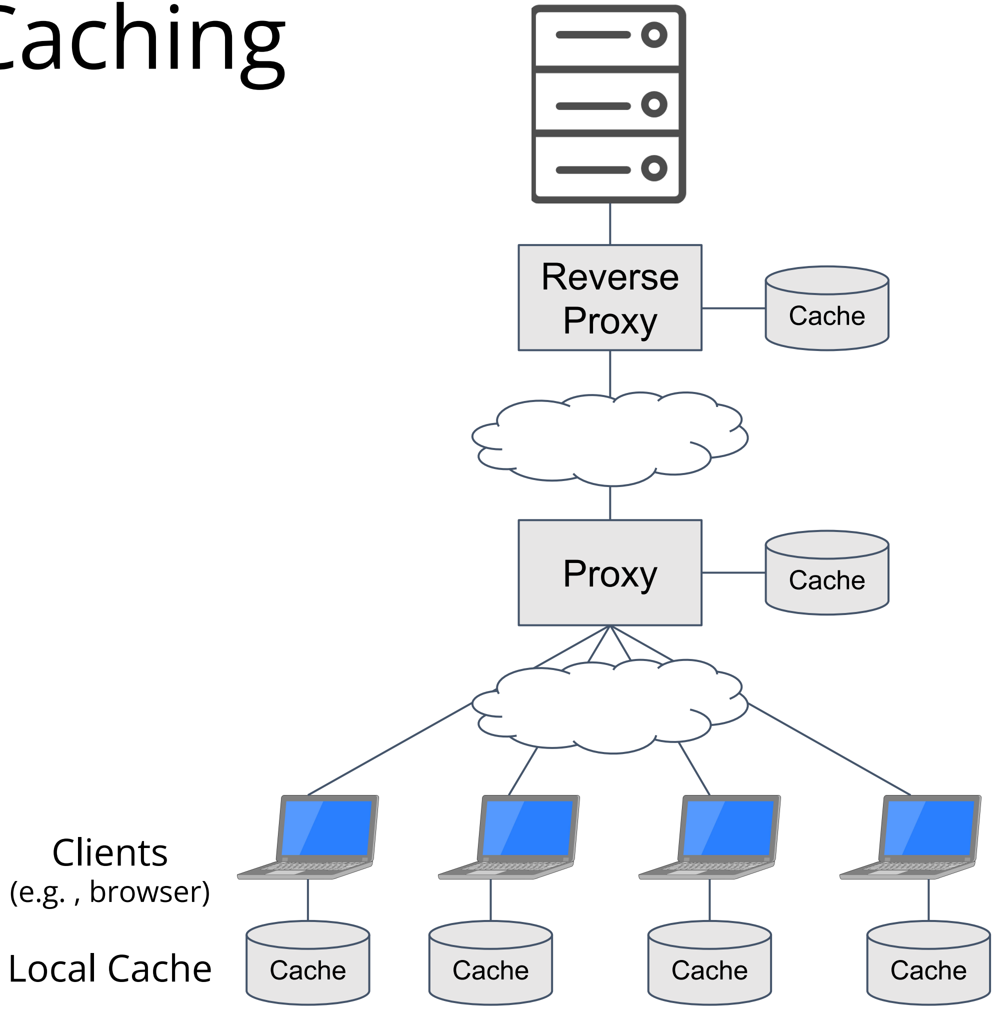
COS 316 Precept #6: *Cache Eviction (Replacement)*

git clone https://github.com/cos316/precepts

Navigate to *precept7* directory

Overview of Web Caching

- Basic idea:
  - Bring objects “closer” to clients
- Three primary features:
  - Reduce network bandwidth
  - Reduce client-perceived delays
  - Reduce load on server
- Cache Replacement Strategy
  - When a cache becomes full, which object should be **evicted/replaced**?



Cache Eviction Algorithms

- High level
    - Client requests a new object
    - If object is in cache, return the object
    - If object is not in cache:
        - Get object from server/provider and return the object
        - Cache full:
            - Identify an object in cache to evict
            - Evict the object in the cache
            - Replace with new object (insert new object)
        - Cache not full:
            - Admit the new object to the cache

