

NATIONAL UNIVERSITY OF SINGAPORE
CS1101S — PROGRAMMING METHODOLOGY

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(AY2018/2019 SEMESTER 1)

READING ASSESSMENT 2, REDACTED EDITION OF 2020/21

Time Allowed: **45 Minutes**

INSTRUCTIONS

1. This question paper comprises **NINE (9)** printed pages, including this page.
2. You are also provided with **one OCR Form** to write your answers.
3. Clearly **write** and **shade** your **STUDENT NUMBER** on your **OCR Form** using a **2B PENCIL**.
4. There are **17** multiple-choice questions. Each question has one correct answer. **1 mark** is awarded for each correct answer and there is no penalty for a wrong answer.
5. The full score is **17 marks**.
6. Answer **ALL** questions.
7. Use only a **2B PENCIL** to **shade** your answers on your **OCR Form**.
8. This is a **CLOSED BOOK** assessment, but you are allowed to bring in one A4 sheet of notes (handwritten or printed on both sides).
9. **Submit only the OCR Form.**

- (1) What is the single-digit **number** at the **top-right corner** on the **front page** of this question paper? (**Important:** Please make sure your answer is correct because it determines how we mark your answers to all the subsequent questions.)

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5

A

Consider the following Source program for the next 3 questions:

Program A:

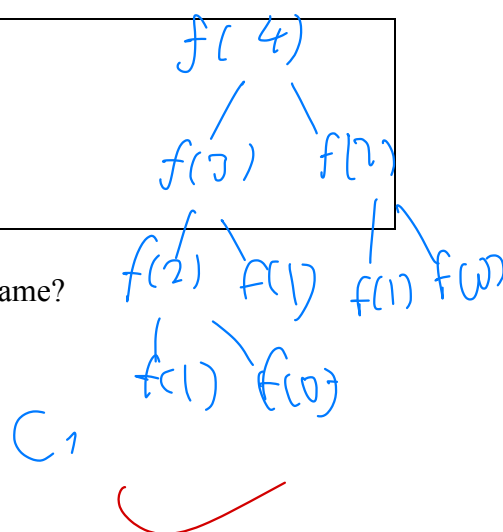
```
x => x + 1;

function funA(n) {
    return n <= 1 ? n : funA(n - 1) + funA(n - 2);
}

const aa = funA(4);
```

- (2) How many bindings appear in the program environment frame?

- A. 0
- B. 1
- C. 2
- D. 3
- E. More than 3



- (3) How many environment frames get created during the evaluation of Program A? (Do not count the global environment frame.)

- A. 0
- B. 1
- C. 4
- D. 10
- E. None of the above

D.

- (4) Of the environment frames that get created during the evaluation of Program A, how many extend the program environment *directly*?

- A. 0
- B. 1
- C. 4
- D. 9
- E. None of the above

D.

- (5) How many environment frames get created during the evaluation of the following program? (Do not count the global environment frame.)

```
function funB(n) {
  if (n <= 1) {
    return n;
  } else {
    let xx = funB(n - 1);
    let yy = funB(n - 2);
    return xx + yy;
  }
}
funB(4);
```

sym
+
9 func calls.
+ 4 xx, yy.

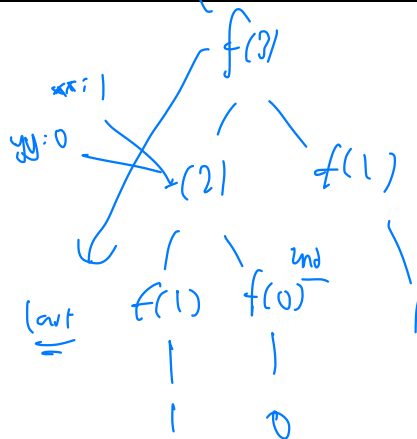
- A. 14
B. 9
C. 4
D. 1
E. None of the above

A.

- (6) What is the result of evaluating the following program?

