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Facultad de Ciencias Exactas y Naturales - UBA

Trabajo Práctico 2

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Grupo 4

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1. Introducción

El Buffer Manager es uno de los componentes más importantes dentro de un motor de BD. Su principal función es administrar un espacio de memoria de la BD, utilizado como una especie de memoria caché. El objetivo es que las diferentes aplicaciones que usan la BD y requieren páginas de disco, puedan recuperar la página de este espacio de memoria y accedan lo menos posible al disco. El espacio de memoria administrado por el Buffer Manager puede ser organizado de diferentes formas y la estrategia para decidir cuál página reemplazar cuando ya no queda más espacio también puede variar.

Este trabajo se encarga de implementar los algoritmos Touch Count, LRU y MRU, y compararemos su comportamiento a partir de posibles situaciones.

2. LRU

2.1. Descripción

El algoritmo Least Recently Used (LRU) descarta primero los elementos menos usados recientemente. El algoritmo lleva el seguimiento de lo que se va usando, lo que resulta caro si se quiere hacer con precisión. La implementación de esta técnica requiere llevar la cuenta de la edad de cada elemento de caché y buscar el menos usado en base a ella. En una implementación como esa, cada vez que se usa un elemento, la edad de todos las demás elementos cambia.

2.2. Implementación

2.2.1. LRU Buffer Frame

```
package ubadb.core.components.bufferManager.bufferPool.replacementStrategies.lru;

import java.util.Date;

import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.exceptions.BufferFrameException;

public class LRUBufferFrame extends BufferFrame
{
                private Date referencedDate;

        public LRUBufferFrame(Page page) {
                super(page);
                referencedDate = new Date();
        }

        public Date getReferencedDate()
        {
                return referencedDate;
        }

        public void pin(){
                super.pin();
                referencedDate = new Date();
        }

        public void unpin() throws BufferFrameException{
                super.unpin();
                referencedDate = new Date();
        }


}
```

2.2.2. LRU Buffer Frame Strategy

```
package ubadb.core.components.bufferManager.bufferPool.replacementStrategies.lru;

import java.util.Collection;
```

```
import java.util.Date;

import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.components.bufferManager.bufferPool.
        replacementStrategies.PageReplacementStrategy;
import ubadb.core.exceptions.PageReplacementStrategyException;

public class LRUReplacementStrategy implements PageReplacementStrategy
{
    public BufferFrame findVictim(Collection<BufferFrame> bufferFrames) throws
       PageReplacementStrategyException
    {
        LRUBufferFrame victim = null;
                Date oldestReplaceablePageDate = null;

                for(BufferFrame bufferFrame : bufferFrames)
                {
                        LRUBufferFrame lruBufferFrame = (LRUBufferFrame)
                           bufferFrame; //safe cast as we know all frames are
                           of this type
                        if(lruBufferFrame.canBeReplaced() &&
                           (oldestReplaceablePageDate==null ||
                                lruBufferFrame.getReferencedDate().
                                        before(oldestReplaceablePageDate)))
                        {
                                victim = lruBufferFrame;
                                oldestReplaceablePageDate =
                                   lruBufferFrame.getReferencedDate();
                        }
                }

                if(victim == null)
                        throw new PageReplacementStrategyException("No page can
                           be removed from pool");
                else
                        return victim;
    }

    public BufferFrame createNewFrame(Page page)
    {
        return new LRUBufferFrame(page);
    }

    public String toString() {
        return "LRU Replacement Strategy";
    }
}
```

3. MRU

3.1. Descripción

MRU descarta primero -al contrario de LRU- los elementos más usados recientemente. Los algoritmos MRU son los más útiles en situaciones en las que cuanto más antiguo es un elemento, más probable es que se acceda a él.

