



YILDIZ TEKNİK ÜNİVERSİTESİ
ELEKTRİK ELEKTRONİK FAKÜLTESİ
BİLGİSAYAR MÜHENDİSLİĞİ

BLM2022 Bilgisayar Organizasyonu
Ödev 4


Öğrenci Adı: Batuhan ODÇIKIN

Öğrenci Numarası: 22011093

Dersin Eğitmeni: Dr. Öğr. Üyesi Erkan USLU

Tarih: 02/06/2025

CPU Information:

	Cihaz özellikleri	Kopyala	^
Cihaz adı	LAPTOP-BT9J0KRV		
İşlemci	11th Gen Intel(R) Core(TM) i5-1135G7 @ 2.40GHz 2.42 GHz		
Takılı RAM	16,0 GB (kullanılabilir: 15,7 GB)		
Cihaz Kimliği	97BCA18B-94C6-487D-B0E0-F248493DB8FC		
Ürün Kimliği	00325-82212-96382-AAOEM		
Sistem türü	64 bit işletim sistemi, x64 tabanlı işlemci		
Kalem ve dokunma	Kalem desteği		
İlgili bağlantılar Etki alanı veya çalışma grubu Sistem koruması Gelişmiş sistem ayarları			

batoddy@batoddy-HP:~/Desktop\$ lscpu

Architecture: x86_64
CPU op-mode(s): 32-bit, 64-bit
Address sizes: 39 bits physical, 48 bits virtual
Byte Order: Little Endian
CPU(s): 8
On-line CPU(s) list: 0-7
Vendor ID: GenuineIntel
Model name: 11th Gen Intel(R) Core(TM) i5-1135G7 @ 2.40GHz
CPU family: 6
Model: 140
Thread(s) per core: 2
Core(s) per socket: 4
Socket(s): 1
Stepping: 1
CPU(s) scaling MHz: 21%
CPU max MHz: 4200.0000
CPU min MHz: 400.0000
BogoMIPS: 4838.40
Virtualization features:
Virtualization: VT-x
Caches (sum of all):
L1d: 192 KB (4 instances)
L1i: 128 KB (4 instances)
L2: 5 MB (4 instances)
L3: 8 MB (1 instance)
NUMA:
NUMA node(s): 1
NUMA node0 CPU(s): 0-7

Calculations:

$$L1d \text{ cache} = 132 \text{ kB} \rightarrow 132 \cdot 1024 \text{ B}$$

$$\text{Line boyutu} = 64 \text{ B}$$

$$\text{Association} \Rightarrow 12\text{-way}$$

$$\text{Satr sayısı} = 132 \cdot 1024 \text{ B} / 64 \text{ B} = 3072 \text{ satır}$$

$$\text{Set sayısı} = 3072 / 12 = 256 \text{ set}$$

$$A, B, C \rightarrow 256 \cdot 256 \rightarrow 65.536 \text{ element (double} \rightarrow 8 \text{ bit)}$$

$$65.536 \cdot 3 \cdot 8 = 524.288 \text{ B} \rightarrow 512 \text{ kB}$$

A \rightarrow Yalın (ordak)

B \rightarrow Diken

C \rightarrow Diken

A

1 line 64 B $\rightarrow 64/8 = 8$ değer saklanabilir.

