# RQ2: Operator Rankings with Statistical Significance

| Metric | Operator | Mean | Rank | Sig. Diff? | K-W p-value |
|---|---|---|---|---|---|
| Elite Hit Rate (%) | InformedEvolutionOperator | 9.72 | 1 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | POSAwareAntonymReplacement | 7.25 | 2 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | LLM_POSAwareSynonymReplacement | 6.77 | 3 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | MLM | 5.84 | 4 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | NegationOperator | 4.93 | 5 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | LLMBackTranslation_HI | 4.70 | 6 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | ConceptAdditionOperator | 4.53 | 7 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | TypographicalErrorsOperator | 3.52 | 8 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | LLMBasedParaphrasing | 3.49 | 9 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | StylisticMutator | 2.83 | 10 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | SemanticFusionCrossover | 2.63 | 11 | No | 0.001260 (Yes) |
| Elite Hit Rate (%) | SemanticSimilarityCrossover | 2.26 | 12 | No | 0.001260 (Yes) |
| Conditional Elite Hit Rate (%) | InformedEvolutionOperator | 16.60 | 1 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | SemanticSimilarityCrossover | 9.98 | 2 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | MLM | 8.66 | 3 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | LLM_POSAwareSynonymReplacement | 8.05 | 4 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | POSAwareAntonymReplacement | 7.79 | 5 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | ConceptAdditionOperator | 7.44 | 6 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | TypographicalErrorsOperator | 7.43 | 7 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | NegationOperator | 6.40 | 8 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | LLMBasedParaphrasing | 6.02 | 9 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | LLMBackTranslation_HI | 5.93 | 10 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | SemanticFusionCrossover | 5.86 | 11 | No | 0.162128 (No) |
| Conditional Elite Hit Rate (%) | StylisticMutator | 4.67 | 12 | No | 0.162128 (No) |
| Invalid Rate (%) | SemanticSimilarityCrossover | 0.00 | 1 | No | 0.000000 (Yes) |
| Invalid Rate (%) | POSAwareAntonymReplacement | 5.00 | 2 | No | 0.000000 (Yes) |
| Invalid Rate (%) | LLM_POSAwareSynonymReplacement | 13.15 | 3 | No | 0.000000 (Yes) |
| Invalid Rate (%) | NegationOperator | 18.81 | 4 | No | 0.000000 (Yes) |
| Invalid Rate (%) | LLMBackTranslation_HI | 21.07 | 5 | No | 0.000000 (Yes) |
| Invalid Rate (%) | MLM | 26.48 | 6 | No | 0.000000 (Yes) |
| Invalid Rate (%) | ConceptAdditionOperator | 38.52 | 7 | No | 0.000000 (Yes) |
| Invalid Rate (%) | StylisticMutator | 39.40 | 8 | No | 0.000000 (Yes) |
| Invalid Rate (%) | InformedEvolutionOperator | 40.06 | 9 | No | 0.000000 (Yes) |
| Invalid Rate (%) | LLMBasedParaphrasing | 40.95 | 10 | No | 0.000000 (Yes) |
| Invalid Rate (%) | TypographicalErrorsOperator | 53.26 | 11 | No | 0.000000 (Yes) |
| Invalid Rate (%) | SemanticFusionCrossover | 56.02 | 12 | No | 0.000000 (Yes) |
| Non-Elite Percentage (%) | SemanticSimilarityCrossover | 21.87 | 1 | No | 0.000000 (Yes) |
| Non-Elite Percentage (%) | SemanticFusionCrossover | 39.74 | 2 | No | 0.000000 (Yes) |
| Non-Elite Percentage (%) | TypographicalErrorsOperator | 41.68 | 3 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | InformedEvolutionOperator | 49.16 | 4 | No | 0.000000 (Yes) |
| Non-Elite Percentage (%) | LLMBasedParaphrasing | 54.81 | 5 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | ConceptAdditionOperator | 55.71 | 6 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | StylisticMutator | 56.68 | 7 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | MLM | 60.65 | 8 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | LLMBackTranslation_HI | 71.03 | 9 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | NegationOperator | 71.47 | 10 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | LLM_POSAwareSynonymReplacement | 75.90 | 11 | Yes | 0.000000 (Yes) |
| Non-Elite Percentage (%) | POSAwareAntonymReplacement | 83.96 | 12 | Yes | 0.000000 (Yes) |
| Mean Delta Score | InformedEvolutionOperator | -0.17 | 1 | No | 0.006552 (Yes) |
| Mean Delta Score | LLMBackTranslation_HI | -0.07 | 2 | No | 0.006552 (Yes) |
| Mean Delta Score | StylisticMutator | -0.07 | 3 | No | 0.006552 (Yes) |
| Mean Delta Score | NegationOperator | -0.06 | 4 | No | 0.006552 (Yes) |
| Mean Delta Score | TypographicalErrorsOperator | -0.06 | 5 | No | 0.006552 (Yes) |
| Mean Delta Score | LLMBasedParaphrasing | -0.06 | 6 | No | 0.006552 (Yes) |
| Mean Delta Score | POSAwareAntonymReplacement | -0.06 | 7 | No | 0.006552 (Yes) |
| Mean Delta Score | LLM_POSAwareSynonymReplacement | -0.05 | 8 | No | 0.006552 (Yes) |
| Mean Delta Score | SemanticFusionCrossover | -0.05 | 9 | No | 0.006552 (Yes) |
| Mean Delta Score | ConceptAdditionOperator | -0.05 | 10 | No | 0.006552 (Yes) |
| Mean Delta Score | MLM | -0.05 | 11 | No | 0.006552 (Yes) |
| Mean Delta Score | SemanticSimilarityCrossover | -0.05 | 12 | No | 0.006552 (Yes) |
| Delta Score Std Dev | SemanticFusionCrossover | 0.09 | 1 | No | 0.002755 (Yes) |
| Delta Score Std Dev | SemanticSimilarityCrossover | 0.09 | 2 | No | 0.002755 (Yes) |
| Delta Score Std Dev | InformedEvolutionOperator | 0.11 | 3 | No | 0.002755 (Yes) |
| Delta Score Std Dev | LLM_POSAwareSynonymReplacement | 0.11 | 4 | No | 0.002755 (Yes) |
| Delta Score Std Dev | MLM | 0.12 | 5 | No | 0.002755 (Yes) |
| Delta Score Std Dev | TypographicalErrorsOperator | 0.12 | 6 | No | 0.002755 (Yes) |
| Delta Score Std Dev | LLMBasedParaphrasing | 0.12 | 7 | No | 0.002755 (Yes) |
| Delta Score Std Dev | POSAwareAntonymReplacement | 0.12 | 8 | No | 0.002755 (Yes) |
| Delta Score Std Dev | StylisticMutator | 0.12 | 9 | No | 0.002755 (Yes) |
| Delta Score Std Dev | NegationOperator | 0.12 | 10 | No | 0.002755 (Yes) |
| Delta Score Std Dev | LLMBackTranslation_HI | 0.12 | 11 | No | 0.002755 (Yes) |
| Delta Score Std Dev | ConceptAdditionOperator | 0.13 | 12 | No | 0.002755 (Yes) |