3.2. Implementación

3.2.1. MRU Buffer Frame

```
package ubadb.core.components.bufferManager.bufferPool.replacementStrategies.mru;
import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.exceptions.BufferFrameException;

import java.util.Date;

public class MRUBufferFrame extends BufferFrame
{
                private Date referencedDate;

        public MRUBufferFrame(Page page) {
                super(page);
                referencedDate = new Date();
        }

        public Date getReferencedDate()
        {
                return referencedDate;
        }

        public void pin(){
                super.pin();
                referencedDate = new Date();
        }

        public void unpin() throws BufferFrameException{
                super.unpin();
                referencedDate = new Date();
        }

}
```

3.2.2. MRU Buffer Frame Strategy

```
package ubadb.core.components.bufferManager.bufferPool.replacementStrategies.mru;

import java.util.Collection;
import java.util.Date;

import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.components.bufferManager.bufferPool.
        replacementStrategies.PageReplacementStrategy;
import ubadb.core.exceptions.PageReplacementStrategyException;

public class MRUReplacementStrategy implements PageReplacementStrategy
{
    public BufferFrame findVictim(Collection<BufferFrame> bufferFrames) throws
       PageReplacementStrategyException
    {
        MRUBufferFrame victim = null;
                Date newestReplaceablePageDate = null;
```

```
                for(BufferFrame bufferFrame : bufferFrames)
                {
                        MRUBufferFrame mruBufferFrame = (MRUBufferFrame)
                           bufferFrame; //safe cast as we know all frames are
                           of this type
                        if(mruBufferFrame.canBeReplaced() &&
                           (newestReplaceablePageDate==null
                                || mruBufferFrame.getReferencedDate().
                                        after(newestReplaceablePageDate)))
                        {
                                victim = mruBufferFrame;
                                newestReplaceablePageDate =
                                   mruBufferFrame.getReferencedDate();
                        }
                }

                if(victim == null)
                        throw new PageReplacementStrategyException("No page can
                           be removed from pool");
                else
                        return victim;
    }

    public BufferFrame createNewFrame(Page page)
    {
        return new MRUBufferFrame(page);
    }

    public String toString() {
            return "MRU Replacement Strategy";
    }
}
```

4. Touch Count

4.1. Motivación

However, there is a cache killer called the full-table scan where each and every table block is placed into the buffer. If the buffer cache is 500 blocks and the table contains 600 blocks, all the popular blocks would be replaced with this full-table scanned table's blocks. This is extremely disruptive to consistent database performance because it forces excessive computer system usage and basically destroys a well-developed cache.

While this might seem like all our buffer cache problems are solved, think again. How about a large index range scan? Picture hundreds of index leaf blocks flowing into the buffer cache. The modified LRU algorithm only addresses full-table scan issues, not index block issues.

4.2. Descripción

El algoritmo que utiliza Oracle para manejar las páginas del Buffer Pool es conocido como "Touch Count" y es una variante del popular LRU.

4.2.1. Hot N Cold

Que significa
Como se mantiene balanceado
Como se crea

4.2.2. Incremento Touch Count

Lo de los 3 segundos
pin y unpin

4.2.3. Hot N Cold Movement

Si es mayor a 2
Mantener balanceo

4.3. Implementación

4.3.1. Touch Count Buffer Frame

```
package
    ubadb.core.components.bufferManager.bufferPool.replacementStrategies.touchcount;

import java.util.Date;

import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.exceptions.BufferFrameException;

public class TouchBufferFrame extends BufferFrame implements
    Comparable<TouchBufferFrame>{

                public Integer count;
                public Date lastTouch;

        public TouchBufferFrame(Page page) {
                super(page);
                count = 0;
                lastTouch = new Date();
        }

        public void pin(){
                super.pin();
                increaseCount();
        }
```

```
        public void unpin() throws BufferFrameException{
                super.unpin();
                increaseCount();
        }

        public void increaseCount(){
                Date now = new Date();

                @SuppressWarnings("unused")
                        long difference = (long) ((now.getTime() -
                           lastTouch.getTime())/1000);

                if((now.getTime() - lastTouch.getTime())/1000 >= 3){
                        count++;
                        lastTouch = new Date();
                }
        }

                @Override
                public int compareTo(TouchBufferFrame arg0) {
                        return count.compareTo(((TouchBufferFrame)arg0).count);
                }

}
```

