1. **Analiza Cerințelor**

**Tema:** Implementarea unui algoritm de convoluție folosind programarea paralelă în Java si C++.

**Cerințe:** Utilizarea diferitelor strategii de partiționare a datelor (pe verticala, pe orizontala, pe blocuri).

1. **Proiectare**

Rularea

**Structuri de Date:**

int[][] F: Matricea initiala

int[][] F\_padded: Matricea de intrare extinsă cu padding.

int[][] C: Matricea de convoluție.

int[][] V: Matricea rezultată după aplicarea convoluției.

int[][] matrixThread: Matrice pentru a stoca numărul thread-ului care a procesat fiecare element.

**Partiționare pe Threaduri:**

Orizontala: Fiecare thread procesează un set de coloane.

Verticală: Fiecare thread procesează un set de randuri.

Pe Blocuri: Fiecare thread procesează un bloc de elemente.

**Clase:**

*Secvential:* Clasa pentru calcularea convolutiei intr un mod secvential

*Convolutie*: Clasa principală care conține metodele de convoluție.

*ConvolutieUtils:* Clasa care stocheaza metoda de bordare

*ThreadVerticala*: Clasa pentru thread-urile care procesează randuri.

*ThreadOrizontala*: Clasa pentru thread-urile care procesează coloane.

*ThreadBloc*: Clasa pentru thread-urile care procesează blocuri.

**Funcții:**

*convolutieSecventiala:* Metoda pentru convolutia secventiala.

convolutieVerticala: Metodă pentru convoluția verticală.

convolutieOrizontala: Metodă pentru convoluția orizontala.

convolutieBloc: Metodă pentru convoluția pe blocuri.

Programele contin main-uri diferite pentru fiecare

1. **Detalii de Implementare**

**Convolutie Secventiala:**

public static int[][] convolutieSecventiala(int[][] F\_padded, int[][] C, int n, int m, int k) {}

void convolutieSecventiala(int F\_padded[N + 2][M + 2], int C[K][K], int V[N][M])

**Convoluția Verticală:**

public static int[][] convolutieVerticala(int[][] F\_padded, int[][] C, int n, int m, int numThreads) {}

void convolutieVerticala(int F\_padded[N + 2][M + 2], int C[K][K], int V[N][M])

**Convoluția Orizontala:**

public static int[][] convolutieOrizontala(int[][] F\_padded, int[][] C, int n, int m, int numThreads){}

void convolutieOrizontala(int F\_padded[N + 2][M + 2], int C[K][K], int V[N][M])

**Convoluția pe Blocuri:**

public static int[][] convolutieBloc(int[][] F\_padded, int[][] C, int n, int m, int numThreads) {}

void convolutieBloc(int F\_padded[N + 2][M + 2], int C[K][K], int V[N][M])

1. **Cazuri de Testare**

Toate tipurile de distributie (pe verticala, pe orizontala, pe blocuri):

- 4 thread-uri pe o matrice de 10x10 si filtru de 3X3.

- 2/4/8/16 thread-uri pe o matrice 1000X1000 si filtru de 5X5

- 2/4/8/16 thread-uri pe o matrice 10X1000 si filtru de 5X5

- 2/4/8/16 thread-uri pe o matrice 1000X10 si filtru de 5X5

- 2/4/8/16 thread-uri pe o matrice 10000X10000 si filtru de 5X5

**Concluzii:**

* C++ static are cei mai buni timpi comparative cu C++ dinamic si Java. Totusi intre C++ si Java, C++ are timpul cel mai bun.

JAVA

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10  K=3 | - | Secvential | 0.069791 |
| 4 | Verticala | 1.7488 |
| Orizontala | 1.77275 |
| Bloc | 1.8448 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=1000  K=5 | - | Secvential | 29.5429 |
| 2 | Verticala | 17.8954 |
| Orizontala | 13.81585 |
| Bloc | 29.14518 |
| 4 | Verticala | 14.84323 |
| Orizontala | 11.95798 |
| Bloc | 12.523169 |
| 8 | Verticala | 14.334269 |
| Orizontala | 13.402839 |
| Bloc | 12.05097 |
| 16 | Verticala | 10.77825 |
| Orizontala | 8.659629 |
| Bloc | 9.60846 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=10 M=1000  K=5 | - | Secvential | 2.9765 |
| 2 | Verticala | 10.457 |
| Orizontala | 8.2649 |
| Bloc | 7.3644 |
| 4 | Verticala | 9.9211 |
| Orizontala | 8.0484 |
| Bloc | 7.7571 |
| 8 | Verticala | 6.5541 |
| Orizontala | 11.3614 |
| Bloc | 12.3707 |
| 16 | Verticala | 9.2949 |
| Orizontala | 9.5585 |
| Bloc | 8.4672 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=1000 M=10  K=5 | - | Secvential | 5.1823 |
| 2 | Verticala | 10.9367 |
| Orizontala | 5.6877 |
| Bloc | 5.8629 |
| 4 | Verticala | 6.8557 |
| Orizontala | 8.332 |
| Bloc | 9.1393 |
| 8 | Verticala | 7.5116 |
| Orizontala | 7.598 |
| Bloc | 9.4685 |
| 16 | Verticala | 8.3193 |
| Orizontala | 8.0075 |
| Bloc | 9.8364 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10000  K=5 | - | Secvential | 2028.2286 |
| 2 | Verticala | 7220.3702 |
| Orizontala | 1416.5392 |
| Bloc | 3174.2274 |
| 4 | Verticala | 3986.9477 |
| Orizontala | 995.4843 |
| Bloc | 1087.9639 |
| 8 | Verticala | 2987.9614 |
| Orizontala | 944.8582 |
| Bloc | 1089.2738 |
| 16 | Verticala | 2229.9657 |
| Orizontala | 713.3098 |
| Bloc | 766.8962 |

