Desarrollo de los Algoritmos Evolutivos: situación actual, abordando problemas reales, y futuros retos



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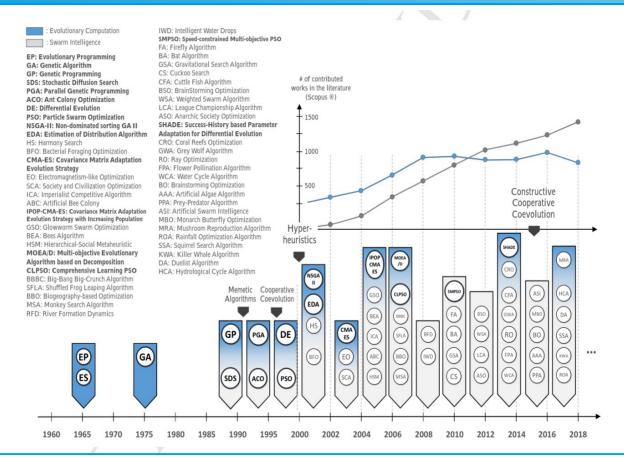


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Sobre la Presentación

- 1. Situación Actual de los algoritmos Evolutivos
- 2. Abordando Problemas Reales
- 3. Futuros Retos

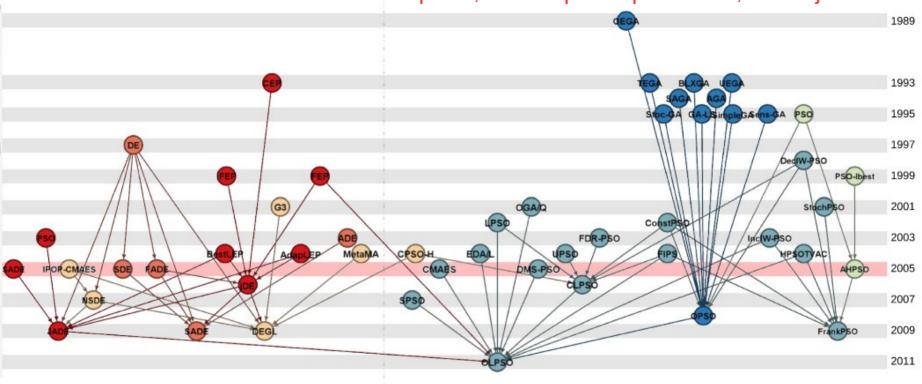
Evolución de Algoritmos Evolutivos



J. Del Ser, E. Osaba, D. Molina, Xin-She Yang, S. Salcedo-Sanz, D. Camacho, S. Das, P. N.Suganthan, C. A.Coello, F. Herrera. Bio-inspired computation: Where we stand and what's next. Swarm and Evolutionary Computation 48 (2019) 220-250. doi: 10.1016/j.swevo.2019.04.008

¿Comparan bien los algoritmos?

Se forman nichos al comparar, se comparan parecidos, no mejores



C. García-Martínez, P.D. Gutiérrez, D. Molina, M. Lozano, F. Herrera. Since CEC 2005 competition on realparameter optimisation: a decade of research, progress and comparative analysis's weakness. Soft Computing, 21:19 (2017) 5573-5583. doi: 10.1007/s00500-016-2471-9

¿Qué aprendemos a través de los años?

- Comparamos resultado de competiciones a través de 10 años.
- Distintos *benchmarks*, permiten comparar directamente resultados.
- ¿Ya los algoritmos comparan con los mejores?
 - NO, mismos errores.
 - Comparamos en un trabajo en 2017 los ganadores entre sí:
 - No todos eran robustos al cambiar entre benchmarks.
 - Ganadores de previas competiciones pueden mejorar anteriores.

D. Molina, F. Moreno-García, F. Herrera. Analysis among winners of different IEEE CEC competitions on real-parameters optimization: Is there always improvement?. 2017 IEEE Congress on Evolutionary Computation, CEC 2017, Donostia-San Sebastian (Spain), 805-812, Juny 5-8, 2017.