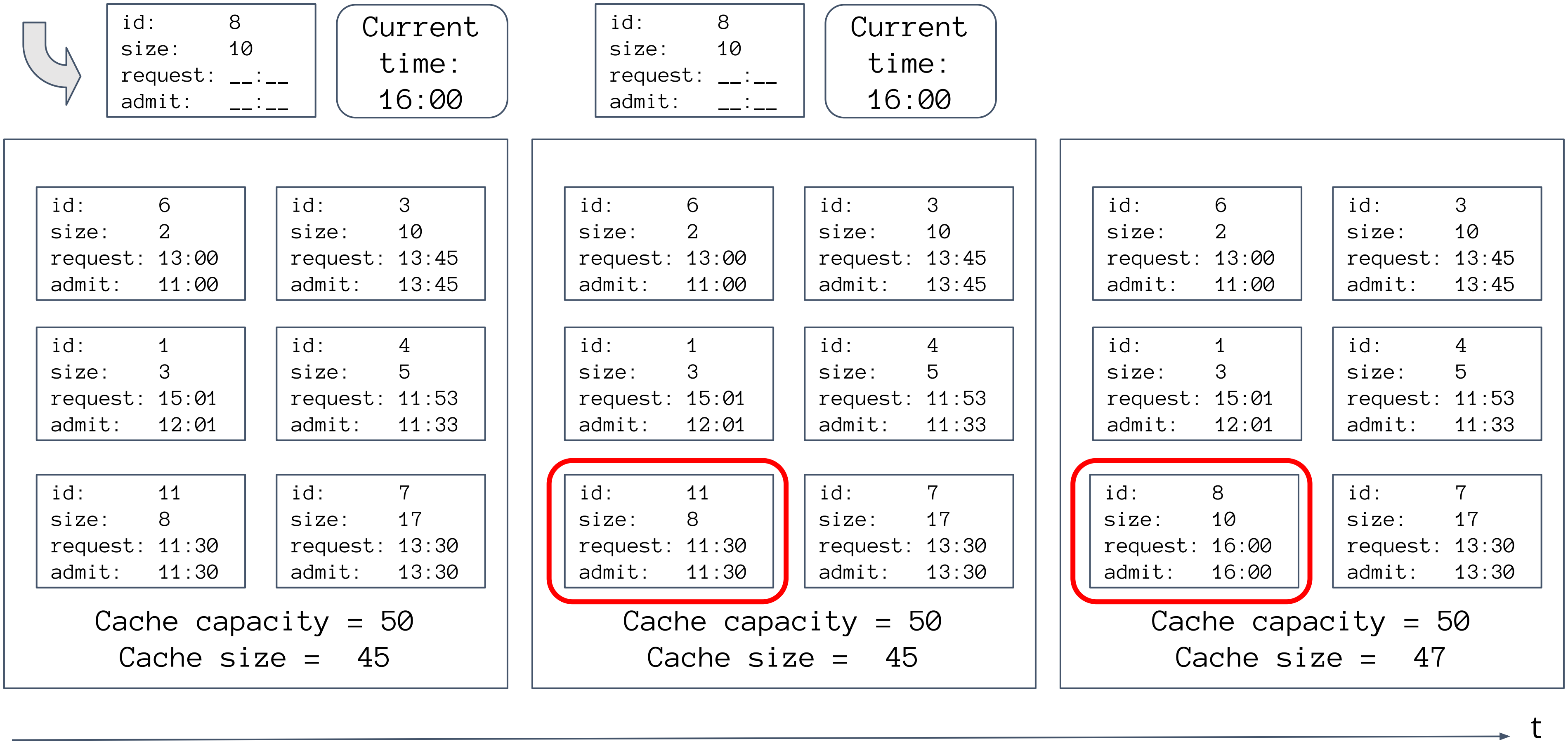
Cache Eviction Algorithms

- Least recently used (LRU): Evict the object from the cache whose last request is the oldest

- First-in, First-out (FIFO): Evict the object from the cache that has been in the cache the longest

- Many others…

LRU



id: 8
size: 10
request: __:__
admit: __:__

Current time: 16:00

id: 6
size: 2
request: 13:00
admit: 11:00

id: 3
size: 10
request: 13:45
admit: 13:45

id: 1
size: 3
request: 15:01
admit: 12:01

id: 4
size: 5
request: 11:53
admit: 11:33

id: 11
size: 8
request: 11:30
admit: 11:30

id: 7
size: 17
request: 13:30
admit: 13:30

Cache capacity = 50
Cache size = 45

id: 8
size: 10
request: __:__
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Current time: 16:00

