CSE 331
Software Design & Implementation

Autumn 2023

Section 10 – Final Review

Administrivia

- HW9
  - Due tomorrow @11pm

- Final
  - **Tuesday, 12/12, MGH 389**
  - Exam A: **2:30 – 4:20**
  - Exam B: **4:30 – 6:20**
  - Please arrive a couple minutes early
  - No notecards, all needed definitions will be included

- Final review session
  - **Monday, 12/11, 7-8:30pm**
  - **CSE1** (Allen), across breakout rooms
  - Bring questions related to practice exams or general concepts

Course Evals!!

- Please fill them out!
- We appreciate the feedback (TAs and Kevin both)
  - We will actually read them, so any suggestions will be considered!

- **If 50% of responses are completed, we will give everyone an additional day to complete HW9!!** 🎉 🎉
  - New on time deadline would be Saturday, 12/9
  - Deadline with late day would be Sunday, 12/10

Final topics

- **All topics covered by midterm are fair game**

  (Remember, midterm was largely final practice)
  - Reasoning about Recursion
  - Reasoning about Loops
  - Writing Methods
  - Testing

- **New topics that may be included:**
  - Writing the code of a for loop, given the loop idea and invariant.
  - Writing or proving correct the methods of classes that implement mutable ADTs

ADT

- **`MutableIntCursor` ADT** represents a list of integers with the ability to insert new characters at the "cursor index" within the list.
  - cursor index can be moved forward or backward

- **`LineCountingCursor`** implements `MutableIntCursor` by:
  - using the abstract state (an index and a list of values) as its concrete state
  - + records the number of newline characters (so class can easily, quickly determine the number of lines in the text)

- **Reminder**: familiar functions on last page of WS!

Problem 1b

{{ **Pre:** $\text{this.numNewlines}_0 = \text{count}(\text{this.values}_0, \text{newline})$ }}

Explain, in English, why the facts listed in **Pre** will be true when the function is called:

- The first fact is from the representation invariant, which must be true when each method starts

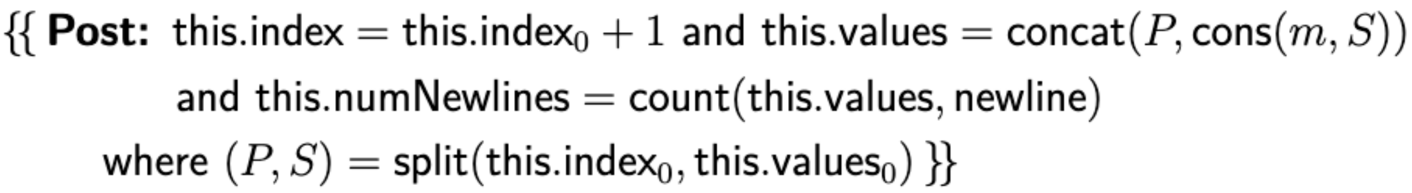
```
// RI: 0 <= this.index <= len(this.values) and
//       this.numNewlines = count(this.values, newline)
```

Problem 1c

$$\begin{aligned}\{\{\ \textbf{Post:}\ & \mathsf{this.index} = \mathsf{this.index}_0 + 1 \text{ and } \mathsf{this.values} = \mathsf{concat}(P, \mathsf{cons}(m, S)) \\ & \text{and } \mathsf{this.numNewlines} = \mathsf{count}(\mathsf{this.values}, \mathsf{newline}) \\ \text{where } & (P, S) = \mathsf{split}(\mathsf{this.index}_0, \mathsf{this.values}_0)\ \}\}\end{aligned}$$

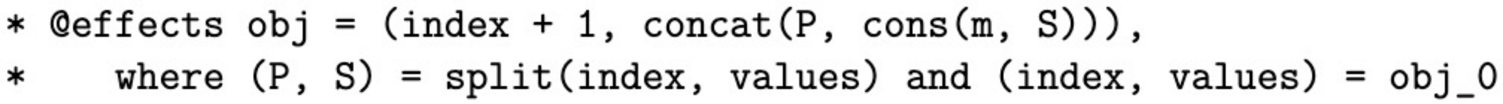
Explain, in English, why the facts listed in **Post** need to be true when the function completes in order for insert to be complete:

Problem 1c

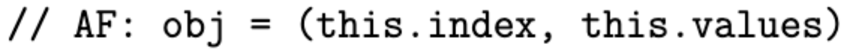


$$\{\{\ \textbf{Post:}\ \text{this.index} = \text{this.index}_0 + 1 \text{ and this.values} = \text{concat}(P, \text{cons}(m, S))$$
$$\text{and this.numNewlines} = \text{count}(\text{this.values}, \text{newline})$$
$$\text{where } (P, S) = \text{split}(\text{this.index}_0, \text{this.values}_0)\ \}\}$$

- The first fact is the statement of effects clause of the spec after we apply the abstraction function:
  - "index" part of abstract state is stored in `this.index` field
  - “values” part of abstract state is stored in `this.values` field.