C++ Dinamic

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10  K=3 | - | Secvential | 0.00509 |
| 4 | Orizontala | 13.969 |
| Verticala | 9.8925 |
| Bloc | 14.0874 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=1000  K=5 | - | Secvential | 9.8338 |
| 2 | Verticala | 8.0126 |
| Orizontala | 6.3853 |
| Bloc | 14.1854 |
| 4 | Verticala | 3.9795 |
| Orizontala | 4.6134 |
| Bloc | 6.1086 |
| 8 | Verticala | 5.7892 |
| Orizontala | 4.4962 |
| Bloc | 5.2789 |
| 16 | Verticala | 3.9818 |
| Orizontala | 3.9131 |
| Bloc | 8.2433 |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=10 M=1000  K=5 | - | Secvential | 0.1095 |
| 2 | Verticala | 0.7972 |
| Orizontala | 0.5342 |
| Bloc | 0.4101 |
| 4 | Verticala | 0.723 |
| Orizontala | 0.5378 |
| Bloc | 0.5775 |
| 8 | Verticala | 0.8414 |
| Orizontala | 1.1753 |
| Bloc | 0.5656 |
| 16 | Verticala | 1.328 |
| Orizontala | 1.3273 |
| Bloc | 2.3604 |

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=1000 M=10  K=5 | - | Secvential | 0.1166 |
| 2 | Verticala | 1.2324 |
| Orizontala | 0.4355 |
| Bloc | 0.5159 |
| 4 | Verticala | 0.6648 |
| Orizontala | 0.4754 |
| Bloc | 0.6416 |
| 8 | Verticala | 1.1512 |
| Orizontala | 0.7671 |
| Bloc | 0.6342 |
| 16 | Verticala | 1.4418 |
| Orizontala | 1.5632 |
| Bloc | 1.2454 |

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10000  K=5 | - | Secvential | 963.398 |
| 2 | Verticala | 1126.62 |
| Orizontala | 595.112 |
| Bloc | 1452.53 |
| 4 | Verticala | 653.011 |
| Orizontala | 313.528 |
| Bloc | 515.16 |
| 8 | Verticala | 713.444 |
| Orizontala | 218.035 |
| Bloc | 520.414 |
| 16 | Verticala | 728.773 |
| Orizontala | 180.452 |
| Bloc | 374.28 |

C++ Static

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| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10  K=3 | - | Secvential | 0.00509 |
| 4 | Orizontala | 13.969 |
| Verticala | 9.8925 |
| Bloc | 14.0874 |

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=1000  K=5 | - | Secvential | 0.00018 |
| 2 | Verticala | 3.0089 |
| Orizontala | 2.22215 |
| Bloc | 1.38813 |
| 4 | Verticala | 2.11779 |
| Orizontala | 1.73359 |
| Bloc | 1.64759 |
| 8 | Verticala | 1.91589 |
| Orizontala | 1.53509 |
| Bloc | 1.73254 |
| 16 | Verticala | 1.85428 |
| Orizontala | 1.82465 |
| Bloc | 1.65599 |

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=10 M=1000  K=5 | - | Secvential | 0.00039 |
| 2 | Verticala | 3.65566 |
| Orizontala | 2.37964 |
| Bloc | 1.49118 |
| 4 | Verticala | 2.61501 |
| Orizontala | 1.94789 |
| Bloc | 2.30422 |
| 8 | Verticala | 2.32963 |
| Orizontala | 2.32246 |
| Bloc | 1.57033 |
| 16 | Verticala | 2.13441 |
| Orizontala | 1.83464 |
| Bloc | 2.02092 |

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=1000 M=10  K=5 | - | Secvential | 0.00039 |
| 2 | Verticala | 3.65566 |
| Orizontala | 2.37964 |
| Bloc | 1.49118 |
| 4 | Verticala | 2.61501 |
| Orizontala | 1.94789 |
| Bloc | 2.30422 |
| 8 | Verticala | 2.32963 |
| Orizontala | 2.32246 |
| Bloc | 1.57033 |
| 16 | Verticala | 2.13441 |
| Orizontala | 1.83464 |
| Bloc | 2.02092 |

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| --- | --- | --- | --- |
| Dimensiune Matrice | Nr Threads | Type | Medie dupa 10 rulari |
| N=M=10000  K=5 | - | Secvential | 960.085 |
| 2 | Verticala | 504.147 |
| Orizontala | 193.989 |
| Bloc | 104.026 |
| 4 | Verticala | 318.121 |
| Orizontala | 105.505 |
| Bloc | 106.462 |
| 8 | Verticala | 232.66 |
| Orizontala | 72.4862 |
| Bloc | 105.268 |
| 16 | Verticala | 218.047 |
| Orizontala | 55.203 |
| Bloc | 102.84 |