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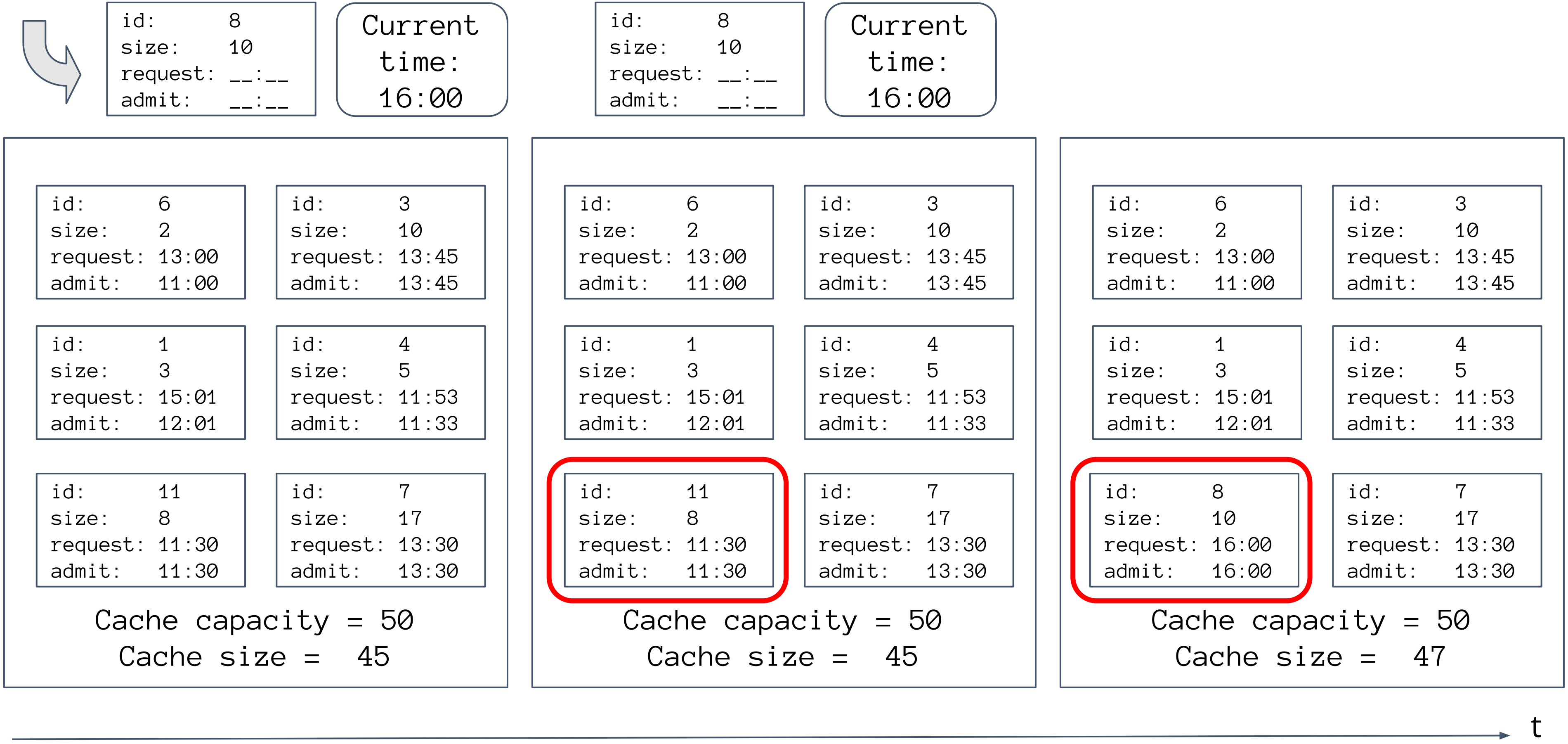
admit: 11:33