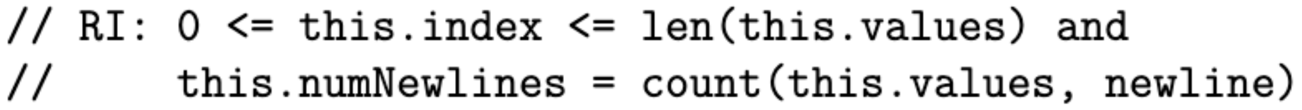


```
* @effects obj = (index + 1, concat(P, cons(m, S))),
*    where (P, S) = split(index, values) and (index, values) = obj_0
```



```
// AF: obj = (this.index, this.values)
```

- The second fact is required by the representation invariant, which must be checked at the end of any mutator method.



```
// RI: 0 <= this.index <= len(this.values) and
//      this.numNewlines = count(this.values, newline)
```

Problem 2

- Fill in the missing parts of the method so it is correct with the *given invariant*

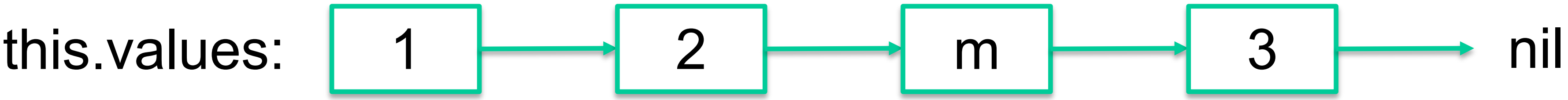
- **Loop idea:**
  - skip past elements in `this.values` until we reach one that equals the given number or we hit the end

- **Invariant:**
  - `this.values` is split up between skipped and rest, with skipped being the front part in reverse order
  - no element of skipped is equal to the number m

- Do not write any other loops or call any other methods. The only list functions that should be needed are `cons` and `len`

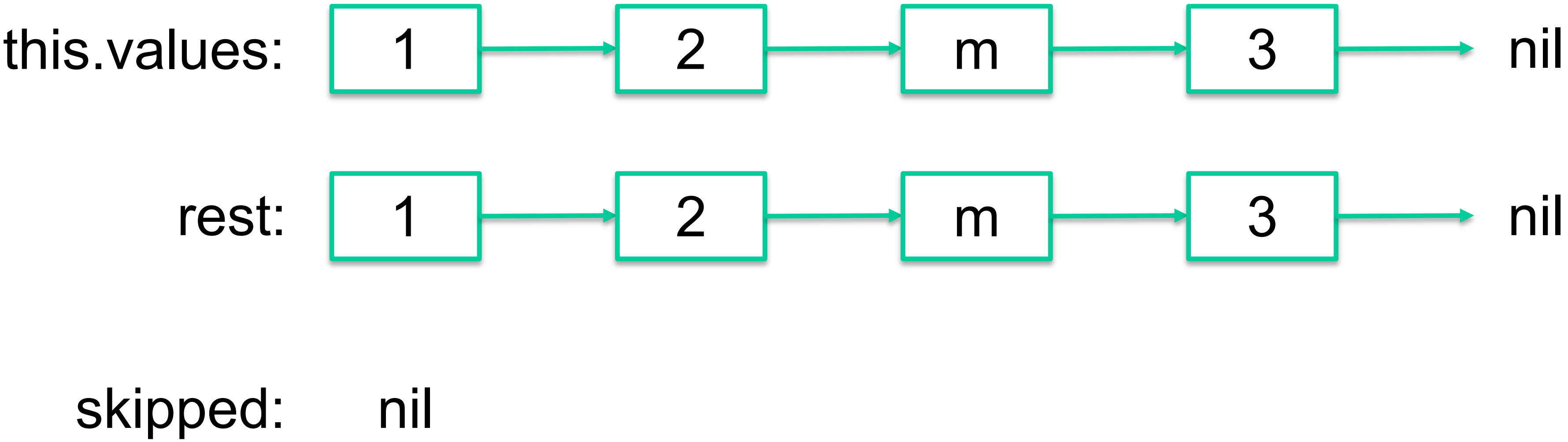
Problem 2

```
// Inv: this.values = concat(rev(skipped), rest) and
//      contains(m, skipped) = false
```



Problem 2

```
// Inv: this.values = concat(rev(skipped), rest) and
//      contains(m, skipped) = false
```



