NSGA-II's improved performance over NSGA-I in many-objective problems (i.e., problems with more than five objectives) is primarily due to several key modifications in its algorithmic structure. These enhancements specifically address the challenges posed by a higher number of objectives:

1. \*\*Efficient Non-Dominated Sorting\*\*:

- In many-objective problems, the computational cost of sorting solutions based on Pareto dominance becomes significant. NSGA-II employs a more efficient non-dominated sorting algorithm, which reduces the computational complexity from \(O(MN^3)\) in NSGA to \(O(MN^2)\) in NSGA-II, where \(M\) is the number of objectives and \(N\) is the population size.

- This efficiency is crucial for handling many-objective problems where the number of comparisons needed to establish dominance relationships increases exponentially with the number of objectives.

2. \*\*Crowding Distance Mechanism\*\*:

- NSGA-II introduces the crowding distance mechanism as a means of maintaining diversity in the population. This mechanism doesn't rely on a shared parameter (unlike NSGA-I) and provides a more practical way of preserving diversity across multiple objectives.

- In many-objective problems, ensuring a diverse set of solutions is challenging due to the curse of dimensionality. The crowding distance helps to maintain a diverse population by favoring solutions that are not crowded in their local neighborhoods in the objective space.

3. \*\*Elitism and Better Preservation of Good Solutions\*\*:

- NSGA-II incorporates an elitist approach, where the top individuals (in terms of Pareto dominance and crowding distance) are always carried over to the next generation.

- This approach ensures that high-quality solutions are not lost over generations, which is particularly important in many-objective problems where finding and maintaining high-quality solutions across many dimensions is more challenging.

4. \*\*Simplified Parameterization\*\*:

- NSGA-II does away with the need for a niche size parameter (σ), which was difficult to set appropriately in NSGA-I, especially for problems with many objectives.

- By simplifying the parameterization, NSGA-II becomes more adaptable and easier to apply to a variety of problems, including those with many objectives.

In summary, the main enhancements in NSGA-II that contribute to its better performance in many-objective problems are its efficient non-dominated sorting process, the crowding distance mechanism for diversity preservation, the incorporation of elitism, and a more straightforward parameter setup. These improvements collectively enable NSGA-II to handle the complexities and challenges associated with problems having a large number of objectives more effectively than NSGA-I.