ICCS311
PROJECT
PRESENTATION.

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OVERVIEW

Implement variance functions to calculate linear algebra problem using parallel programming. With parallel technique, we aim to optimize time complexity compared to sequential programming.

IMPLEMENTED FUNCTIONS

```
dot()
```

```
matrixMult()
```

```
transpose()
```

```
trace()
```

```
det()
```

dot()

dot product with 1024-size

sequential dot product

output: 358438400.0
time: 15.291µs

parallel dot product

output: 358438400.0
time: 161.084µs

dot product with 20,000,000-size

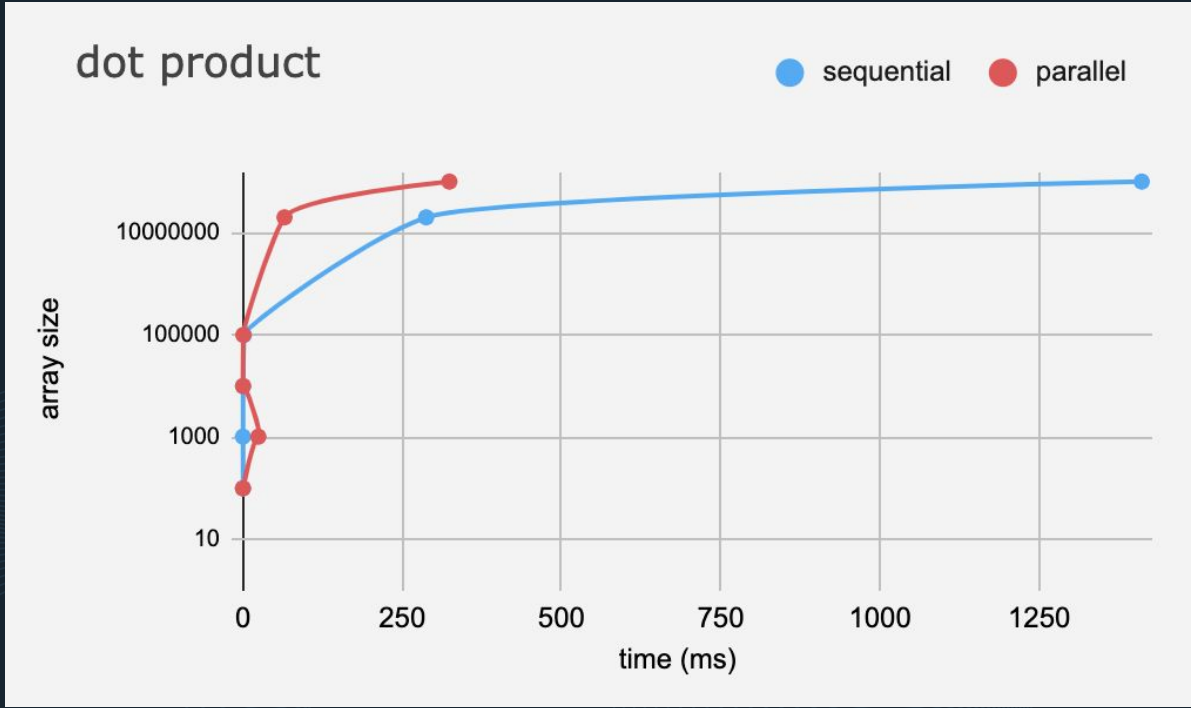