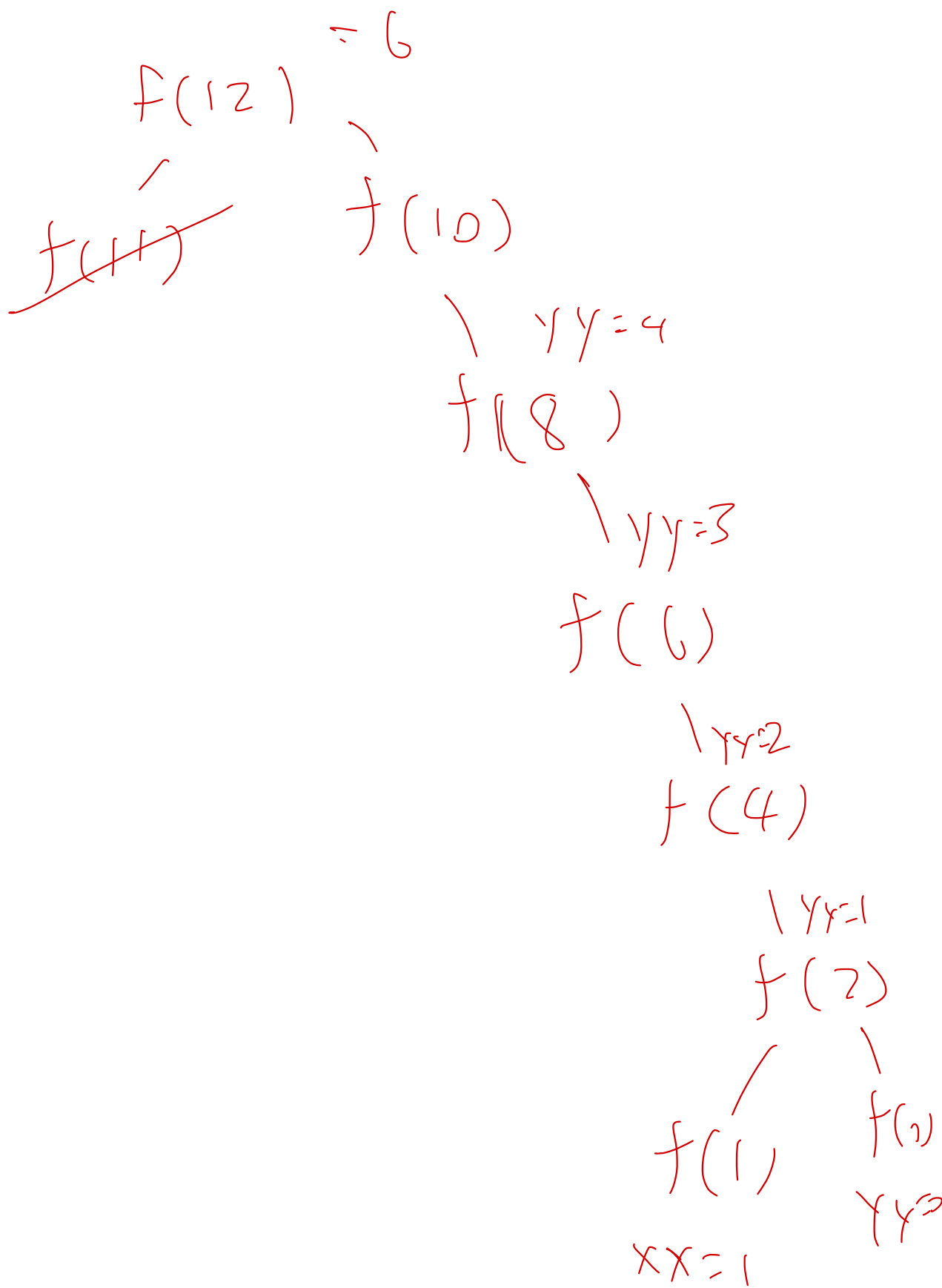
```
let xx = 0;
let yy = 0;

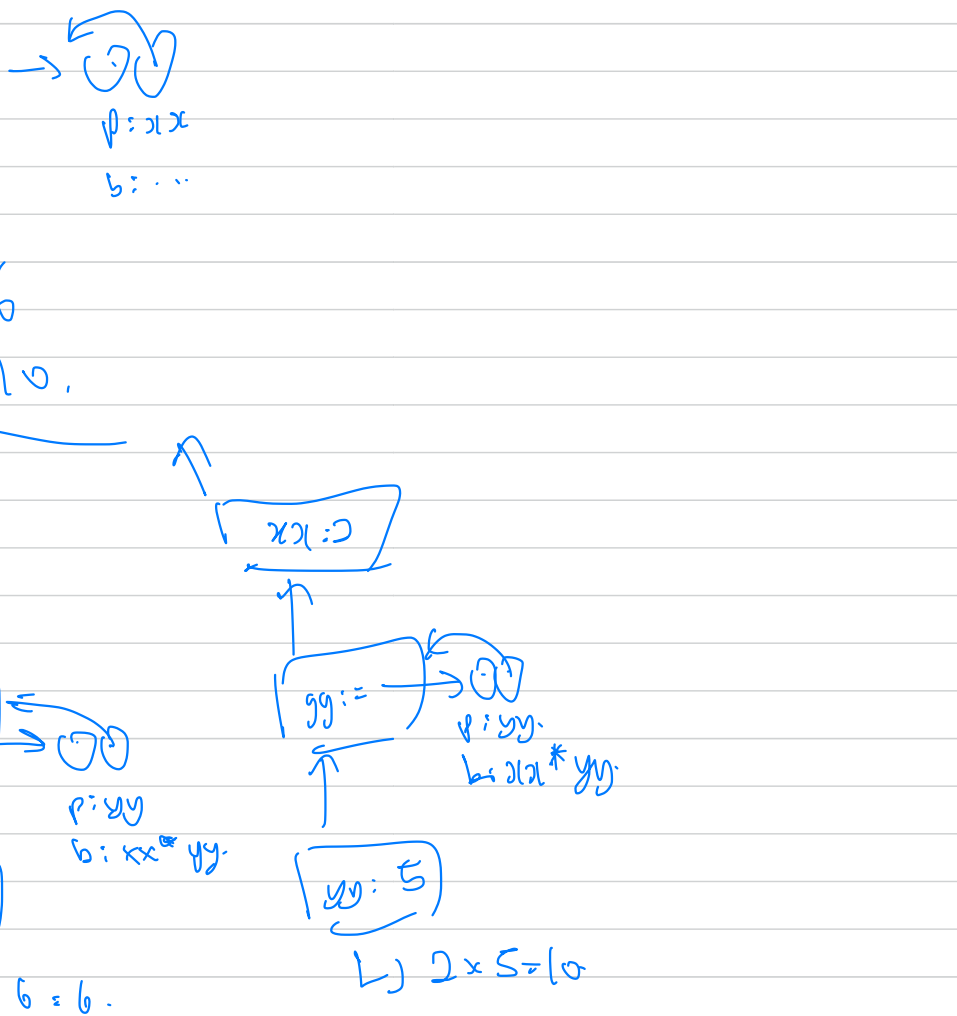
function funC(n) {
  if (n <= 1) {
    return n;
  } else {
    xx = funC(n - 1);
    yy = funC(n - 2);
    return xx + yy;
  }
}
funC(12);
```



