COMP108
Data Structures and Algorithms

Data structures - Arrays (Part III Finding Maximum/Minimum)

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Finding maximum / minimum

- Input: n +ve numbers
- Output: find the maximum number
- Solutions:
  - Sort all numbers in descending order?
  - Any better way?

Finding maximum from n +ve numbers

```
// Skeleton is the same as before
i ← 1
while i ≤ n do
begin
   i ← i + 1
end
```

Finding maximum from n +ve numbers

$i \leftarrow 1$
$M \leftarrow 0$

output M

```
// Skeleton is the same as before
i ← 1
while i ≤ n do
begin
   i ← i + 1
end
```

Finding maximum from n +ve numbers

$i \leftarrow 1$
$M \leftarrow 0$
while $i \leq n$ do
begin

    $i \leftarrow i + 1$
end
output M

```
// Skeleton is the same as before
i ← 1
while i ≤ n do
begin
   i ← i + 1
end
```

Finding maximum from n +ve numbers

```
i ← 1
M ← 0
while i ≤ n do
begin
    if A[i] > M then
        M ← A[i]
    i ← i + 1
end
output M
```

```
// Skeleton is the same as before
i ← 1
while i ≤ n do
begin
   i ← i + 1
end
```

Finding maximum from n +ve numbers

```
i ← 1
M ← 0
while i ≤ n do
begin
    if A[i] > M then
        M ← A[i]
    i ← i + 1
end
output M
```

What about minimum?

```
// Skeleton is the same as before
i ← 1
while i ≤ n do
begin
   i ← i + 1
end
```

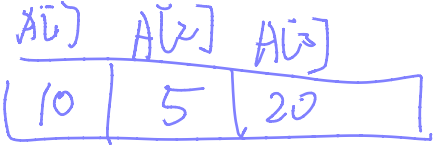
Finding minimum from n +ve numbers

while $i \leq n$ do
begin

$i \leftarrow i + 1$

end
output M

Finding minimum from n +ve numbers



$M \leftarrow A[1]$
while $i \leq n$ do
begin
    if $A[i] < M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

M 10 5

Finding minimum from n +ve numbers

$i \leftarrow 2$
$\boxed{M \leftarrow A[1]}$
while $i \leq n$ do
begin
    if $\boxed{A[i] < M}$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding minimum from n +ve numbers

$i \leftarrow 2$

$M \leftarrow A[1]$

while $i \leq n$ do

begin

if $A[i] < M$ then

$M \leftarrow A[i]$

$i \leftarrow i + 1$

end

output M

Finding minimum from n +ve numbers

```
i ← 2
M ← A[1]
while i ≤ n do
begin
    if A[i] < M then
        M ← A[i]
    i ← i + 1
end
output M
```

Finding minimum from n +ve numbers (see `SampleFindMin.java` on Canvas)

$i \leftarrow 2$
$M \leftarrow A[1]$
while $i \leq n$ do
begin
    if $A[i] < M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding location of maximum

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

loc 1 2

A[1] A[2] A[3]
10 20 5

Finding location of maximum:

$loc \leftarrow$?? 1
$i \leftarrow$?? 2
while $i \leq n$ do
begin
    if $A[i] >$?? then
        ??
    $i \leftarrow i + 1$
end
output *loc* and $A[loc]$

A[loc]
loc ← i

Finding location of maximum

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding location of maximum:

$loc \leftarrow 1$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] >$ then

    $i \leftarrow i + 1$
end
output loc and $A[loc]$

Finding location of maximum

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding location of maximum:

$loc \leftarrow 1$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > A[loc]$ then

    $i \leftarrow i + 1$
end
output loc and $A[loc]$

Finding location of maximum

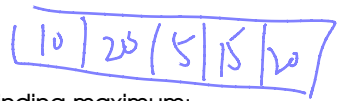
Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding location of maximum:

$loc \leftarrow 1$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > A[loc]$ then
        $loc \leftarrow i$
    $i \leftarrow i + 1$
end
output loc and $A[loc]$

Finding location of maximum

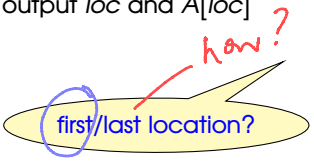


Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding location of maximum:

$loc \leftarrow 1$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > A[loc]$ then
        $loc \leftarrow i$
    $i \leftarrow i + 1$
end
output loc and $A[loc]$



$A[i] \geq A[loc]$

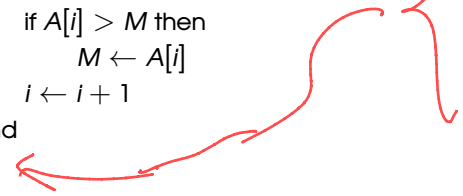
Finding all locations of maximum

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end

Finding all locations of maximum:

