Key Terms and Concepts

1. **First Non-Dominated Front** ($\alpha^{(i)}$):
   - The set of solutions in the current population that are not dominated by any other solution. These represent the best trade-offs among the objectives.
2. **Infeasible Solutions** ($\gamma^{(i)}$):
   - The set of solutions in the current population that violate one or more constraints. These solutions need to be repaired to become feasible.
3. **Normalized Constraint Violation**:
   - A measure of how much a solution violates the constraints, normalized to allow comparison between different types of violations. This helps in identifying which solutions are closer to being feasible.
4. **Crowding Distance**:
   - A measure of the density of solutions surrounding a particular solution in the objective space. Solutions with a higher crowding distance are more diverse and less likely to be similar to other solutions in the population.
5. **Non-Domination Rank**:
   - A ranking system where solutions are ranked based on the number of solutions that dominate them. Solutions in the first non-dominated front have a rank of 1, those dominated by one solution have a rank of 2, and so on.

Repair Algorithm 1 (Reparating Entire Population)

- **Repair Algorithm 1a**:
  - **Set of Repair Candidates** (R_1): Select solutions starting with those having the lowest sum of normalized constraint violation.
  - **Replace Procedure**: For each repair candidate, replace infeasible variables with feasible ones from donor solutions in the set D, starting with the best-ranked solutions.
  - **Donor Solutions** (D): Select solutions with the best non-domination rank and lowest Euclidean distance to the infeasible solution.
- **Repair Algorithm 1b**:
  - **Set of Repair Candidates** (R_2): Select solutions with the best non-domination rank and highest crowding distance.
  - Repeat the replace procedure for each repair candidate in R_2.

Repair Algorithm 2 (Repairing Using Feasible Solutions)

- **Set of Feasible Solutions** ($\omega^{(i)}$):
  - The set of feasible solutions in the current parent population.
- **Set of Infeasible Solutions** ($\gamma^{(i-1)}$):
  - The set of infeasible solutions in the previous generation.
- **Potential Repair Candidates** ($\alpha^{(i-1)}$):
  - Members of $\gamma^{(i-1)}$ that dominate $\omega^{(i)}$.
- **Repair Procedure**:
  - Rank solutions in $\alpha^{(i-1)}$ based on non-domination rank and crowding distance.
  - Form a set of repair candidates R from $\alpha^{(i-1)}$ until its size equals N_R.
  - Replace infeasible variables in each repair candidate with values from the closest feasible solutions in $\omega^{(i)}$.

Summary

- **Repair Algorithm 1** focuses on repairing the entire population of infeasible solutions by leveraging normalized constraint violation and Euclidean distance.
- **Repair Algorithm 2** emphasizes using feasible solutions from the current population to repair infeasible solutions, taking into account non-domination rank and crowding distance to guide the repair process.