- A. 1
B. 6
C. 21
D. 144
E. None of the above

B.





Consider the following Source program for the next 4 questions:

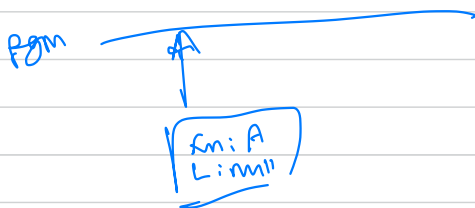
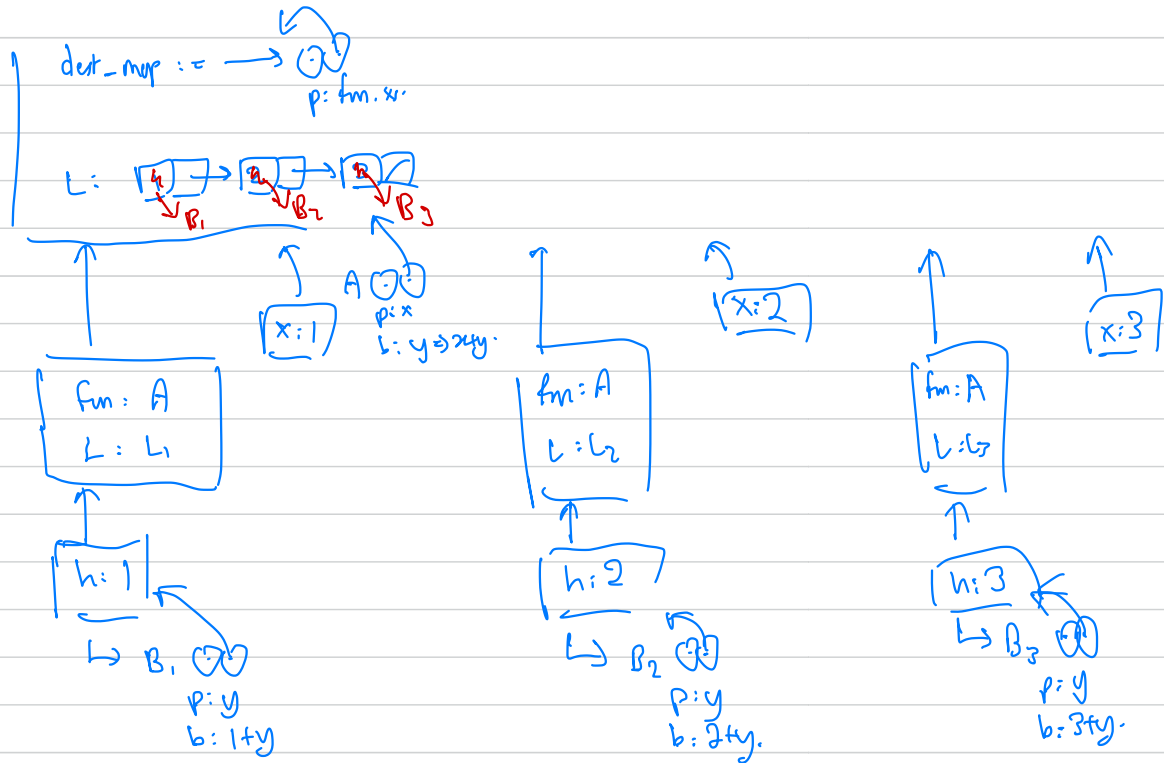
Program D:

```
function ff(xx) {
  function gg(yy) {
    return xx * yy;
  }
  return gg;
}
const aa = ff(1)(6);
const bb = ff(2)(5);
ff(aa)(bb);
```