D. Molina, A. LaTorre, F. Herrera. An Insight into Bio-inspired and Evolutionary Algorithms for Global Optimization: Review, Analysis, and Lessons Learnt over a Decade of Competitions. Cognitive Computation (2018) 10:4, 517-544. doi: 10.1007/s12559-018-9554-0

¿Cómo se debe comparar?



Guideline #1: Benchmarks

- Proper selection of benchmark (bias avoidance, number of local optima)
- Usage of standard benchmarks unless the problem itself is new in the literature
- Measure of performance linked to the problem under study
- Selection of the reference algorithm(s)



Guideline #2: Validation of Results

- Statistical analysis: parametric/non-parametric hypothesis tests
- · Bayesian tests as an alternative for significance assessment
- Correction procedures for multiple comparisons
- · Visualization techniques for comparative analysis



Guideline #3: Components analysis and parameter tuning

- Clear statement of objectives and rationale for the proposal design
- Quantitative evidence of algorithmic design claims (e.g. exploration/exploitation tradeoff)
- Simplicity of the proposal design, with operators proven to yield significant contributions
- Mandatory parameter tuning for all algorithms considered in the benchmark



Guideline #4: Why is my algorithm useful?

- Support of statements by a rigorous discussion of the results
- If novelty resides in the algorithmic design, metaphors must be avoided and components must be described non-ambiguously
- Methodological contributions must discriminate the novel building block of the proposal, and design experiments towards quantifying its provided gain

A. LaTorre, D. Molina, E. Osaba, J. Poyatos, J. Del Ser, F. Herrera. A Prescription of Methodological Guidelines for Comparing Bio-inspired Optimization Algorithms. Sometido a Swarm and Evolutionary Computation

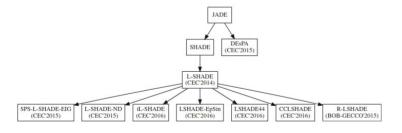
FAIRNESS

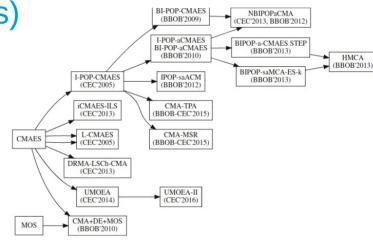
Algoritmos competitivos

- No siempre bio-inspirados, como el Differential Evolution.
 - Las variedad de bio-inspirados no se refleja en más competencia.

Algoritmos Meméticos (más eficientes)

Resultado de una evolución.





Algoritmos más Influyentes: CMA-ES, SHADE, MVMO, ...

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Tendencias de algoritmos competitivos

- Uso de parámetros auto-adataptivos.
 - Más flexibles.
 - Más robustos.
- Modelos Meméticos.
- Adaptación de componentes (BL, ...) no sólo parámetros.
- Parámetros adaptan durante la evaluación:
 - Mayor exploración al principio, explotación más adelante.
- Valorar no sólo mejores soluciones, si no también las peores.

Los problemas reales implican prioridades y requisitos nuevos.

Problem Modeling and Mathematical Formulation ✓ Problem statement and list of requirements Real-world ✓ Priorities of the user optimization consuming the solution(s) with ✓ Problem complexity and metaheuristics need for meta-heuristics **Algorithmic Deployment for** and Replicability **Real-World Applications**

- ✓ Degradation between laboratory and real environment
- ✓ Parameter tuning, but only for the selected algorithm
- ✓ Good programming skills
- ✓ When possible, open-source software frameworks
- ✓ Visualization: the solution must be made valuable for the user

