Micro-optimization for competitive programming

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IPST Computer Olympiad Camp

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Special Thanks

This Slide adapt from UMN CSCI2021 lecture slide by Christopher Kauffman

What Computer actually did when compile and run C file ?

How to optimize?

- Algorithm and Data Structure
- Remove unnecessary work
- Memory Utilization
- Micro Optimization

Algorithm and Data Structure

```
void sort(vector<int>arr ,int N) {
    bubble_sort(arr, N);
}
```

Remove unnecessary work

```
bool is_palindrome(char *s) {
    for(int i = 0; i < strlen(s); i++) {
        if(s[i] != s[strlen(s) - i - 1])
            return false;
    }
    return true;
}
```

Remove unnecessary work

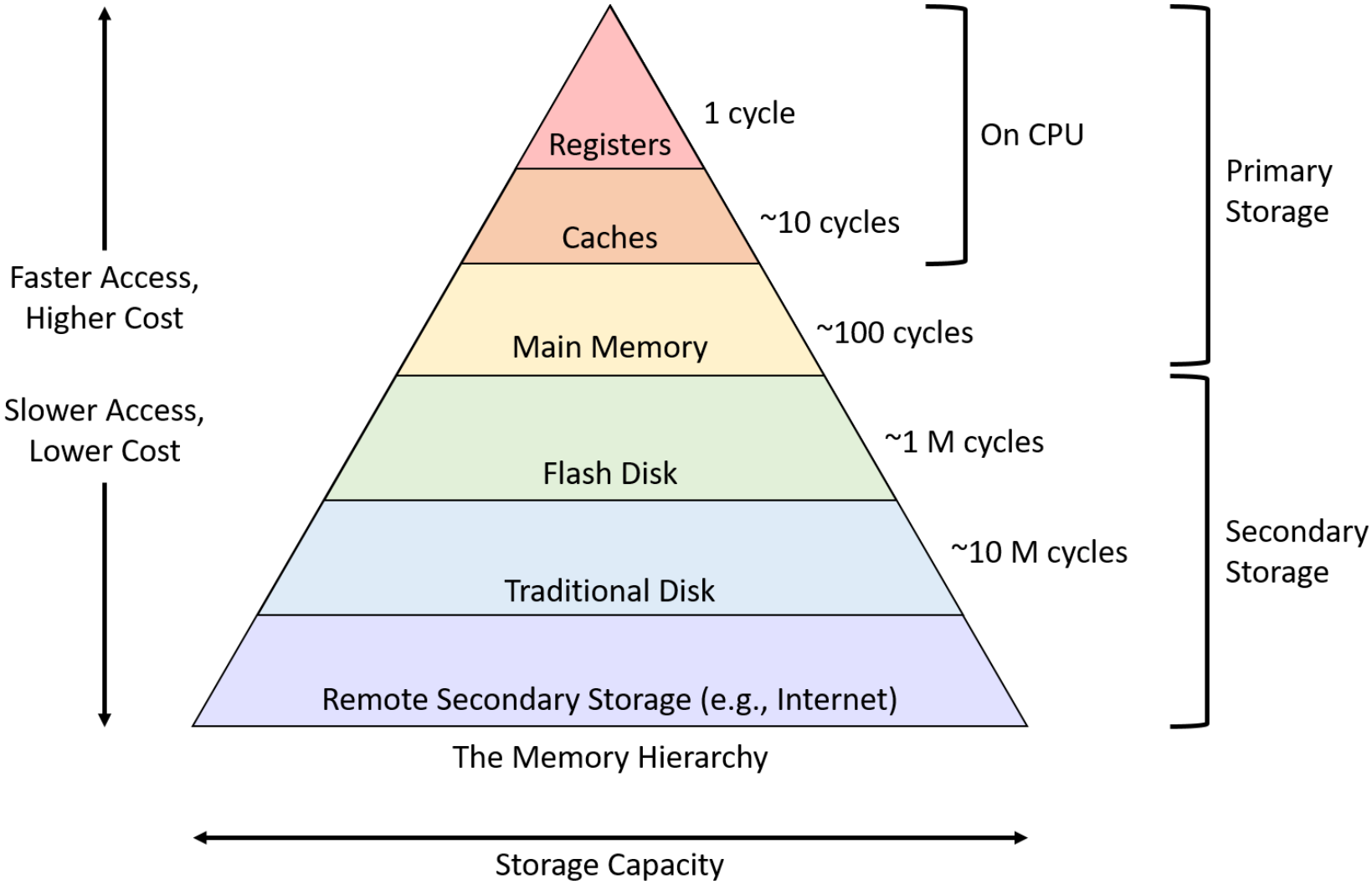
```
bool is_palindrome_opt1(char *s) {
    int n = strlen(s);
    for(int i = 0; i < n; i++) {
        if(s[i] != s[n - i - 1])
            return false;
    }
    return true;
}
```

