Replacement Policy

- Deals with the selection of a page in main memory to be replaced when a new page must be brought in.
  - Objective is that the page that is removed be the page least likely to be referenced in the near future.
- The more elaborate the replacement policy the greater the hardware and software overhead to implement it.

Basic Algorithms

- Algorithms used for the selection of a page to replace:
  - Optimal
  - Least recently used (LRU)
  - First-in-first-out (FIFO)
  - Clock
Least Recently Used (LRU)

- Replaces the page that has not been referenced for the longest time
- By the principle of locality, this should be the page least likely to be referenced in the near future
- Difficult to implement
  - One approach is to tag each page with the time of last reference
  - This requires a great deal of overhead
**First-in-First-out (FIFO)**

- Treats page frames allocated to a process as a circular buffer
- Pages are removed in round-robin style
  - Simple replacement policy to implement
- Page that has been in memory the longest is replaced

**Clock Policy**

- Requires the association of an additional bit with each frame
  - Referred to as the *use* bit
- When a page is first loaded in memory or referenced, the use bit is set to 1
- The set of frames is considered to be a circular buffer
- Any frame with a use bit of 1 is passed over by the algorithm
- Page frames visualized as laid out in a circle
Improves paging performance and allows the use of a simpler page replacement policy.

A replaced page is not lost, but rather assigned to one of two lists:

- **Free page list**: List of page frames available for reading in pages.
- **Modified page list**: Pages are written out in clusters.
Replacement Policy and Cache Size

- With large caches, replacement of pages can have a performance impact
  - If the page frame selected for replacement is in the cache, that cache block is lost as well as the page that it holds
  - In systems using page buffering, cache performance can be improved with a policy for page placement in the page buffer
  - Most operating systems place pages by selecting an arbitrary page frame from the page buffer

Figure 8.17 Working Set of Process as Defined by Window Size
Page Fault Frequency (PFF)

- Requires a use bit to be associated with each page in memory
- Bit is set to 1 when that page is accessed
- When a page fault occurs, the OS notes the virtual time since the last page fault for that process
- Does not perform well during the transient periods when there is a shift to a new locality