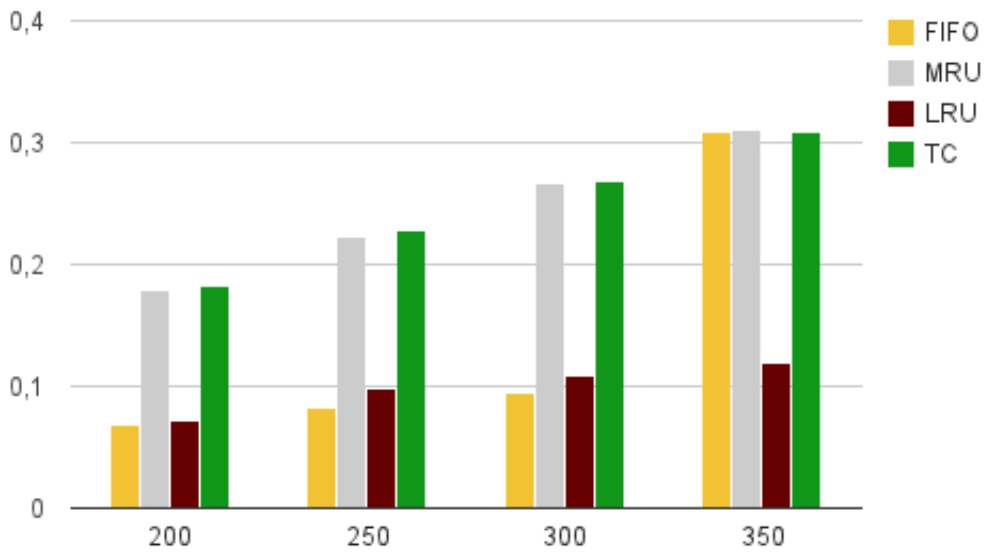
4.3.2. Touch Count Buffer Frame Strategy

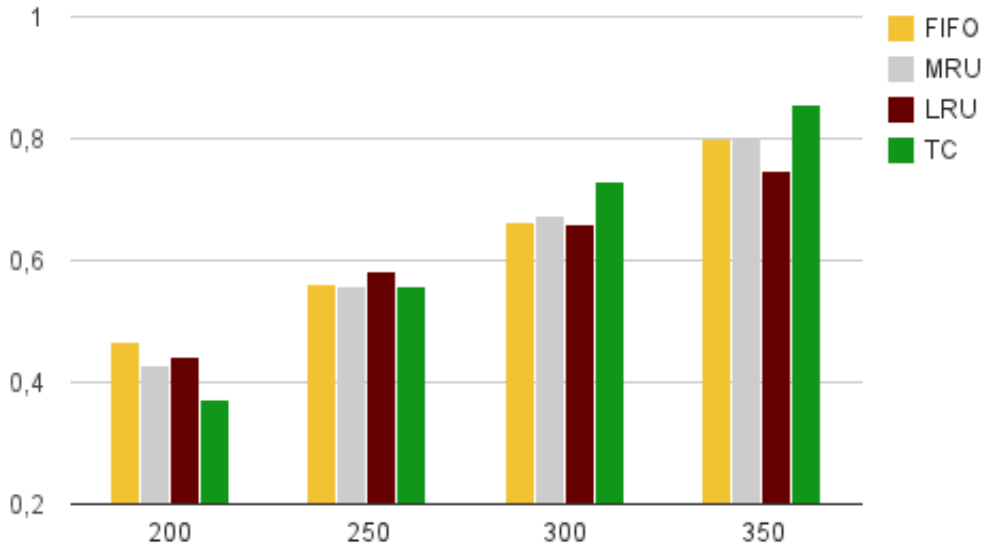
```
package
    ubadb.core.components.bufferManager.bufferPool.replacementStrategies.touchcount;

import java.util.Collection;
import java.util.LinkedList;

import ubadb.core.common.Page;
import ubadb.core.components.bufferManager.bufferPool.BufferFrame;
import ubadb.core.components.bufferManager.bufferPool.
        replacementStrategies.PageReplacementStrategy;
import ubadb.core.exceptions.PageReplacementStrategyException;

public class TouchCountReplacementStrategy implements PageReplacementStrategy {

                private LinkedList<TouchBufferFrame> cold;
                private LinkedList<TouchBufferFrame> hot;

        public BufferFrame findVictim(Collection<BufferFrame> bufferFrames)
           throws PageReplacementStrategyException {

                        hotNColdMovement();

                        TouchBufferFrame victim = firstColdFrame();
                return victim;
        }

        private TouchBufferFrame firstColdFrame() throws
           PageReplacementStrategyException{
                for (TouchBufferFrame bufferFrame : cold) {
                        if (bufferFrame.canBeReplaced()){
                                cold.remove(bufferFrame);

                                if(Math.abs(cold.size() - hot.size())>0){
                                        cold.addLast(hot.removeLast());
                                }
```