sequential dot product

output: 2.66666686666689715e21
time: 287.792375ms

parallel dot product

output: 2.6666668666666832e21
time: 66.765417ms

dot product

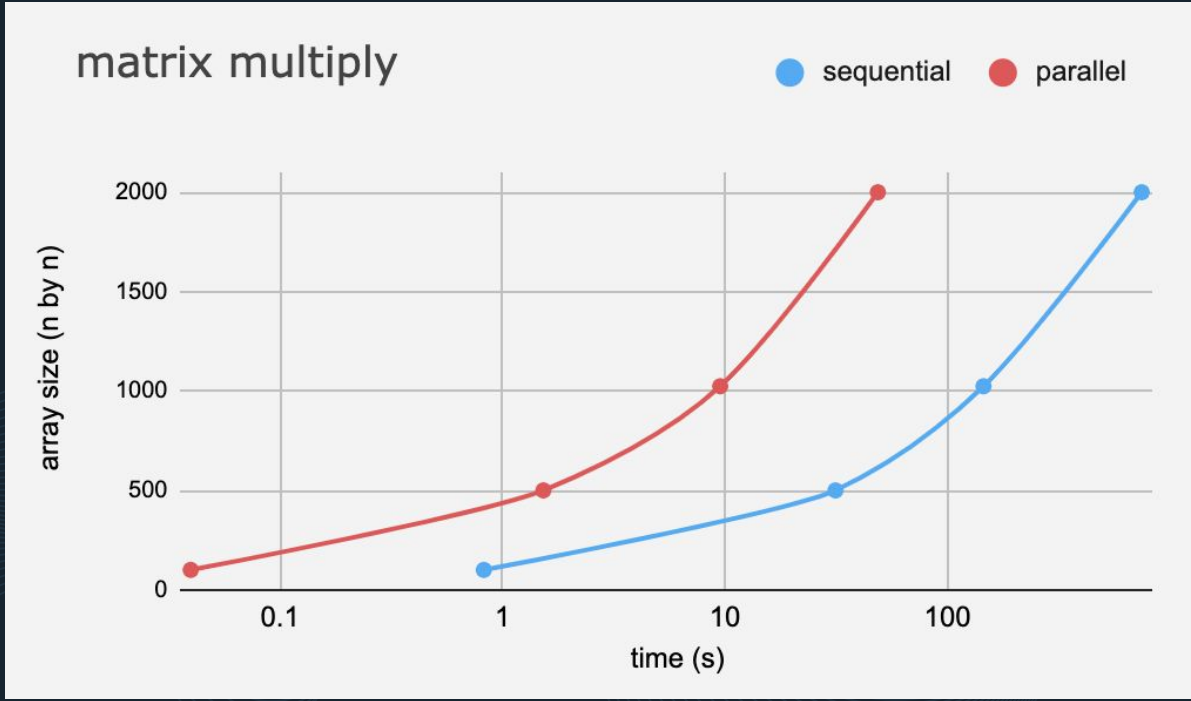


matrixMult()

```
sequential matrix multiply with 1024-size   time: 127.209171042s

parallel matrix multiply with 1024-size     time: 8.308849375s
```

matrix multiply

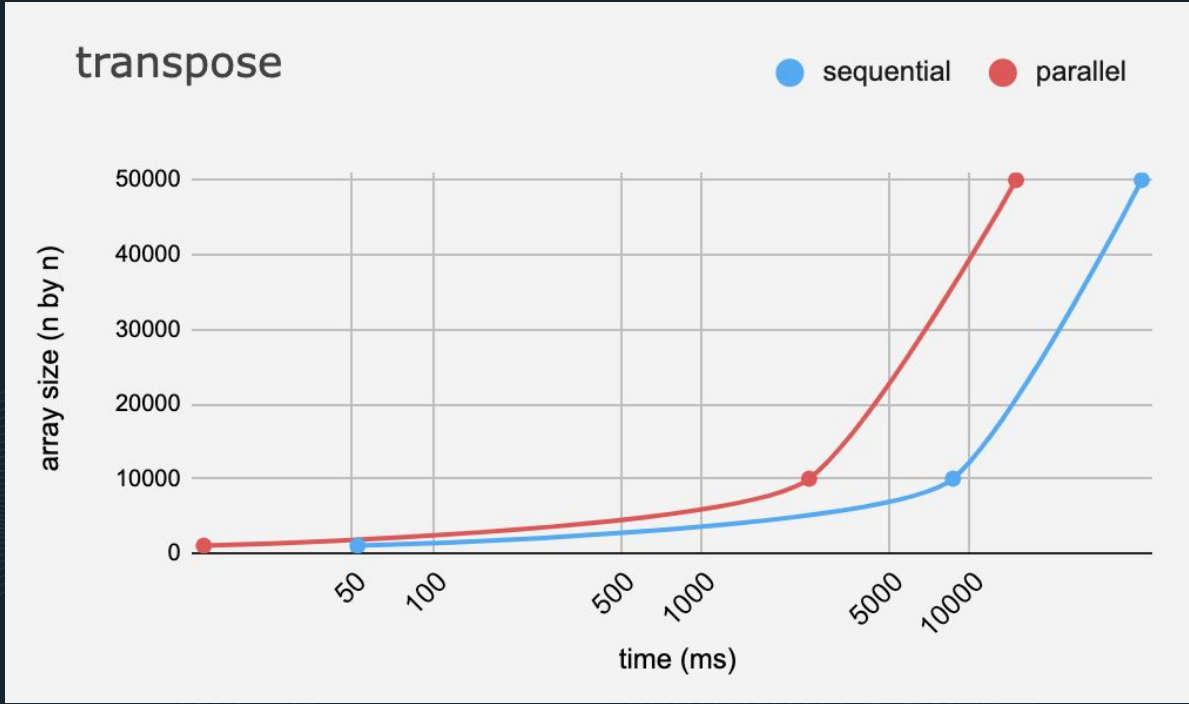


transpose()

```
sequential matrix transpose with 1024-size    time: 52.542417ms

parallel matrix transpose with 1024-size      time: 14.656708ms
```

transpose



trace()