Remove unnecessary work

```
bool is_palindrome_opt2(char *s) {
    int n = strlen(s);
    for(int i = 0; i < n / 2; i++) {
        if(s[i] != s[n - i - 1])
            return false;
    }
    return true;
}
```

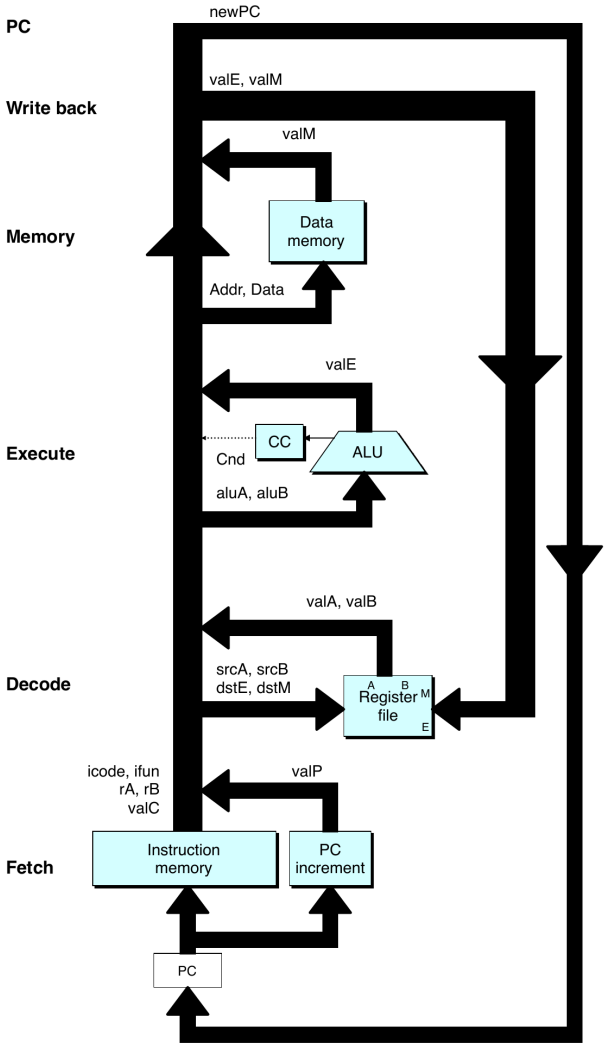
Benchmark

Memory Utilization



Source

Y86-64 SEQ sequential



Source

Memory Reference

```
void sum_1(){
    int s = 0;
    for(int i = 0; i < SIZE; i++)s += arr[i];
    return;
}

void sum_2(){
    int s1 = 0;
    int *ptr = &s1;
    for(int i = 0; i < SIZE; i++)
        *ptr += arr[i];
    return;
}
```

Operation

Modulo and division is very slow.

Pipeline and Superscalar

Loop unroll.

