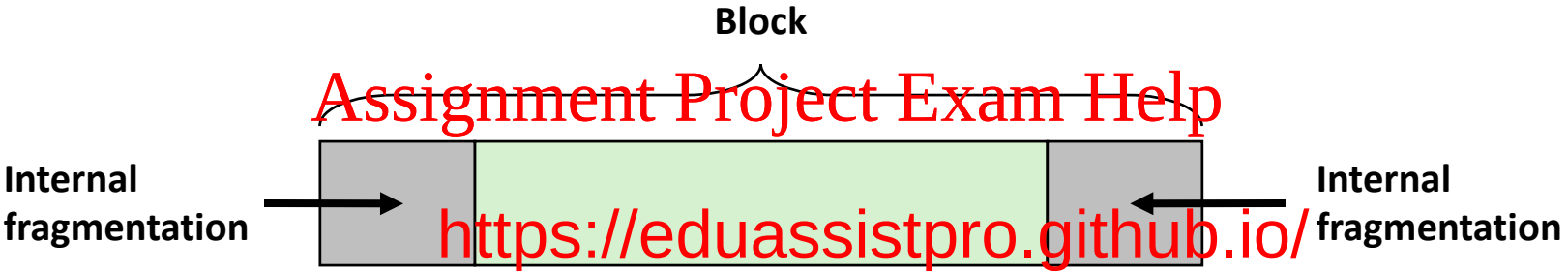
# Fragmentation

- **Poor memory utilization caused by *fragmentation***
  - ***internal*** fragmentation
  - ***external*** fragmentation

# Internal Fragmentation

- **For a given block, *internal fragmentation* occurs if payload is smaller than block size**



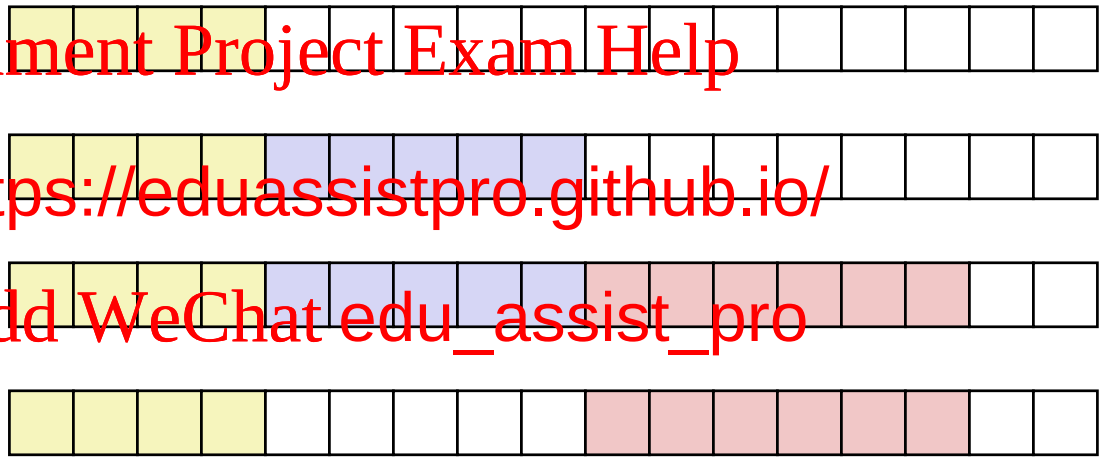



- **Caused by**
  - Overhead of maintaining heap data structures
  - Padding for alignment purposes
  - Explicit policy decisions
    (e.g., to return a big block to satisfy a small request)
- **Depends only on the pattern of *previous* requests**
  - Thus, easy to measure

# External Fragmentation

- Occurs when there is enough aggregate heap memory, but no single free block is large enough

```
p1 = malloc(4)
p2 = malloc(5)
p3 = malloc(6)
free(p2)
p4 = malloc(6)
```





*Oops! (what would happen now?)*

- Depends on the pattern of future requests
  - Thus, difficult to measure