Stack ADT

CMPT 125
Feb. 27

Lecture 21

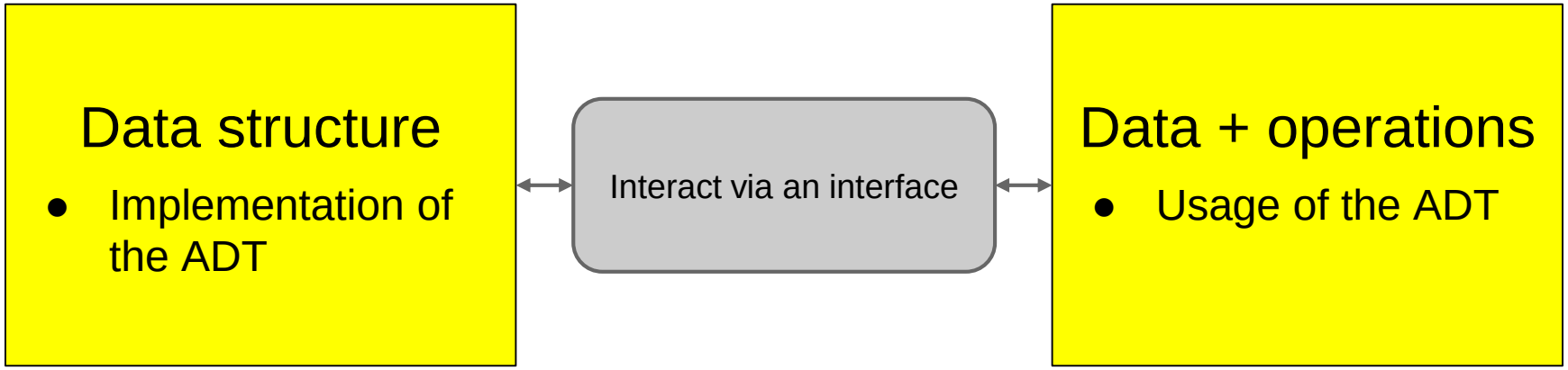
Today:

- Stack ADT
- Algorithms that use a Stack
- Implementing a Stack (with a Linked List)

Abstract Data Types (Review)

Abstract data type (ADT): a collection of data and a set of allowed operations on that data.

- specifies data and operations, not how the data are stored or how operations are carried out
- different from the data structure, which deals with the implementation



Why use interfaces? (Review)

Algorithm that implements a Stack ADT

Stack Interface:

- a sequence of data (LIFO)
- push element
- pop element
- isEmpty?

Algorithm that requires a Stack ADT

Why use interfaces? (Review)

Stack ADT, implemented using arrays

Stack Interface:

- a sequence of data (LIFO)
- push element
- pop element
- isEmpty?

Code that instantiates and uses a Stack ADT

Why use interfaces? (Review)

Stack ADT, implemented using arrays

Stack ADT, implemented by linked lists

Stack Interface:

- a sequence of data (LIFO)
- push element
- pop element
- isEmpty?

Code that instantiates and uses a Stack ADT

Code independence

Why use interfaces? (Review)

Stack ADT, implemented using arrays

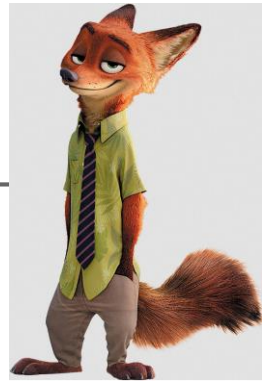
Stack ADT, implemented by linked lists

Stack Interface:

- a sequence of data (LIFO)
- push element
- pop element
- isEmpty?

Code that instantiates and uses a Stack ADT

Other code that instantiates and uses a Stack ADT



Code independence

Code re-usage

Postfix Calculation

A *postfix* operator comes after its operands

E.g. `24 6 +` → `30` `24 6 *` → `144`

`24 6 -` → `18` `24 6 /` → `4`

You are accustomed to `24 + 6`, which is *infix*.

No brackets are required in postfix

- operator always refers to last two numbers / results
- E.g. `24 6 * 15 3 - /` → `(24*6)/(15-3)`

Q. Evaluate: `(24((6 5 *)(6 8 *) -) -)` → `42`

Stack-Based Postfix Calculator

Use a Stack ADT to evaluate postfix.