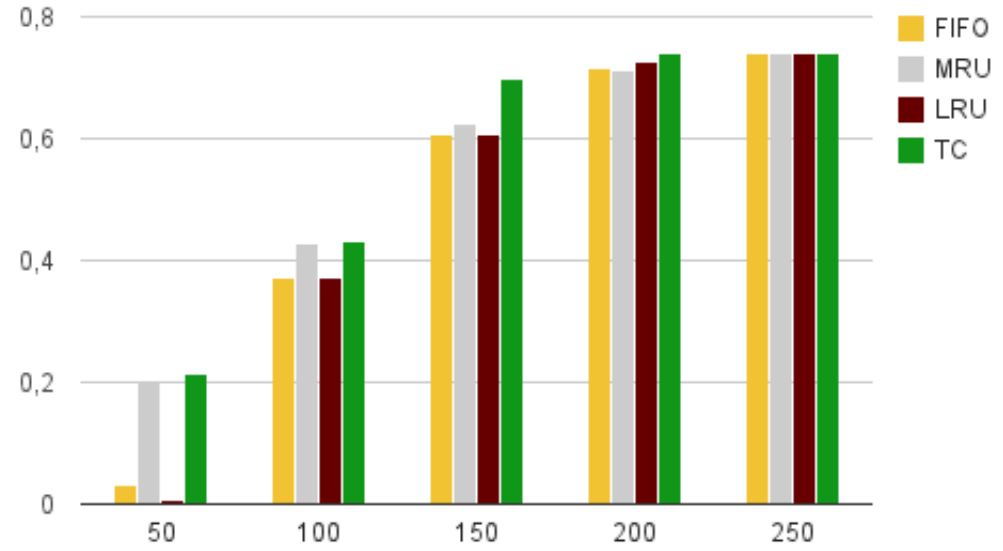
```
                        return bufferFrame;
                }
        }
        throw new PageReplacementStrategyException("No hay Cold Buffer
           reemplazable");
    }

    private void hotNColdMovement(){
        for(TouchBufferFrame bufferFrame : cold){
                if(bufferFrame.count > 2 ){
                        bufferFrame.count = 0;
                        hot.addFirst(bufferFrame);
                        cold.remove(bufferFrame);
                        cold.addLast(hot.removeLast());
                }
        }

    }


    public BufferFrame createNewFrame(Page page) {
        TouchBufferFrame bufferFrame = new TouchBufferFrame(page);

        cold.addFirst(bufferFrame);

        if (cold.size() >= 2){
                TouchBufferFrame coldToHodFrame = cold.pop();
                hot.addLast(coldToHodFrame);
        }

        return bufferFrame;

    }

    public String toString() {
        return "Touch Count Replacement Strategy";
    }

}
```