this.values: 1 → 2 → m → 3 → nil

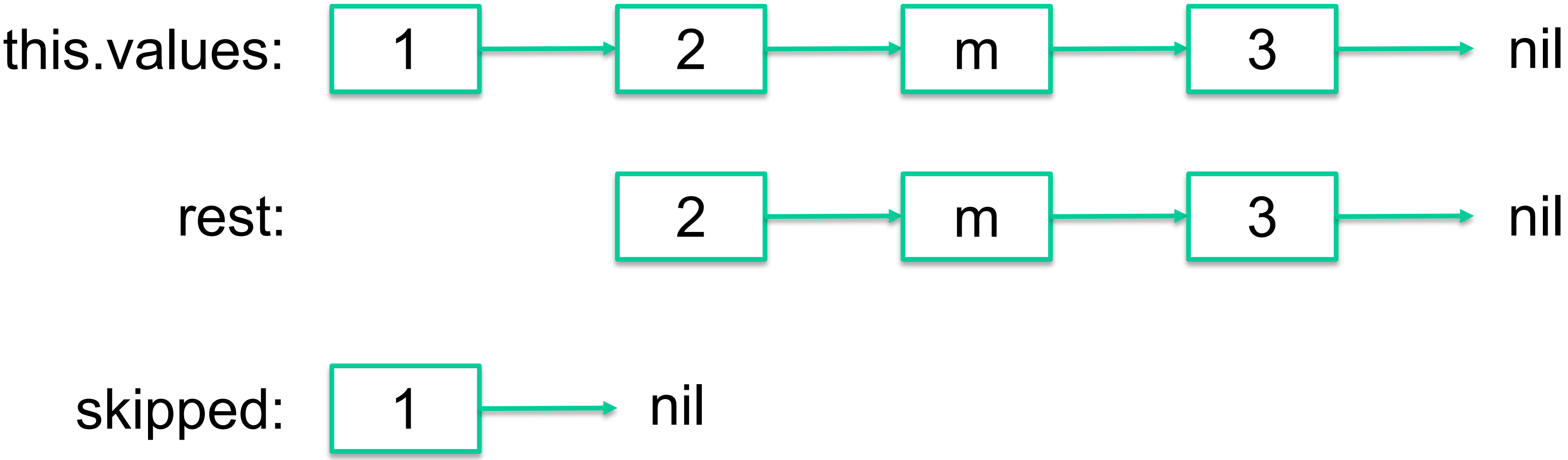
rest: 1 → 2 → m → 3 → nil

skipped: nil

Easiest way to satisfy the invariant

Problem 2

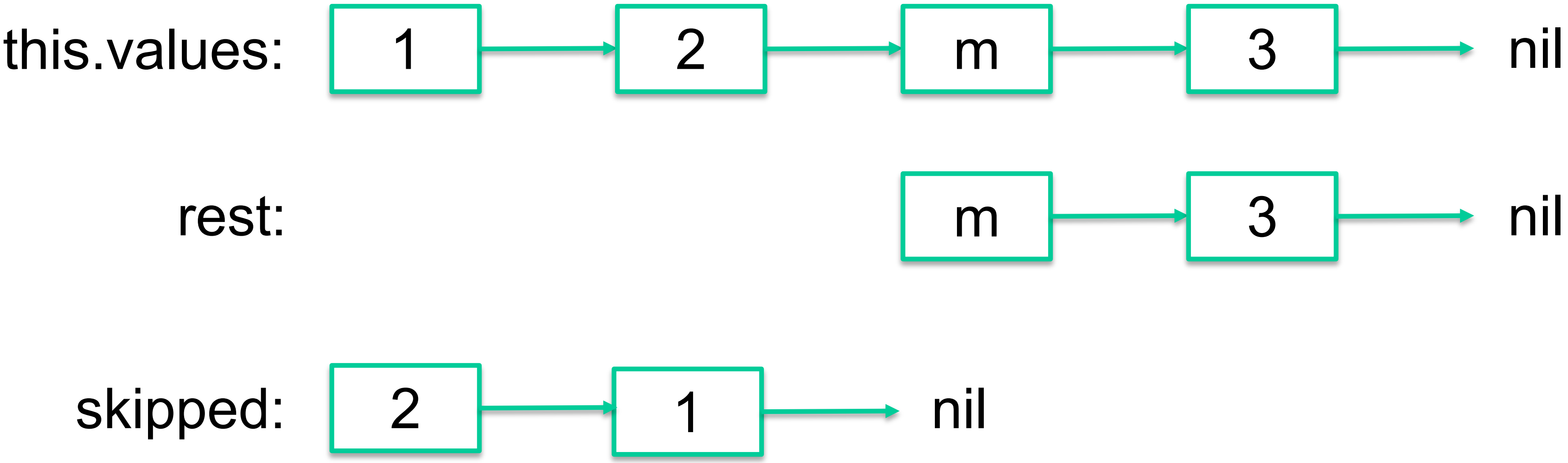
```
// Inv: this.values = concat(rev(skipped), rest) and
//      contains(m, skipped) = false
```



While rest.hd != m (need to check rest != nil first), remove and append rest.hd to skipped (cons adds to front which reverses the list which matches the invariant)

Problem 2

```
// Inv: this.values = concat(rev(skipped), rest) and
//      contains(m, skipped) = false
```