- (7) How many function objects get created during the evaluation of Program D?
- A. 6
B. 4
C. 3
D. 2
E. 1
- (8) How many environment frames get created during the evaluation of Program D? (Do not count the global environment frame.)
- A. 1
B. 3
C. 7
D. 9
E. None of the above
- (9) Of the environment frames that get created during the evaluation of Program D, how many extend the program environment *directly*?
- A. 1
B. 3
C. 6
D. 9
E. None of the above
- (10) During the evaluation of Program D, some of the environment frames contain the name `xx`. Which other name do these frames also contain?
- A. `gg`
B. `ff`
C. `yy`
D. `aa`
E. None of the above

Program E:

```
function dest_map(fun, xs) {
  if (! is_null(xs)) {
    const h = head(xs);
    set_head(xs, fun(h));
    dest_map(fun, tail(xs));
  } else { }
}
const L = list(1, 2, 3);
dest_map(x => y => x + y, L);
```



Consider the following Source program for the next 4 questions:

Program E:

```
function dest_map(fun, xs) {
  if (! is_null(xs)) {
    const h = head(xs);
    set_head(xs, fun(h));
    dest_map(fun, tail(xs));
  } else { }
}
const L = list(1, 2, 3);
dest_map(x => y => x + y, L);
```

(11) How many function objects get created during the evaluation of Program E?

- A. 1
- B. 2
- C. 4
- D. 5
- E. None of the above

D - ✓

(12) How many environment frames get created during the evaluation of Program E? (Do not count the global environment frame. We assume that the application of a primitive function does not create any frame. See Appendix for a list of primitive functions.)

- A. 7
- B. 3
- C. 11
- D. 4
- E. None of the above

C - ✓

(13) Of the environment frames that get created during the evaluation of Program E, how many extend the program environment *directly*?

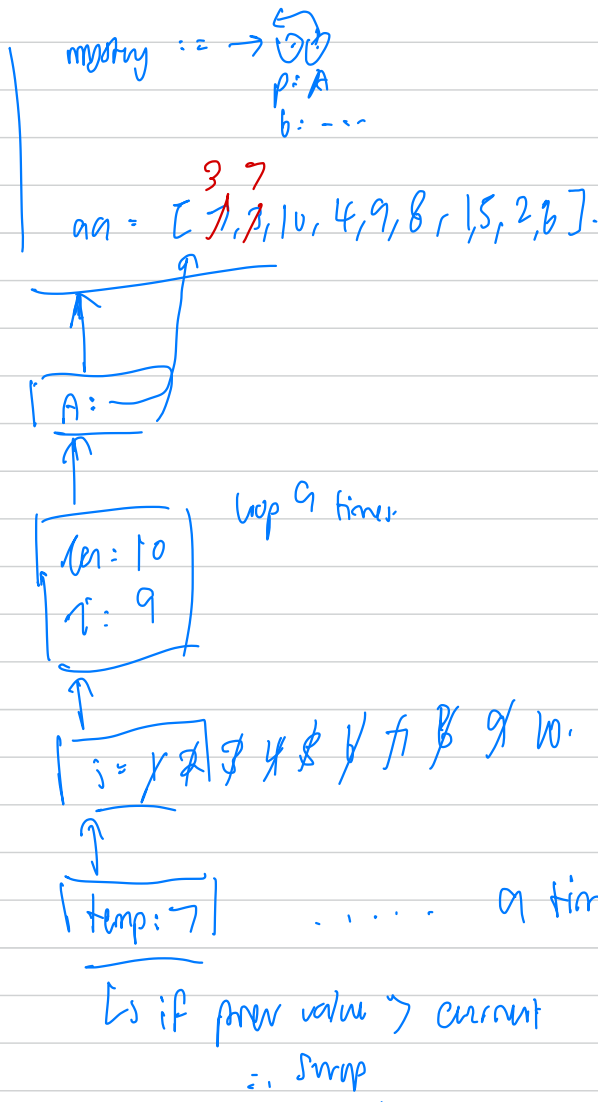
- A. 7
- B. 3
- C. 2
- D. 4
- E. None of the above

