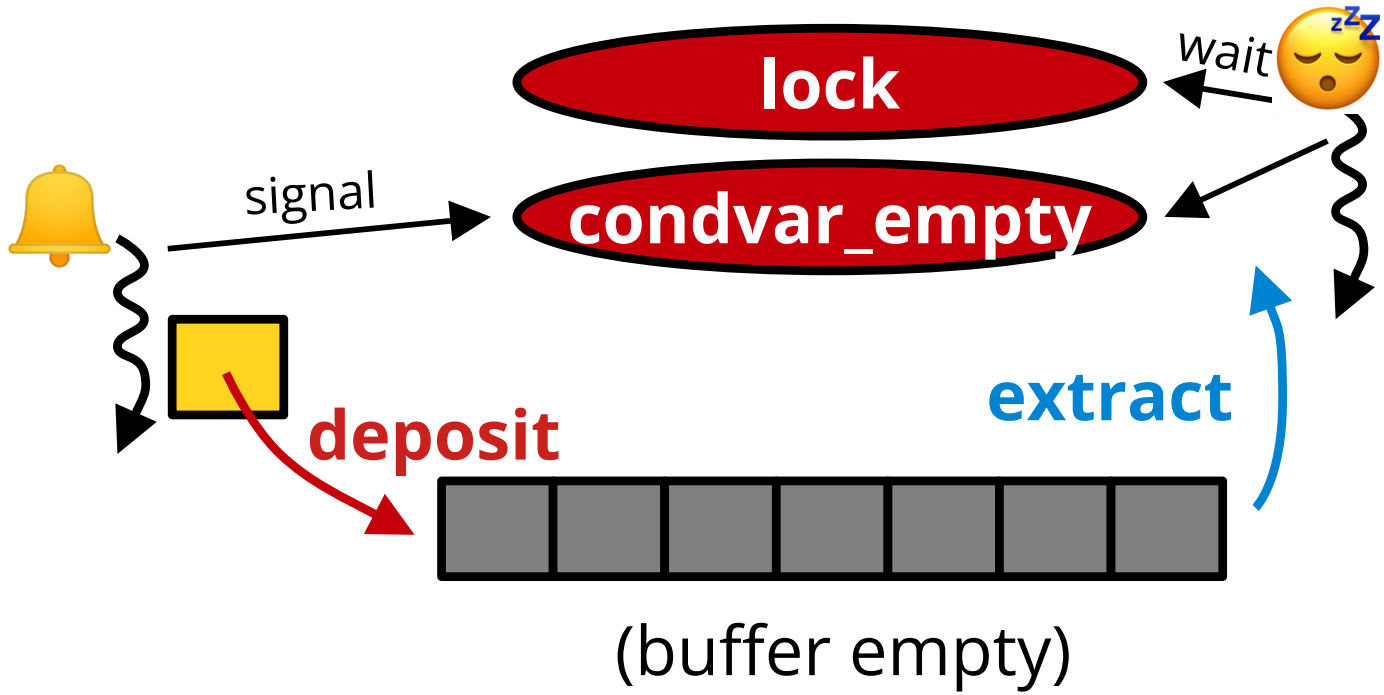

Condition Variables

```c
void deposit(bounded_buffer *b, int message) {
  pthread_mutex_lock(&b->lock);

  int full = (b->count == b->max_elements);
  while(full) {
    // wait on condfull to be signalled
    // when the buffer becomes non-full
    // and the lock is free
    pthread_cond_wait(&b->condfull, &b->lock);
    // we hold the lock here
    full = (b->count == b->max_elements);
  }

  b->buffer[b->in_index] = message;
  b->in_index = (b->in_index + 1) %
    b->max_elements;

  //signal condempty if buf. becomes non-empty
  if(b->count++ == 0)
    pthread_cond_signal(&b->condempty);

  pthread_mutex_unlock(&b->lock);
}
```

```c
int extract(bounded_buffer *b) {
  pthread_mutex_lock(&b->lock);

  int empty = !(b->count);
  while(empty) {
    // wait on condempty to be signalled when
    // the buffer becomes non-empty
    // and the lock is free
    pthread_cond_wait(&b->condempty, &b->lock);
    empty = !(b->count);
  }

  int message = b->buffer[b->out_index];
  b->out_index = (b->out_index + 1) %
    b->max_elements;

  //signal condfull if buf. becomes non-full
  if(b->count-- == b->max_elements)
    pthread_cond_signal(&b->condfull);

  pthread_mutex_unlock(&b->lock);
  return message;
}
```

08b-condition-variables/condvar.c

Summary

- **Condition variables**: useful mechanism for event signalling
  - Avoid delayed wakeup resulting from arbitrary sleeps
  - Avoid wasting CPU cycle due to busy waiting
- Next lecture: more about locks