

Homework Assignment 6

Any automatically graded answer may be manually graded by the instructor. Submissions are expected to only use functions taught in the course. If a submission uses a disallowed function, that exercise can get zero points. Excluding promises, *all functions that mutate values are disallowed* (mutable functions usually have a **!** in their name).

Memory management

1. Implement function **frame-refs** that returns the set of all handles contained in the given frame, according to the notion of *contains* introduced in Lecture 27.¹ *Hint:* Consider using function **frame-fold**. If your solution uses **frame-fold**, then the solution should **not** be recursive.

```
(-> frame? set?)
```

2. Implement function **(mem-mark contained mem ref)** that returns the set of all reachable handles from handle **ref**, and takes: **contained** a function that takes an element of the heap and returns a set of handles contained in that element, **mem** is a heap, and **ref** is the initial handle, according to the memory sweep algorithm discussed in Lecture 27. An example of a **contained** function is function **frames-refs** for a heap of frames. Notice that function **mem-mark** expects a heap of any data.

```
(-> (-> any/c set?) heap? handle? set?)
```

3. Implement function **(mem-sweep mem to-keep)** that given a heap **mem** and a set of handles to keep (parameter **to-keep**) returns a new heap of frames that only contains the handles in the given set. *Hint:* Peruse **hw6-util.rkt** for heap-related functions. The solution should be a single function call.

```
(-> heap? set? heap?)
```

¹<https://cogumbreiro.github.io/teaching/cs450/s21/lecture27.html#19>

Monads

4. Implement the monadic operation (`mlist bind pure args`) that takes a list `args` of monadic operations and binds each result in a new list. Do not hardcode the implementation of `mlist` to `eff-bind` or `eff-pure`. *Hint:* Check if your code works with `list-bind` and `list-pure`.

For instance, (`mlist eff-bind eff-pure (list op1 op2 op3)`) is equivalent to the code below

```
(do
  x1 <- op1 ; using eff-bind
  x2 <- op2 ; using eff-bind
  x3 <- op3 ; using eff-bind
  (eff-pure (list x1 x2 x3)))
```

5. Implement the monadic operation (`mapply bind pure f . args`) that takes a function `f`, a variable number of monadic operations `args`, and returns the pure result of applying function `f` to a list that is obtained by binding the result of each monadic operation in `args` into a list (by the same order). The solution can be solved by using function `mlist`. *Hint:* this exercise should `bind` the result of `mlist`, and feed it to function `apply`.

For instance, (`mapply eff-bind eff-pure * op1 op2 op3`) is equivalent to the code below

```
(do
  x1 <- op1 ; using eff-bind
  x2 <- op2 ; using eff-bind
  x3 <- op3 ; using eff-bind
  (eff-pure (* x1 x2 x3)))
```

Manually graded questions

6. **Manually graded.** Consider memory management via reference counting and the increment count operation. Suppose that the reference count algorithm is faulty and the reference count overflows resetting back to zero. *Discuss if overflowing the reference count affects soundness or completeness of memory management.*