id: 8
size: 10
request: 16:00
admit: 16:00

id: 7
size: 17
request: 13:30
admit: 13:30

Cache capacity = 50
Cache size = 47

LRU



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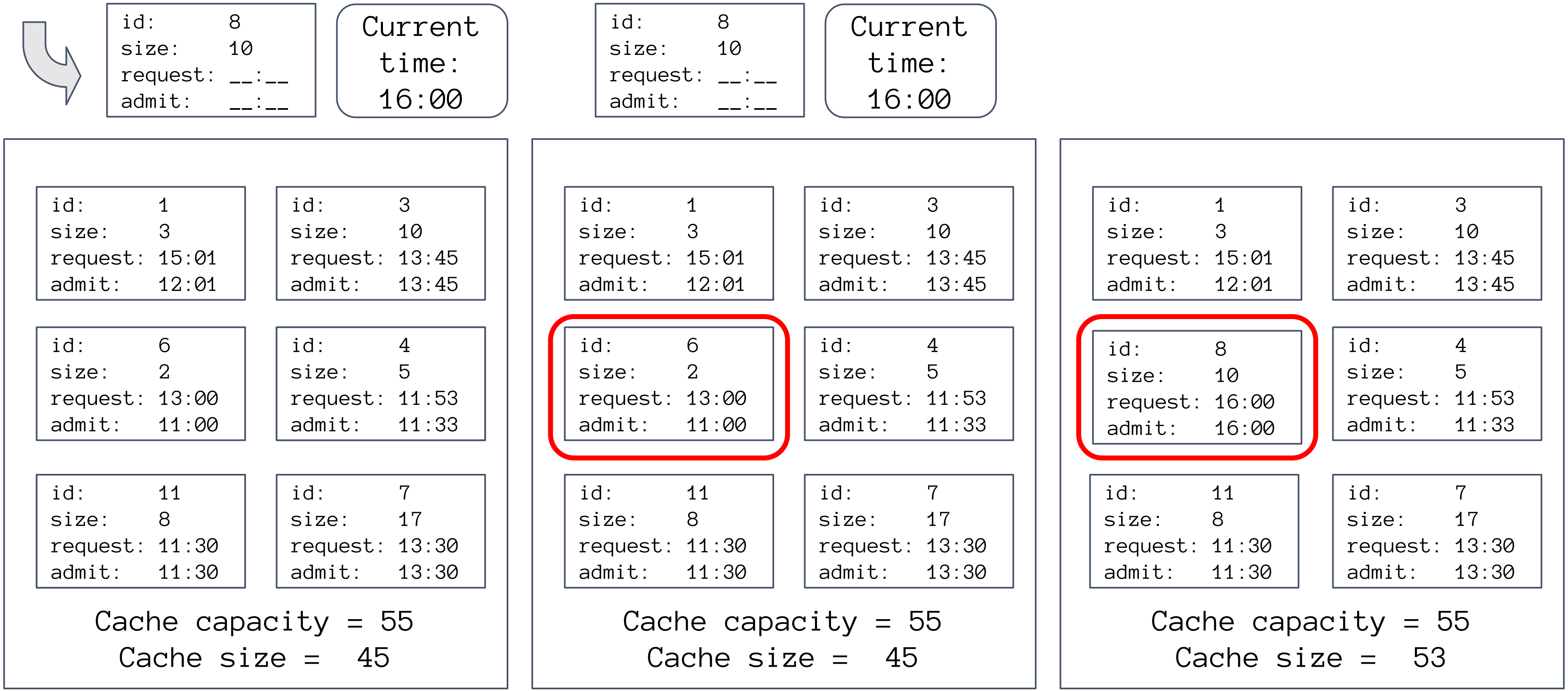
FIFO



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admit: 11:33

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admit: 11:30

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size: 17
request: 13:30
admit: 13:30

Cache capacity = 55
Cache size = 45

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size: 10
request: __:__
admit: __:__

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size: 3
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admit: 12:01

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Experiments

- cd <Precepts repo> #https://github.com/cos316/Precepts
- Make sure you have the main branch checked out
- git pull
- cd precept7/webcachesim-master
- make

Trace File Form

- Request traces must be given in a space-separated format with three columns
- time - long long int
- id - long long int, used to uniquely identify objects
- size should be a long long int, object's size in bytes

- Example

```
time    id  size

1       1   120

2       2   64

3       1   120

4       3   14

4       1   120
```

- See `test.tr`

Using the Simulator*

```
> ./webcachesim test.tr LRU 1000

LRU:1000 bytes, 10492 reqs, 8495 hits, 81 hits/reqs(%)


> ./webcachesim test.tr FIFO 1000

FIFO:1000 bytes, 10492 reqs, 8206 hits, 78 hits/reqs(%)
```

* Derived from https://github.com/dasebe/webcachesim

Experiments

- Trace data from a production CDN
    - cd1-10M.tr *
    - 10 million requests / Object sizes from 10 byte to .7GB
- LIFO and FIFO
- Vary cache sizes

- 16000000
- 32000000
- 64000000
- 128000000
- 256000000

- 512000000
- 1024000000
- 2048000000
- 4096000000

- Create a Google Sheet
- Three columns
- SIZE LRU FIFO
- Copy results accordingly
- Select three columns to create

  line chart

* Practical Bounds on Optimal Caching with Variable Object Sizes Daniel S. Berger, Nathan Beckmann, Mor Harchol-Balter. ACM SIGMETRICS, June 2018

Experiments

- LRU and FIFO
- Vary cache sizes
  - 80
  - 160
  - 320
  - 640
  - 1280
  - 2560
  - 5120

- Create a Google Sheet
- Three columns
- SIZE LRU FIFO
- Copy results accordingly
- Select three columns to create line chart