Algorithm:

Create an empty stack S

while there is still input {

    if next input token is a number

        push the number to S

    if next input token is an operator {

        pop from S → b

        pop from S → a

        push (a op b) to S

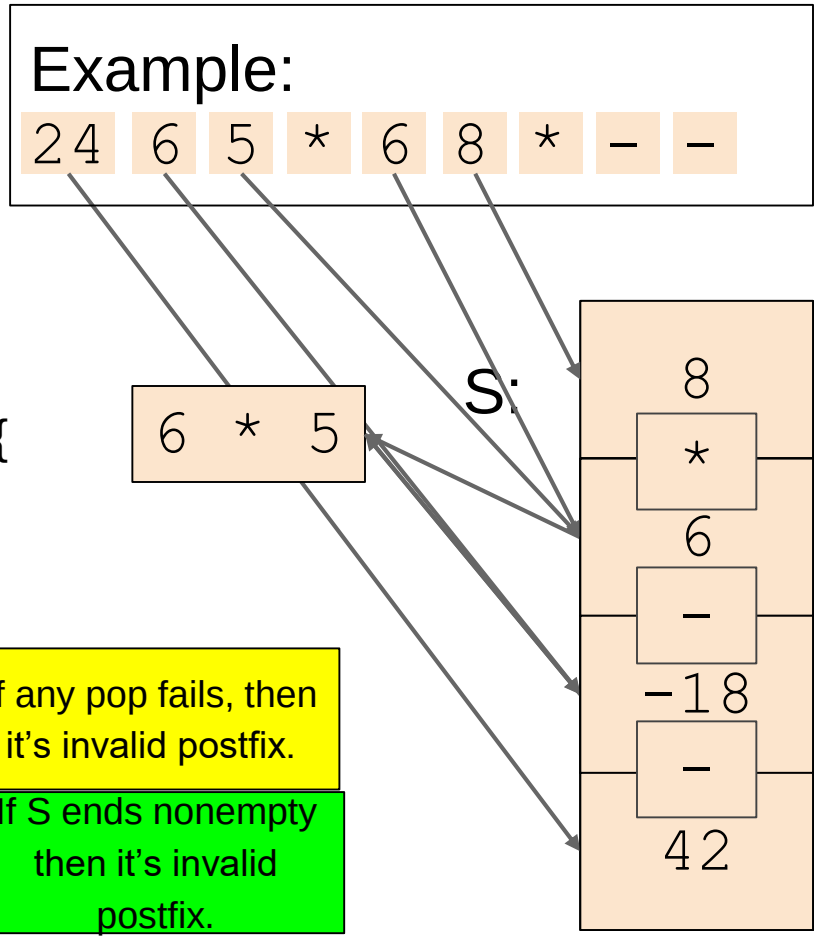
    }

}

pop from S → result

If any pop fails, then it's invalid postfix.

If S ends nonempty then it's invalid postfix.



Balancing Brackets

Your compiler needs to be able to match pairs of 3 different types of brackets: `()`, `[]`, `{}`

- Each left one must have a matching right one.
- Nested brackets are OK, but mismatched brackets are disallowed.

E.g. `{[()]}` is acceptable, but `([)]` is not.

Neither is `())` nor `{{}`.

Your compiler uses a stack to solve this problem too.

Stack-Based Bracket Balancer

Use a Stack ADT to balance brackets.

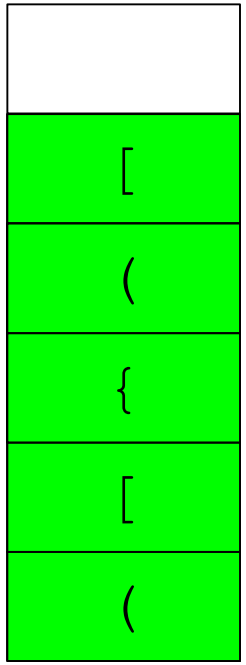
Algorithm:

```
Create an empty stack S
while there is still input {
        if next input token is a left bracket
                push it to S
        if next input token is a right bracket {
                pop from S → left
                if left doesn't match right or failed pop then error
        }
}
if S not empty then error
```

Example:

([{ [ ] ([ ]) { } } [[ ]]])

S:



Implementation of Stack ADT

ADT implementations are tied to the data structure you choose:

- the faster, the better
- the smaller, the better

Big-*O* is the measuring stick

For today's implementation of a Stack, we choose linked lists, i.e., 1 Stack ↔ 1 Linked List.