5. Comparaciones

Usamos los problemas mencionados en TouchCount



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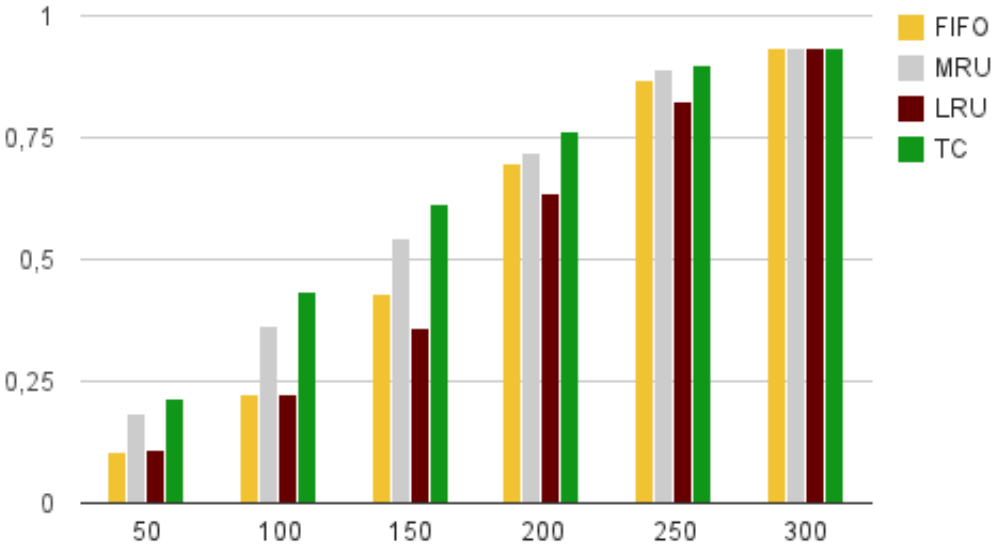
0,4
0,2
0
50
100
150
200
250
FIFO
MRU
LRU
TC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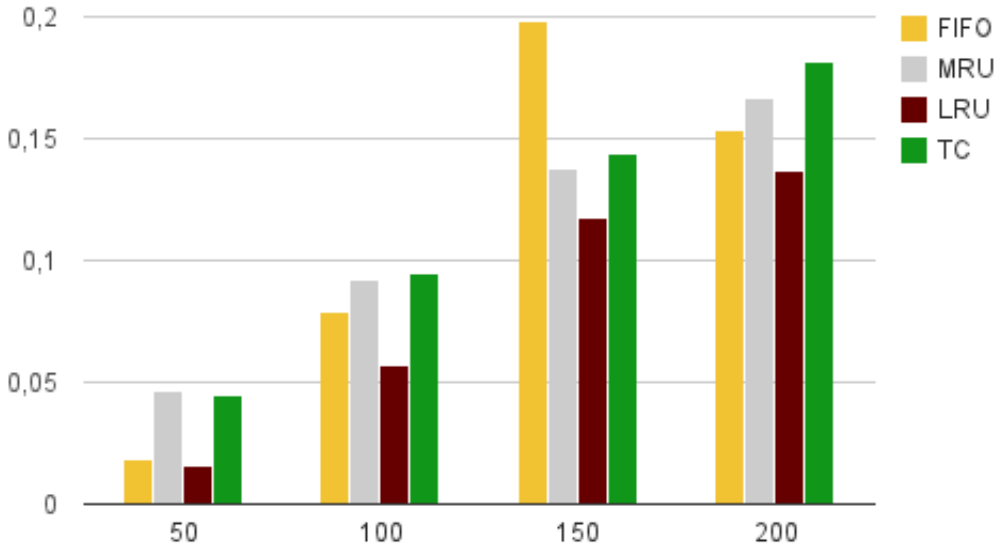
0,25
0
50
100
150
200
250
300
FIFO
MRU
LRU
TC



6. Conclusión