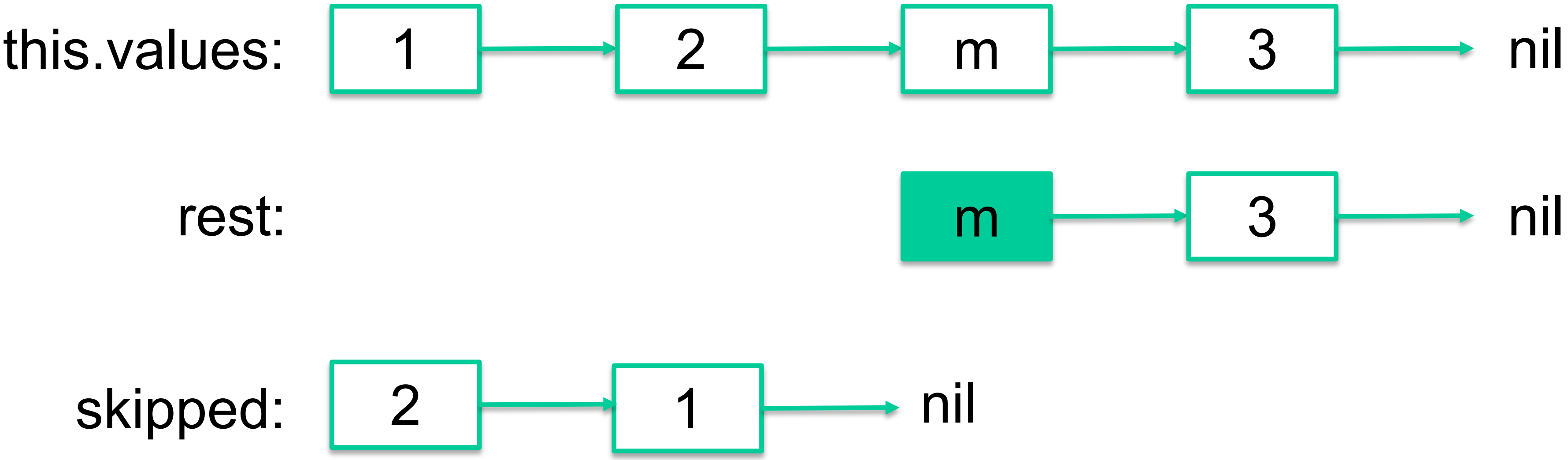
this.values: 1 → 2 → m → 3 → nil

rest: m → 3 → nil

skipped: 2 → 1 → nil

Problem 2

```
// Inv: this.values = concat(rev(skipped), rest) and
//      contains(m, skipped) = false
```



When we exit the loop

- If rest = nil then we didn’t find m
- Otherwise, Index of m is the length of the skipped list

Problem 2

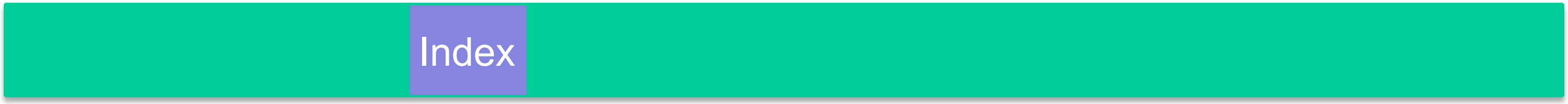
```
// Move the index to the first occurrence of m in values.
moveToFirst = (m: number): void => {
  let skipped: List<number> = _______nil________________;
  let rest: List<number> = _______this.values__________;

  // Inv: this.values = concat(rev(skipped), rest) and
  //      contains(m, skipped) = false
  while (______rest !== nil && rest.hd !== x____) {
      skipped = cons(rest.hd, skipped);
      rest = rest.tl;
  }

  if (rest === nil) {
    throw new Error(‘did not find ${x}‘);
  } else {
    this.index = __________len(skipped)_______________;
  }
};
```

Problem 3

- Fill **`removeNextLine`** so it removes all the text on the next line: text between the first and second newline characters *after* the cursor index
  - remove second newline, but leave cursor index in place
  - If there are no newlines after cursor, then do nothing
  - If there is only one newline after cursor, remove all text after it
- method of LineCountingCursor, so you can access `this.index` and `this.values`
- Can use any Familiar List Functions from final page and assume they've been translated to TS
- Hint: split-at function from HW5 may be useful, assume the TS translation of it is called `splitAt`

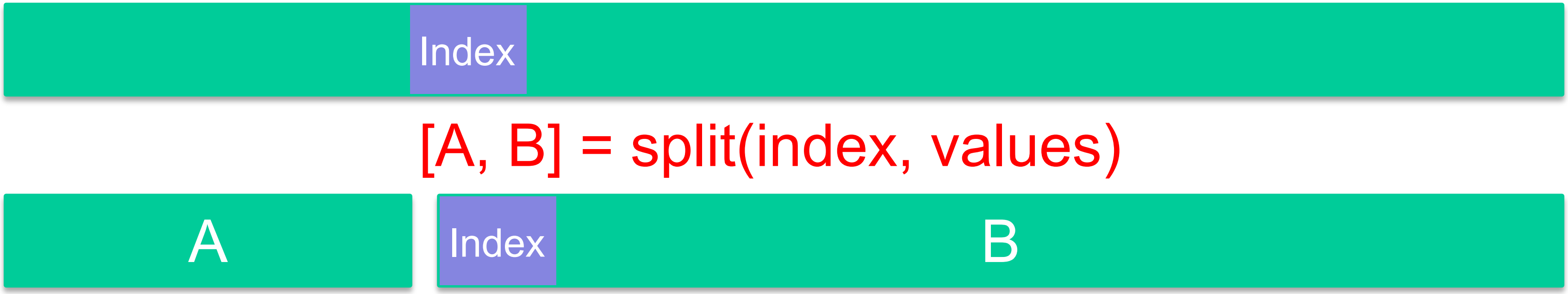
Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