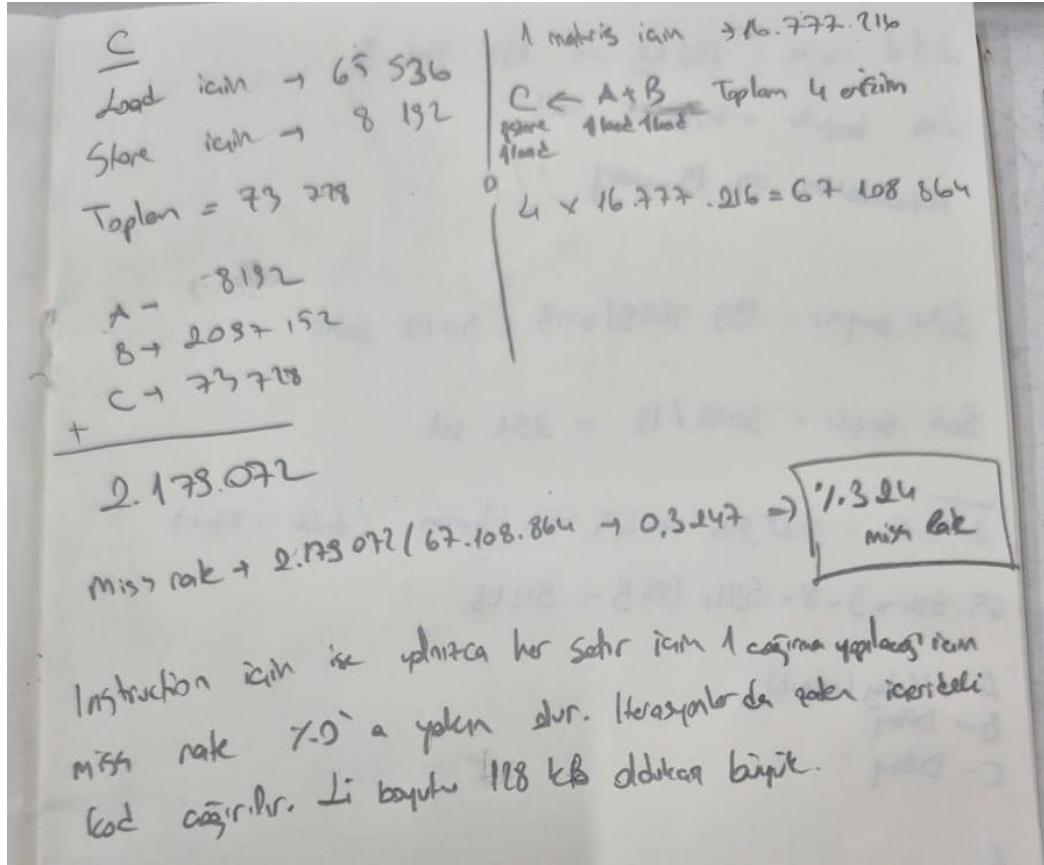
Ardrık sırtığı için \rightarrow 0. deyer mis 1-7 deyerleri hit

256 B için \rightarrow 32 miss 224 hit (iç başına)

$$\text{Total} \rightarrow 32 \cdot 256 = 8.192 \text{ miss}$$

B (ordak deyer)

$$256 \cdot 256 \cdot 32 = 2.097.152 \text{ miss}$$



Code results:

```

batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/Ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./1.out
==7294== Cachegrind, a high-precision tracing profiler
==7294== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7294== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7294== Command: ./1.out
==7294==
--7294-- warning: L3 cache found, using its data for the LL simulation.

secs:1.830228
==7294==
==7294== I refs:      783,202,683
==7294== I1 misses:    1,422
==7294== L1i misses:    1,400
==7294== I1 miss rate:  0.00%
==7294== L1i miss rate: 0.00%
==7294==
==7294== D refs:      307,290,631 (288,925,695 rd + 18,364,936 wr)
==7294== D1 misses:    16,893,634 ( 16,868,627 rd +   25,007 wr)
==7294== L1d misses:    26,016 (   1,062 rd +  24,954 wr)
==7294== D1 miss rate:   5.5% (   5.8% +   0.1% )
==7294== L1d miss rate:  0.0% (   0.0% +   0.1% )
==7294==
==7294== LL refs:      16,895,056 ( 16,870,049 rd +   25,007 wr)
==7294== LL misses:     27,416 (   2,462 rd +  24,954 wr)
==7294== LL miss rate:  0.0% (   0.0% +   0.1% )
==7294==
==7294== Branches:      18,315,915 ( 18,184,472 cond +  131,443 ind)
==7294== Mispredicts:    78,808 (   78,633 cond +    175 ind)
==7294== Mispred rate:  0.4% (   0.4% +   0.1% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/Ödev 4$
  
```

Bu hesap 1.c için yapılmıştır. Sonuç %3.24 olarak bulunmuştur.

2.c için:

A: Her (i,k) çifti için $A[i][k]$ bir kez L1d'ye yüklenip içteki j döngüsünde 256 kez kullanıldığı için çok az miss oluşur.

B: k sabitken j artışıyla $B[k][j]$ satır satır taranır, bu da her 8 çift için bir cache satırı getirerek miss sayısını azaltır.

