Programming Assignment: Buffer Manager

- Implement a Buffer Manager that uses the 2Q replacement strategy
- `BufferManager` class with `fix(page_id, exclusive)` and `unfix(page_id, dirty)` methods
- Page id is split into segment (16 bits) and segment page id (48 bits)
- Segments must be written into files that have the segment id as name
- Must be thread-safe!
- Use `std::mutex` and `std::shared_mutex`
- Must be efficient:
  - Hold latches as short as possible
  - Don’t hold latches while doing I/O
Example of Buffer Manager with 2Q

\[
\text{fix}(1, \text{false})
\]

- FIFO queue
- LRU queue
Example of Buffer Manager with 2Q

fix(1, false)✓

1

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

fix(2, true)

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

\[ \text{fix(2, true)} \]

1 \( S \) 2 \( X \) FIFO queue

LRU queue
Example of Buffer Manager with 2Q

fix(3, false)

1
S

2
X

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

fix(3, false)✓

1 S 2 X 3 S FIFO queue

LRU queue
Example of Buffer Manager with 2Q

\[ \text{fix}(4, \text{false}) \rightarrow \text{buffer full} \]

1  S
2  X
3  S
FIFO queue

LRU queue
Example of Buffer Manager with 2Q

unfix(1, false)

1 2 3 FIFO queue
  S X S

LRU queue
Example of Buffer Manager with 2Q

unfix(1, false)✓

1 2 3

FIFO queue

✓

X

S

LRU queue
Example of Buffer Manager with 2Q

\[ \text{fix}(4, \text{false}) \]

\begin{center}
\begin{tabular}{c|c|c|c}
1 & 2 \_ & 3 \_ & FIFO queue \\
\end{tabular}
\end{center}

LRU queue
Example of Buffer Manager with 2Q

fix(4, false)

2 3  
X S  FIFO queue

LRU queue
Example of Buffer Manager with 2Q

fix(4, false)✓

2

✓

3

S

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

fix(4, false)

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

.fix(4, false)

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

\( \text{fix}(4, \text{false}) \checkmark \)

- FIFO queue
  - 2\( \times \)
  - 3\( s \)

- LRU queue
  - 4\( s \)
Example of Buffer Manager with 2Q

unfix(2, true)

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

unfix(2, true) ✓

[Diagram of Buffer Manager with FIFO and LRU queues, showing fix(2, true)]
Example of Buffer Manager with 2Q

\[ \text{unfix}(3, \text{false}) \]

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

\[\text{unfix}(3, \text{false})\checkmark\]

\[
\begin{array}{c|c}
2 & 3 \\
D & \text{FIFO queue} \\
\end{array}
\]

\[
\begin{array}{c|c}
4 & \text{LRU queue} \\
S & \\
\end{array}
\]
Example of Buffer Manager with 2Q

\[
\text{fix}(3, \text{false})
\]

2 3 \hspace{1cm} \text{FIFO queue}

4 \hspace{1cm} \text{LRU queue}
Example of Buffer Manager with 2Q

fix(3, false)

FIFO queue

LRU queue
Example of Buffer Manager with 2Q

\[ \text{fix}(3, \text{false}) \checkmark \]

- FIFO queue
  - 2
  - D

- LRU queue
  - 4
  - 3
  - S
  - S
Example of Buffer Manager with 2Q

fix(4, false)

2 D FIFO queue

4 S 3 S LRU queue
Example of Buffer Manager with 2Q

\[ \text{fix}(4, \text{false}) \checkmark \]

<table>
<thead>
<tr>
<th>FIFO queue</th>
<th>LRU queue</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 D</td>
<td>3 S 4 S</td>
</tr>
</tbody>
</table>

Moritz Sichert (TUM) | Database Systems on Modern CPU Architectures