Problem 3

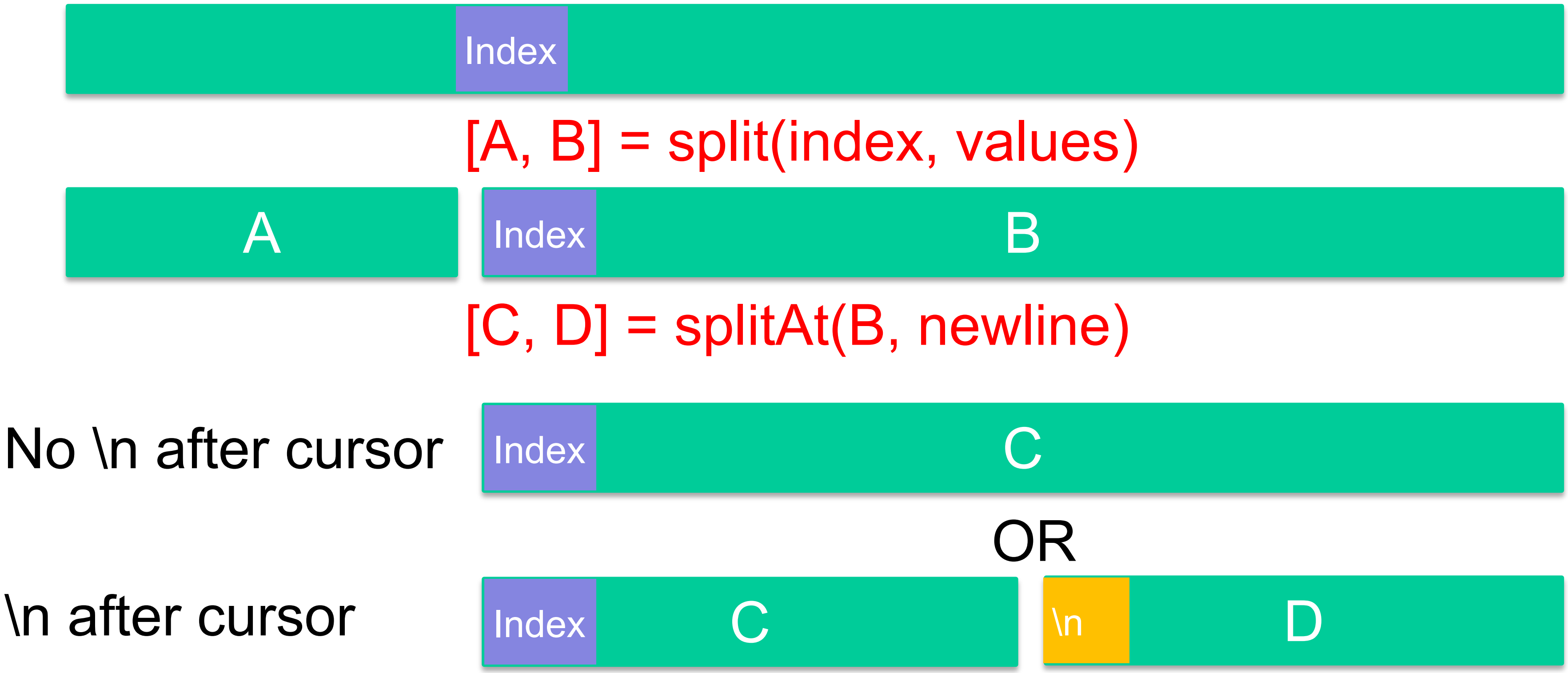
```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



[A, B] = split(index, values)

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



[A, B] = split(index, values)

[C, D] = splitAt(B, newline)

No \n after cursor

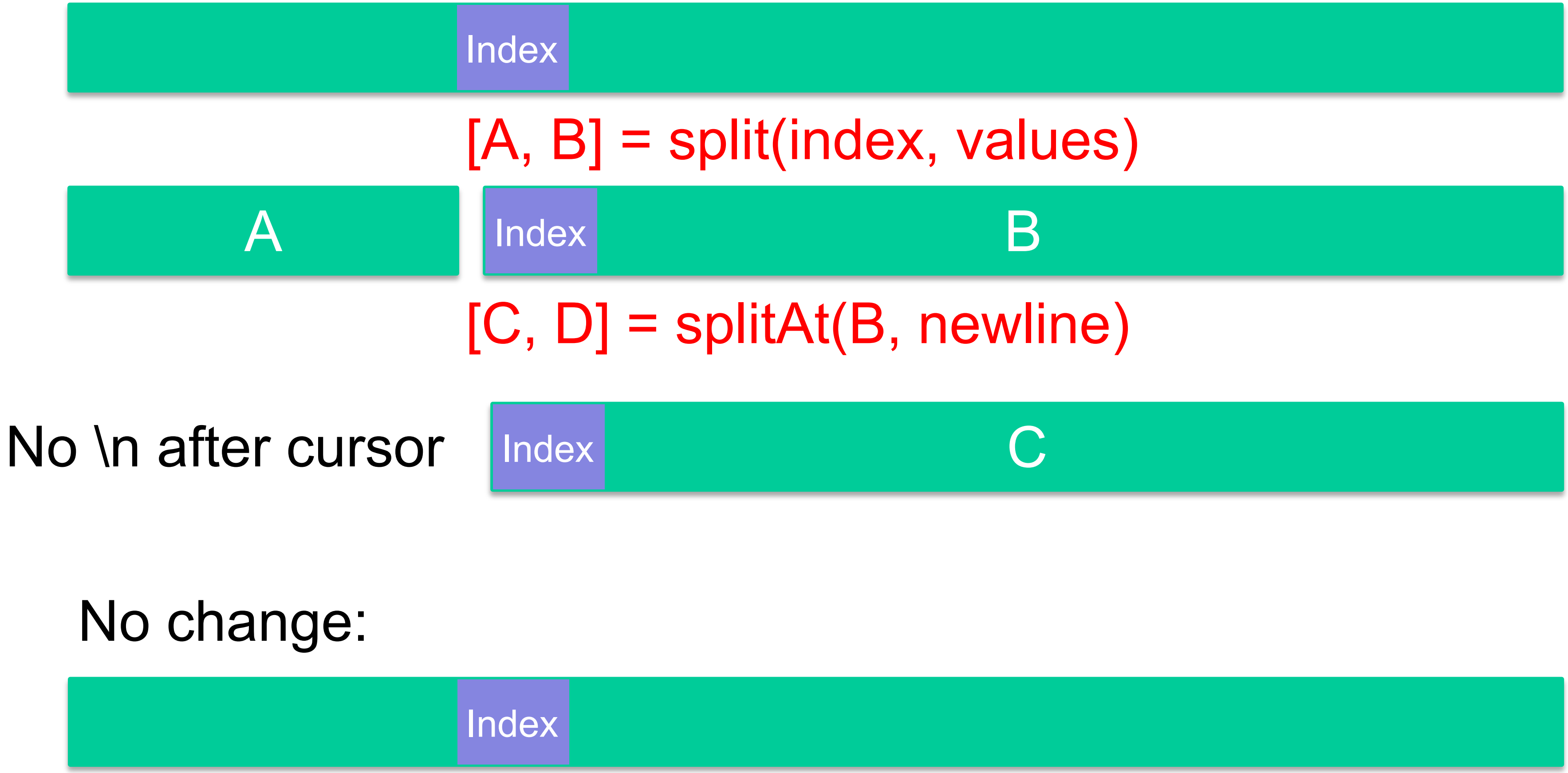
OR

\n after cursor

hi

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



[A, B] = split(index, values)