C: i ve k sabitken j artışıyla $C[i][j]$ sıra sıra tarandığında her 8 elemanda bir miss, geri kalanında hit olur.

1.c'de C'ye (i,j) başına 1 miss düşerken burada C'ye (i,k) başına 32 miss düştüğü için 2.c toplamda 1.c'ye göre daha çok L1d miss üretir.

3.c için:

A: j sabitken i değişimiyle her yeni i için $A[i][0..255]$ yeniden satır satır tarandığından her (j,i) bloğunda 32 miss oluşur.

B: j sabit, k artarken $B[k][j]$ sütun sütun (her adım 256 eleman atlayarak) erişildiği için her k'de yeni bir cache satırı yüklendiğinden sürekli miss olur.

C: j sabitken i değişimi $C[i][j]$ 'yi farklı satırlara taşır ve ardından k içinde tekrar $C[i][j]$ kullanılsa da önceki satır muhtemelen atıldığı için her (j,i) başına 1 miss meydana gelir.

1.c'ye kıyasla A ve B erişimleri çok daha kötü cache lokalitesine sahip olup C'de de her (j,i) için ayrı miss üretildiğinden, 3.c toplamda 1.c'ye göre çok daha fazla L1d miss üretir.

Terminal çıktıları:

```
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./2.out
==7395== Cachegrind, a high-precision tracing profiler
==7395== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7395== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7395== Command: ./2.out
==7395==
--7395-- warning: L3 cache found, using its data for the LL simulation.

secs:1.861142
==7395==
==7395== I refs:      783,202,691
==7395== I1 misses:    1,423
==7395== LL1 misses:    1,401
==7395== I1 miss rate:  0.00%
==7395== LL1 miss rate: 0.00%
==7395==
==7395== O refs:      307,290,633 (288,925,696 rd + 18,364,937 wr)
==7395== D1 misses:    2,140,098 ( 2,115,091 rd +   25,007 wr)
==7395== LLd misses:    26,016 (   1,062 rd +   24,954 wr)
==7395== D1 miss rate:  0.7% (   0.7% +   0.1% )
==7395== LLd miss rate: 0.0% (   0.0% +   0.1% )
==7395==
==7395== LL refs:      2,141,521 ( 2,116,514 rd +   25,007 wr)
==7395== LL misses:    27,417 (   2,463 rd +   24,954 wr)
==7395== LL miss rate:  0.0% (   0.0% +   0.1% )
==7395==
==7395== Branches:    18,315,915 ( 18,184,472 cond +  131,443 ind)
==7395== Mispredicts:  78,804 (   78,629 cond +    175 ind)
==7395== Mispred rate:  0.4% (   0.4% +   0.1% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$
```

```

batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./3.out
==7432== Cachegrind, a high-precision tracing profiler
==7432== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7432== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7432== Command: ./3.out
==7432==
--7432-- warning: L3 cache found, using its data for the LL simulation.

secs:1.862738
==7432==
==7432== I refs:      783,202,668
==7432== I1 misses:    1,421
==7432== L1i misses:   1,399
==7432== I1 miss rate: 0.00%
==7432== L1i miss rate: 0.00%
==7432==
==7432== D refs:      307,290,626 (288,925,690 rd + 18,364,936 wr)
==7432== D1 misses:   18,966,464 ( 18,941,457 rd +   25,007 wr)
==7432== L1d misses:   26,016 (   1,062 rd +   24,954 wr)
==7432== D1 miss rate:  6.2% (    6.6% +    0.1% )
==7432== L1d miss rate: 0.0% (    0.0% +    0.1% )
==7432==
==7432== LL refs:      18,967,885 ( 18,942,878 rd +   25,007 wr)
==7432== LL misses:    27,415 (    2,461 rd +   24,954 wr)
==7432== LL miss rate:  0.0% (    0.0% +    0.1% )
==7432==
==7432== Branches:     18,315,910 ( 18,184,467 cond +  131,443 ind)
==7432== Mispredicts:   78,803 (    78,628 cond +    175 ind)
==7432== Mispred rate:  0.4% (    0.4% +    0.1% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$

