1. Suppose we are operating on a 1D vector. Which of the following operation is not data parallel over the vector elements? 1 point

- ○ Add a constant to every element.
- ◉ Multiply the vector by a constant.
- ○ Increment the vector by another vector of the same dimension.
- ◉ Compute the average of the elements.
- ○ Compute the sign of each element.

2. (True/False) A single mapper call can emit multiple (key,value) pairs. 1 point

- ◉ True
- ○ False

3. (True/False) More than one reducer can emit (key,value) pairs with the same key simultaneously. 1 point

- ○ True
- ◉ False

4. (True/False) Suppose we are running k-means using MapReduce. Some mappers may be launched for a new k-means iteration even if some reducers from the previous iteration are still running. 1 point

- ○ True
- ◉ False

5. 1 point

Consider the following list of binary operations. Which can be used for the reduce step of MapReduce? Choose all that apply.
Hints: The reduce step requires a binary operator that satisfied both of the following conditions.

- Commutative: $OP(x_1, x_2) = OP(x_2, x_1)$
- Associative: $OP(OP(x_1, x_2), x_3) = OP(x_1, OP(x_2, x_3))$

- ☑ $\mathrm{OP1}(x_1, x_2) = \max(x_1, x_2)$
- ☑ $\mathrm{OP2}(x_1, x_2) = x_1 + x_2 - 2$
- ☐ $\mathrm{OP3}(x_1, x_2) = 3x_1 + 2x_2$
- ☐ $\mathrm{OP4}(x_1, x_2) = x_1^2 + x_2$
- ☐ $\mathrm{OP5}(x_1, x_2) = (x_1 + x_2)/2$