A - ✓

Program 1.

```
function mystery(A) {
  const len = array_length(A);
  let i = len - 1;
  while (i >= 1) {
    let j = 1;
    while (j <= i) {
      const temp = A[j - 1];
      if (A[j - 1] > A[j]) {
        A[j - 1] = A[j];
        A[j] = temp;
      } else { }
      j = j + 1;
    }
    i = i - 1;
  }
}
const aa = [7, 3, 10, 4, 9, 8, 1, 5, 2, 6];
mystery(aa);
aa;
```

7, 3, 10, 4, 9, 8, 1, 5, 2, 6
 3, 7, 4, 9, 8, 1, 5, 2, 6, 10
 3, 4, 7, 8, 1, 5, 2, 6, 9, 10



1, 2, 3, 4... 10.

+ 3 frames

+ 9 frames. } 12.

9 + 8 + 7 + 6 + 5 + 4 + 3
 + 2 + 1 frames } 45.

57 frames.

(14) Which of the following statements, when added to the end of Program E, will change the value of L back to `list(1, 2, 3)`?

- A. `dest_map(x => y => x - y, L);`
- B. `dest_map(x => x - y, L);`
- C. `dest_map(x => x(0), L);`
- D. `dest_map(x => y => x(-y), L);`
- E. None of the above

C.

Consider the following Source program for the next 3 questions:

Program F:

```
function mystery(A) {
  const len = array_length(A);
  let i = len - 1;
  while (i >= 1) {
    let j = 1;
    while (j <= i) {
      const temp = A[j - 1];
      if (A[j - 1] > A[j]) {
        A[j - 1] = A[j];
        A[j] = temp;
      } else { }
      j = j + 1;
    }
    i = i - 1;
  }
}
const aa = [7, 3, 10, 4, 9, 8, 1, 5, 2, 6];
mystery(aa);
aa;
```

(15) How many environment frames get created during the evaluation of Program F? (Do not count the global environment frame. We assume that the application of a primitive function does not create any frame. See Appendix for a list of primitive functions.)

- A. 91
- B. 56
- C. 46
- D. 19
- E. None of the above

E.

(16) Of the environment frames that get created during the evaluation of Program F, how many are created for the *inner while*-loop in the function *mystery*?

- A. 0
- B. 9
- C. 45
- D. 81
- E. None of the above

C. ✓

(17) What is the value of *aa* at the end of the evaluation of Program F?

- A. [1, 3, 5, 7, 9, 10, 2, 4, 6, 8]
- B. [3, 7, 4, 9, 8, 1, 5, 2, 6, 10]
- C. [7, 7, 7, 7, 7, 7, 7, 7, 7, 7]
- D. [10, 9, 8, 7, 6, 5, 4, 3, 2, 1]
- E. [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

E. ✓

———— END OF QUESTIONS ————

Appendix

Primitive Functions

The following are some of the primitive functions in Source §3:

- `display(a)`
- `pair(x, y)`
- `is_pair(x)`
- `head(x)`
- `tail(x)`
- `is_null(xs)`
- `list(x1, x2, ..., xn)`
- `set_head(p, x)`
- `set_tail(p, x)`
- `array_length(x)`

Pre-declared Functions

Some of the pre-declared functions in Source §3 are declared as follows:

```
function length(xs) {
  return is_null(xs)
    ? 0
    : 1 + length(tail(xs));
}

function map(f, xs) {
  return is_null(xs)
    ? xs
    : pair(f(head(xs)), map(f, tail(xs)));
}

function filter(pred, xs) {
  return is_null(xs)
    ? xs
    : pred(head(xs))
      ? pair(head(xs), filter(pred, tail(xs)))
      : filter(pred, tail(xs));
}

function accumulate(op, initial, xs) {
  return is_null(xs)
    ? initial
    : op(head(xs), accumulate(op, initial, tail(xs)));
}
```

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