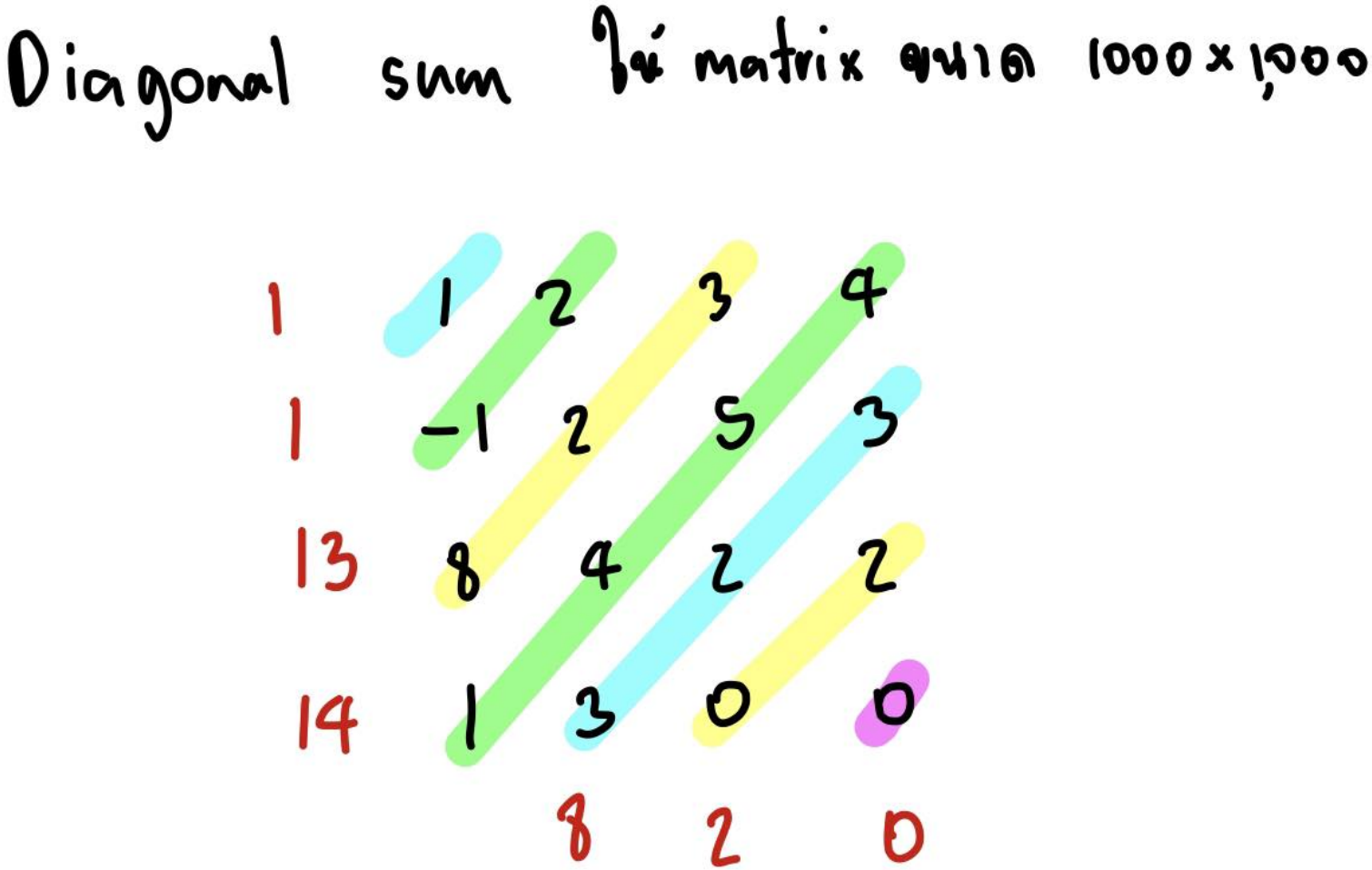
Branching Prediction

inline function

function stack

problem 1

Find diagonal sum.



Solution

Unroll loop cache

problem 2

Matrix Square.

ให้ matrix A ขนาด 1,000 × 1,000 หาค่า A^2

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \qquad A^2 = \begin{bmatrix} 7 & 10 \\ 15 & 22 \end{bmatrix}$$

Solution

Strassen algorithm.