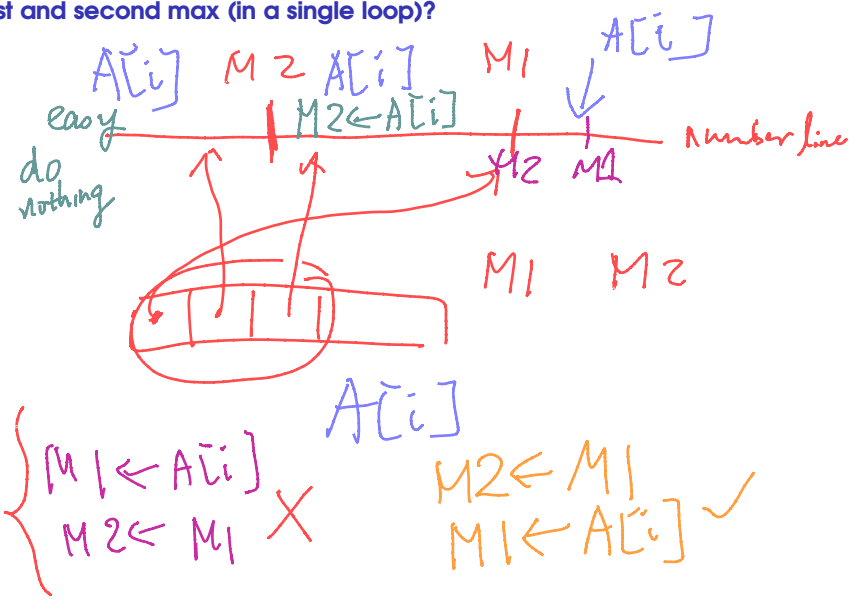
$i \leftarrow 1$
while $i \leq n$ do
begin
    if $A[i] == M$ then
        output i
    $i \leftarrow i + 1$
end
output M



What about finding both first and second max (in a single loop)?

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M



What about finding both first and second max (in a single loop)?

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding 1st and 2nd maximum:

$M1 \leftarrow$??
$M2 \leftarrow$??
$i \leftarrow$??
while $i \leq n$ do
begin
    if $A[i] > M1$ then
    begin
        ??
        ??
    end
    else if $A[i] > M2$ then
        ??
    $i \leftarrow i + 1$
end
output $M1$ and $M2$

What about finding both first and second max (in a single loop)?

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

Finding 1st and 2nd maximum:

$M1 \leftarrow \max(A[1], A[2])$
$M2 \leftarrow \min(A[1], A[2])$
$i \leftarrow 3$
while $i \leq n$ do
begin
    if $A[i] > M1$ then
    begin

difficult

    end
    else if $A[i] > M2$ then

medium

    $i \leftarrow i + 1$
end
output $M1$ and $M2$

What about finding both first and second max (in a single loop)?

Finding maximum:

```
M ← A[1]
i ← 2
while i ≤ n do
begin
    if A[i] > M then
        M ← A[i]
    i ← i + 1
end
output M
```

Finding 1st and 2nd maximum:

```
M1 ← max(A[1], A[2])
M2 ← min(A[1], A[2])
i ← 3
while i ≤ n do
begin
    if A[i] > M1 then
    begin
        M2 ← M1
        M1 ← A[i]
    end
    else if A[i] > M2 then

    i ← i + 1
end
output M1 and M2
```

What about finding both first and second max (in a single loop)?

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M

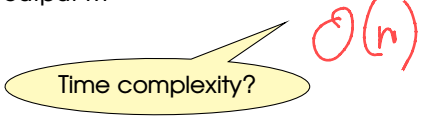
Finding 1st and 2nd maximum:

$M1 \leftarrow \max(A[1], A[2])$
$M2 \leftarrow \min(A[1], A[2])$
$i \leftarrow 3$
while $i \leq n$ do
begin
    if $A[i] > M1$ then
    begin
        $M2 \leftarrow M1$
        $M1 \leftarrow A[i]$
    end
    else if $A[i] > M2$ then
        $M2 \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output $M1$ and $M2$

What about finding both first and second max (in a single loop)?

Finding maximum:

$M \leftarrow A[1]$
$i \leftarrow 2$
while $i \leq n$ do
begin
    if $A[i] > M$ then
        $M \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output M



Finding 1st and 2nd maximum:

$M1 \leftarrow \max(A[1], A[2])$
$M2 \leftarrow \min(A[1], A[2])$
$i \leftarrow 3$
while $i \leq n$ do
begin
    if $A[i] > M1$ then
    begin
        $M2 \leftarrow M1$
        $M1 \leftarrow A[i]$
    end
    else if $A[i] > M2$ then
        $M2 \leftarrow A[i]$
    $i \leftarrow i + 1$
end
output $M1$ and $M2$

Summary: Finding max/min, 2nd max/min, locations

Next: Stacks/~~Queues~~ 2D Arrays

For note taking