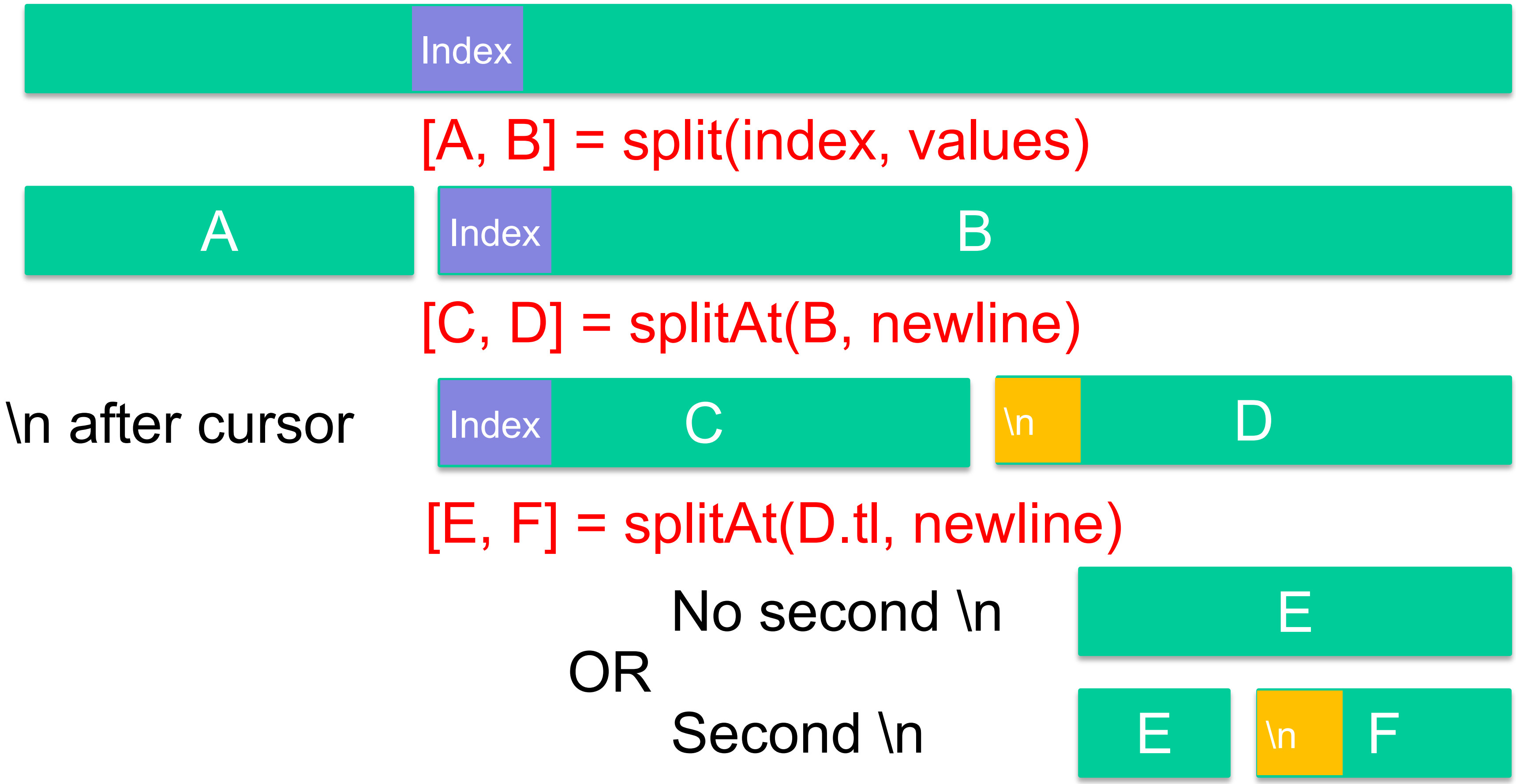
[C, D] = splitAt(B, newline)

No \n after cursor

No change:

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



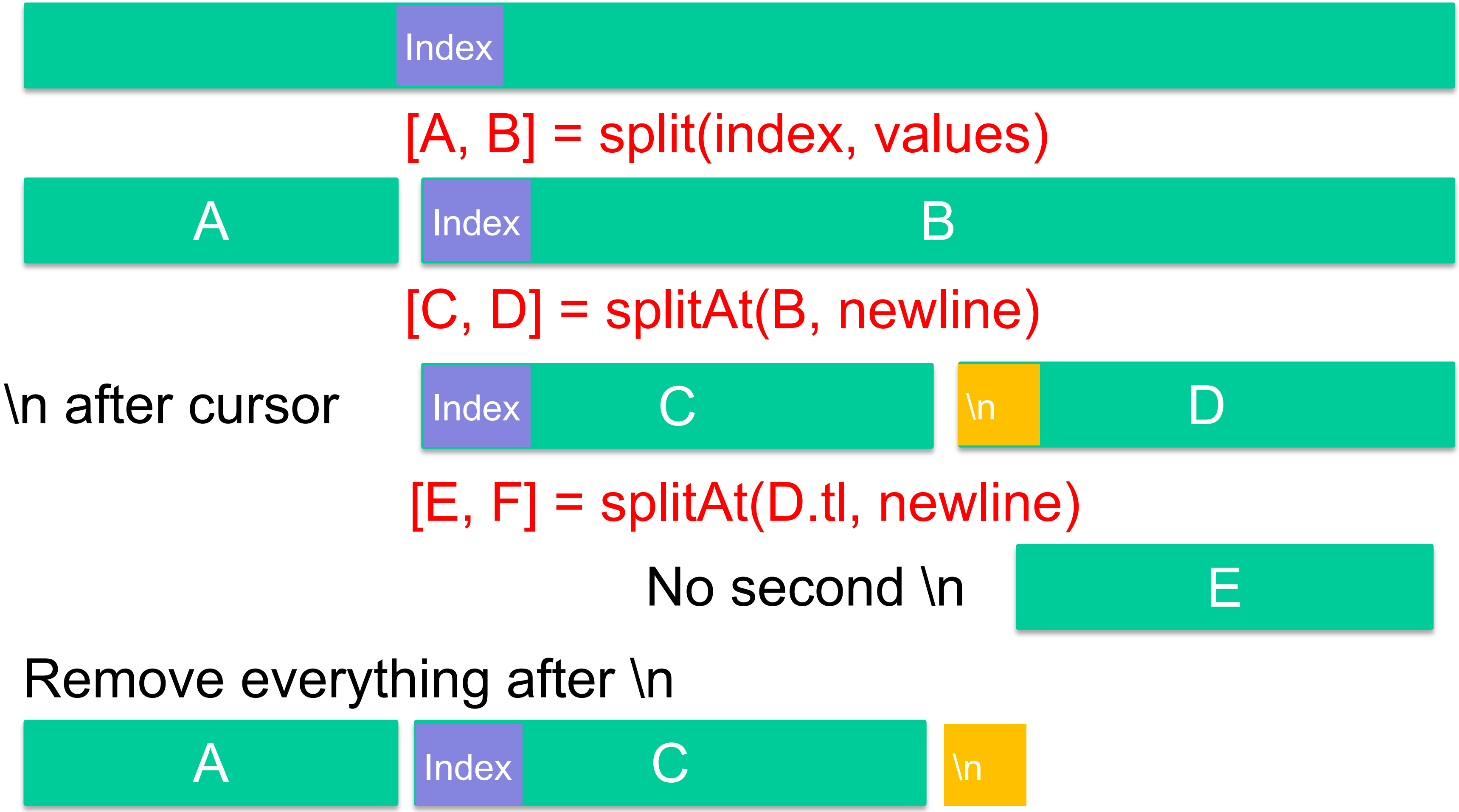
[A, B] = split(index, values)

[C, D] = splitAt(B, newline)

[E, F] = splitAt(D.tl, newline)

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



[A, B] = split(index, values)

[C, D] = splitAt(B, newline)