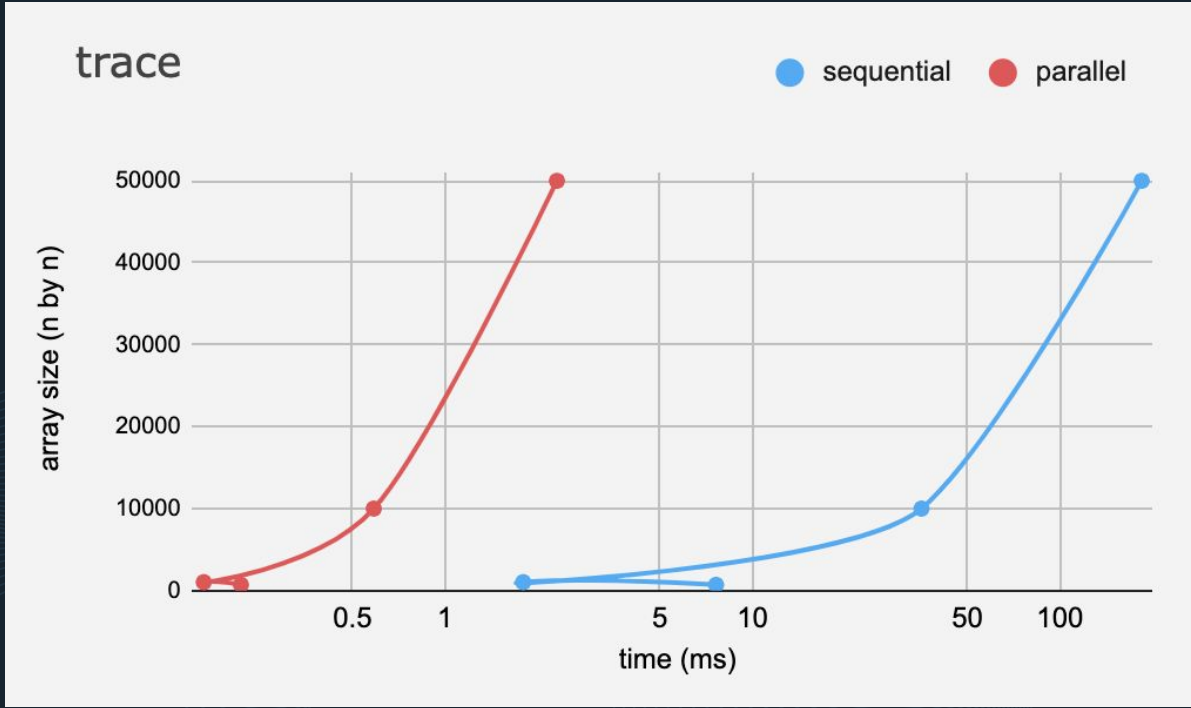
```
Matrix trace with small matrix (less than ~700)

sequential matrix trace     time: 542ns  output: 15.0
parallel matrix trace       time: 28.541µs  output: 15.0

matrix trace with 1024-size

sequential matrix trace     time: 347.333µs  output: 523776.0
parallel matrix trace       time: 334.875µs  output: 523776.0
```

trace



QR-DECOMPOSITION

$$
\begin{aligned}
\mathbf{u}_1 &= \mathbf{a}_1, & \mathbf{e}_1 &= \frac{\mathbf{u}_1}{\|\mathbf{u}_1\|} \\
\mathbf{u}_2 &= \mathbf{a}_2 - \operatorname{proj}_{\mathbf{u}_1} \mathbf{a}_2, & \mathbf{e}_2 &= \frac{\mathbf{u}_2}{\|\mathbf{u}_2\|} \\
\mathbf{u}_3 &= \mathbf{a}_3 - \operatorname{proj}_{\mathbf{u}_1} \mathbf{a}_3 - \operatorname{proj}_{\mathbf{u}_2} \mathbf{a}_3, & \mathbf{e}_3 &= \frac{\mathbf{u}_3}{\|\mathbf{u}_3\|} \\
&\vdots & &\vdots \\
\mathbf{u}_k &= \mathbf{a}_k - \sum_{j=1}^{k-1} \operatorname{proj}_{\mathbf{u}_j} \mathbf{a}_k, & \mathbf{e}_k &= \frac{\mathbf{u}_k}{\|\mathbf{u}_k\|}
\end{aligned}
$$