```

```

batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./1_64.out
==7454== Cachegrind, a high-precision tracing profiler
==7454== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7454== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7454== Command: ./1_64.out
==7454==
--7454-- warning: L3 cache found, using its data for the LL simulation.

secs:0.027720
==7454==
==7454== I refs:      12,942,356
==7454== I1 misses:    1,448
==7454== L1i misses:   1,425
==7454== I1 miss rate: 0.01%
==7454== L1i miss rate: 0.01%
==7454==
==7454== D refs:      5,102,670 (4,727,721 rd +  374,949 wr)
==7454== D1 misses:    4,683 (   2,715 rd +   1,968 wr)
==7454== L1d misses:    2,981 (   1,068 rd +   1,913 wr)
==7454== D1 miss rate:  0.1% (    0.1% +   0.5% )
==7454== L1d miss rate: 0.1% (    0.0% +   0.5% )
==7454==
==7454== LL refs:        6,131 (   4,163 rd +   1,968 wr)
==7454== LL misses:    4,406 (   2,493 rd +   1,913 wr)
==7454== LL miss rate:  0.0% (    0.0% +   0.5% )
==7454==
==7454== Branches:      390,961 (  382,399 cond +   8,562 ind)
==7454== Mispredicts:    9,082 (   8,907 cond +    175 ind)
==7454== Mispred rate:  2.3% (    2.3% +    2.0% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$

```

```

batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./2_64.out
==7473== Cachegrind, a high-precision tracing profiler
==7473== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7473== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7473== Command: ./2_64.out
==7473==
--7473-- warning: L3 cache found, using its data for the LL simulation.

secs:0.026205
==7473==
==7473== I refs:      12,942,368
==7473== I1 misses:    1,448
==7473== L1i misses:   1,425
==7473== I1 miss rate: 0.01%
==7473== L1i miss rate: 0.01%
==7473==
==7473== D refs:      5,102,674 (4,727,725 rd +  374,949 wr)
==7473== D1 misses:    4,682 (   2,714 rd +   1,968 wr)
==7473== L1d misses:    2,981 (   1,068 rd +   1,913 wr)
==7473== D1 miss rate:  0.1% (    0.1% +   0.5% )
==7473== L1d miss rate: 0.1% (    0.0% +   0.5% )
==7473==
==7473== LL refs:        6,130 (   4,162 rd +   1,968 wr)
==7473== LL misses:    4,406 (   2,493 rd +   1,913 wr)
==7473== LL miss rate:  0.0% (    0.0% +   0.5% )
==7473==
==7473== Branches:      390,965 (  382,403 cond +   8,562 ind)
==7473== Mispredicts:    9,087 (   8,912 cond +    175 ind)
==7473== Mispred rate:  2.3% (    2.3% +    2.0% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$

```

```
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$ valgrind --tool=cachegrind --cache-sim=yes --branch-sim=yes ./3_64.out
==7485== Cachegrind, a high-precision tracing profiler
==7485== Copyright (C) 2002-2017, and GNU GPL'd, by Nicholas Nethercote et al.
==7485== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==7485== Command: ./3_64.out
==7485==
--7485-- warning: L3 cache found, using its data for the LL simulation.

secs:0.028621
==7485==
==7485== I refs:      12,942,379
==7485== I1 misses:    1,450
==7485== LLi misses:    1,427
==7485== I1 miss rate:  0.01%
==7485== LLi miss rate: 0.01%
==7485==
==7485== D refs:      5,102,677 (4,727,727 rd + 374,950 wr)
==7485== D1 misses:    13,585 ( 11,617 rd + 1,968 wr)
==7485== L1d misses:    2,981 ( 1,068 rd + 1,913 wr)
==7485== D1 miss rate:  0.3% ( 0.2% + 0.5% )
==7485== L1d miss rate: 0.1% ( 0.0% + 0.5% )
==7485==
==7485== LL refs:      15,035 ( 13,067 rd + 1,968 wr)
==7485== LL misses:    4,408 ( 2,495 rd + 1,913 wr)
==7485== LL miss rate:  0.0% ( 0.0% + 0.5% )
==7485==
==7485== Branches:      390,966 ( 382,404 cond + 8,562 ind)
==7485== Mispredicts:    9,083 ( 8,908 cond + 175 ind)
==7485== Mispred rate:  2.3% ( 2.3% + 2.0% )
batoddy@batoddy-HP:~/Desktop/YTU_CE_Ubuntu/Bilgisayar_Organizasyonu/ödev 4$
```