\n after cursor

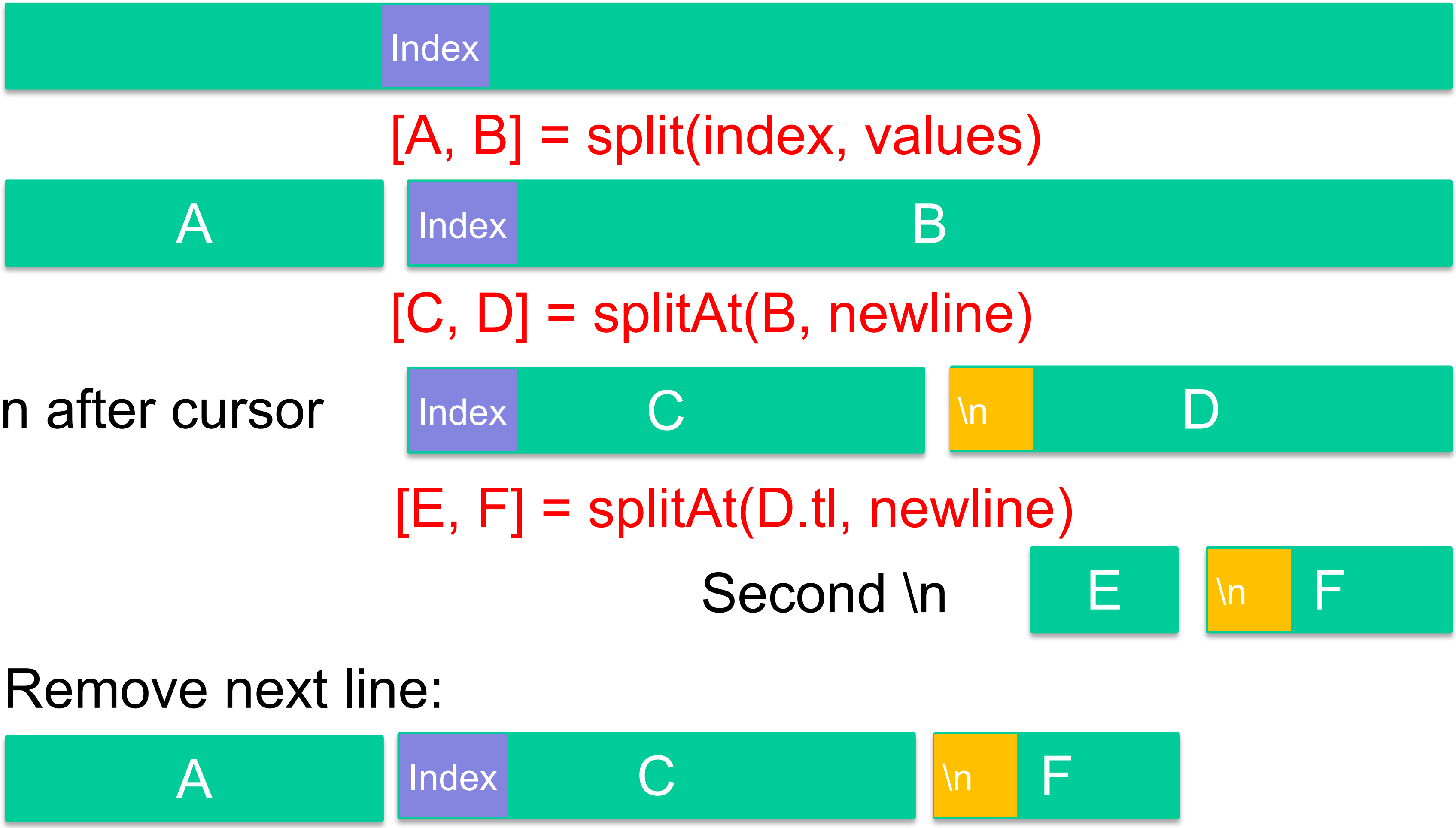
[E, F] = splitAt(D.tl, newline)

No second \n

Remove everything after \n

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
```



[A, B] = split(index, values)

[C, D] = splitAt(B, newline)

\n after cursor

[E, F] = splitAt(D.tl, newline)

Second \n

Remove next line:

Problem 3

```
// Removes the line of text after the one containing the cursor index
removeNextLine = (): void => {
  const [A, B] = split(this.index, this.values);
  const [C, D] = splitAt(B, newline);
  if (D !== nil) {
    // after the newline
    const [E, F] = splitAt(D.tl, newline);
    if (F == nil) {
      this.values = concat(A, concat(C, cons(newline, nil)));
    } else {
      // drop one newline
      this.values = concat(A, concat(C, F));
      this.numNewLines = this.numNewlines - 1;
    }
  }
};
```