$$
Q = \begin{bmatrix} \mathbf{e}_1 & \cdots & \mathbf{e}_n \end{bmatrix}
$$

$$
R = \begin{bmatrix}
\langle \mathbf{e}_1, \mathbf{a}_1 \rangle & \langle \mathbf{e}_1, \mathbf{a}_2 \rangle & \langle \mathbf{e}_1, \mathbf{a}_3 \rangle & \cdots & \langle \mathbf{e}_1, \mathbf{a}_n \rangle \\
0 & \langle \mathbf{e}_2, \mathbf{a}_2 \rangle & \langle \mathbf{e}_2, \mathbf{a}_3 \rangle & \cdots & \langle \mathbf{e}_2, \mathbf{a}_n \rangle \\
0 & 0 & \langle \mathbf{e}_3, \mathbf{a}_3 \rangle & \cdots & \langle \mathbf{e}_3, \mathbf{a}_n \rangle \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
0 & 0 & 0 & \cdots & \langle \mathbf{e}_n, \mathbf{a}_n \rangle
\end{bmatrix}.
$$

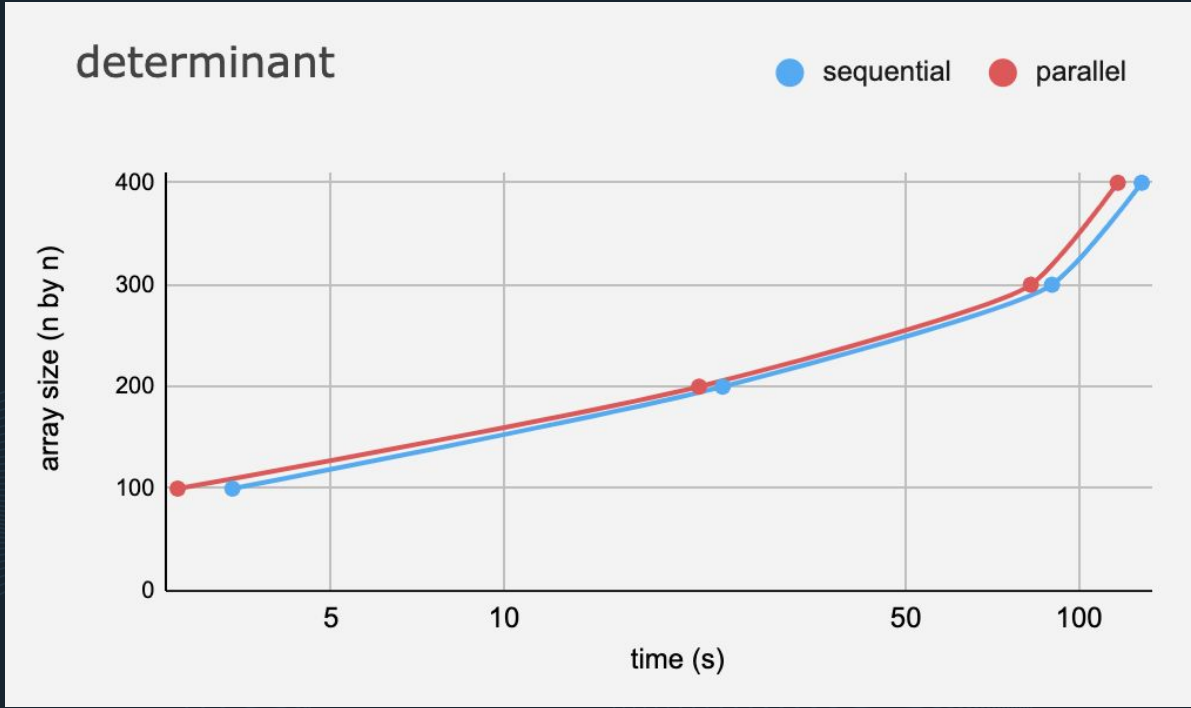
det()

```
determinant of matrix with 100-size    time: 2.351741208s

determinant of matrix with 300-size    time: 70.579182875s

determinant of matrix with 400-size    time: 179.376007041s
```

det



THANK YOU