Q. What's the running time of:

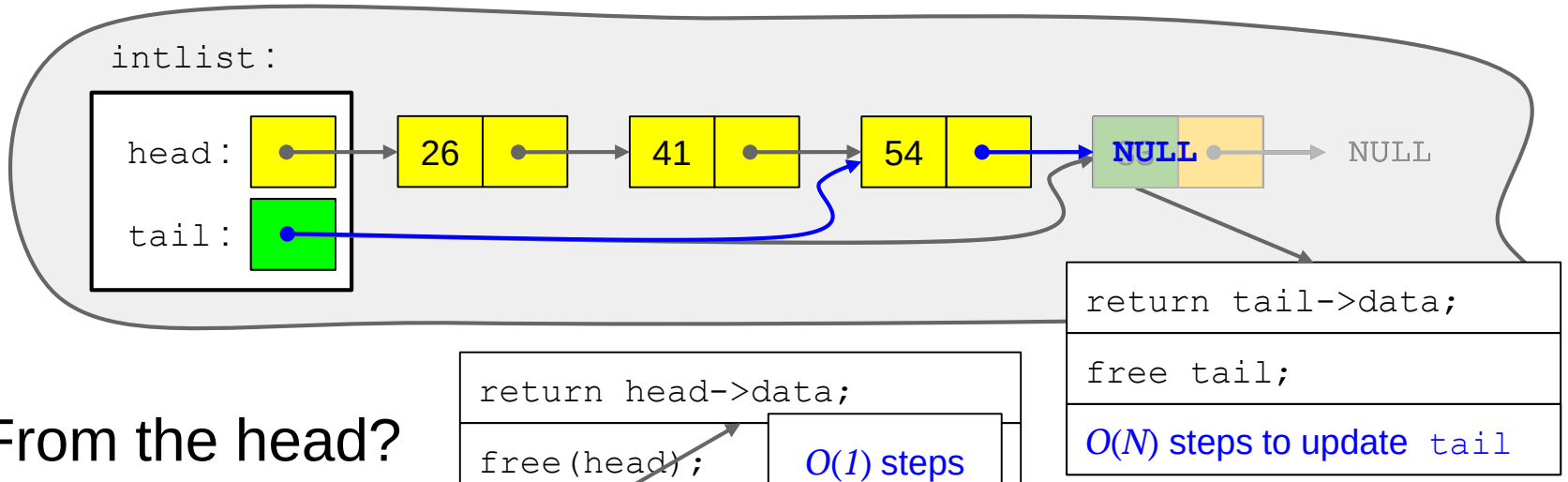
- `create()`?
- `isEmpty(S)`?
- `push(S, x)`?

Two options:
Can `LLappend(x)` to the tail OR can `LLprepend(x)` to the head.
Both are *O*(*1*).

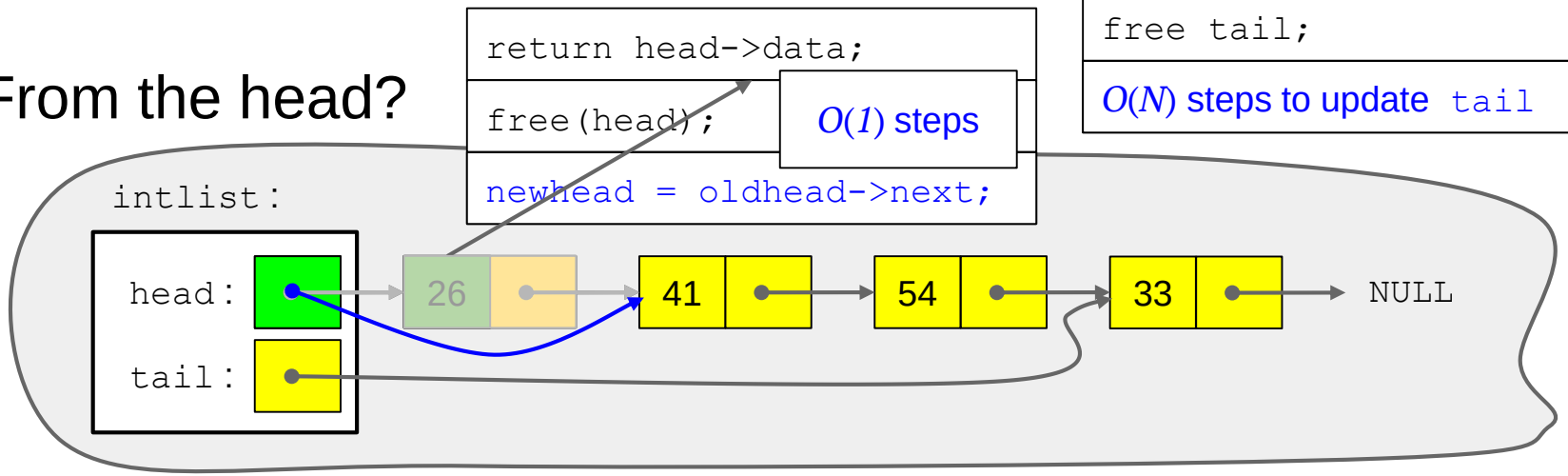
Implementing `pop(S)`

Q. From which end should you remove an item?

From the tail?



From the head?



Stack Implementation: Algorithms

```
create():
     return LLcreate();

isEmpty(S):
     return (S->head == NULL);

pop(S):
     return LLremoveHead(S);

push(S, x):
     LLprepend(S, x);
```