Algorithmic Design, Solution **Encoding and Search Operators**

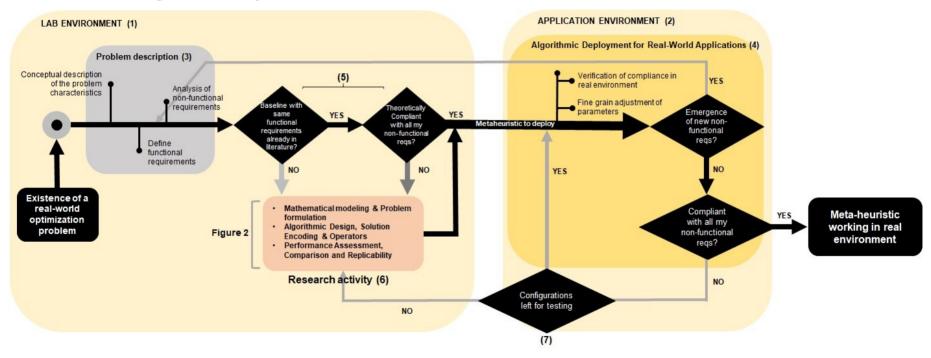
- Baseline models
- ✓ Complexity at its minimum
- ✓ Encoding and operators coupled to the imposed requirements
- ✓ Expert knowledge in the algorithms
- ✓ If explicit equations of objective / constraints are available, exploit them to solve the problem efficiently and accurately

Performance Assessment, Comparison

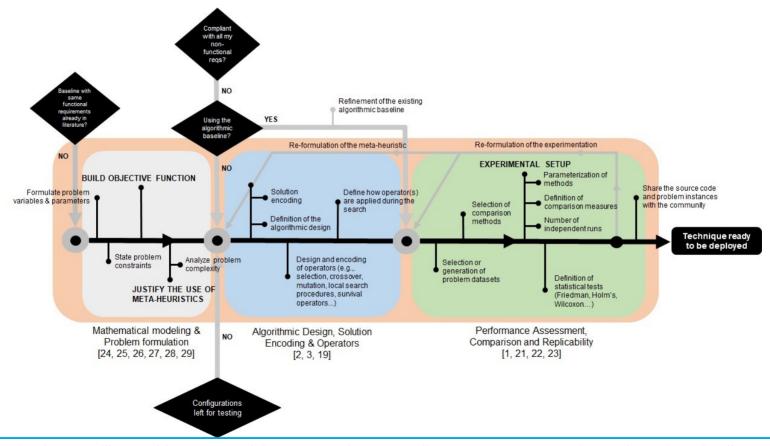
- ✓ Quantitative metrics for all requirements
- ✓ Variability of scenarios
- ✓ Fairness in comparisons
- ✓ User in the loop for validating the solution(s)
- ✓ Publish code and results (whenever possible)

E. Osaba, E. Villar-Rodriguez, J. Del Ser, A. J. Nebro, D. Molina, A. La Torre, P.N. Suganthan, C.A. Coello, F. Herrera. A Tutorial on the Design, Experimentation and Application of Metaheuristic Algorithms to Real-World Optimization Problems. Swarm and Evolutionary Computation, in press

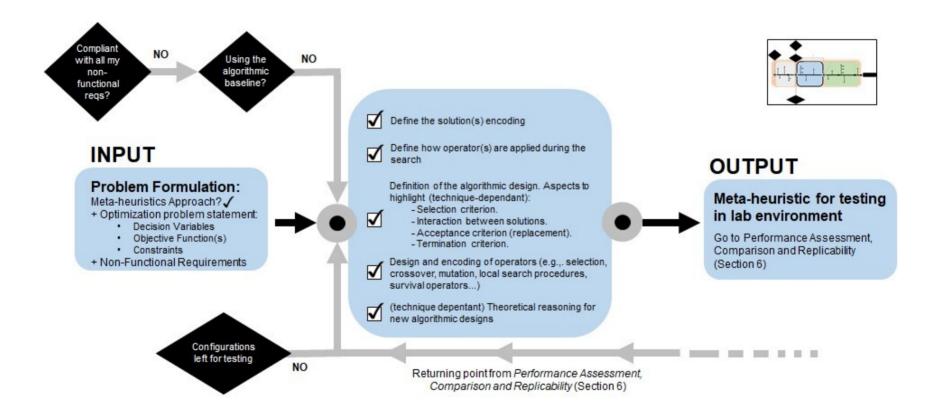
Metodología Propuesta



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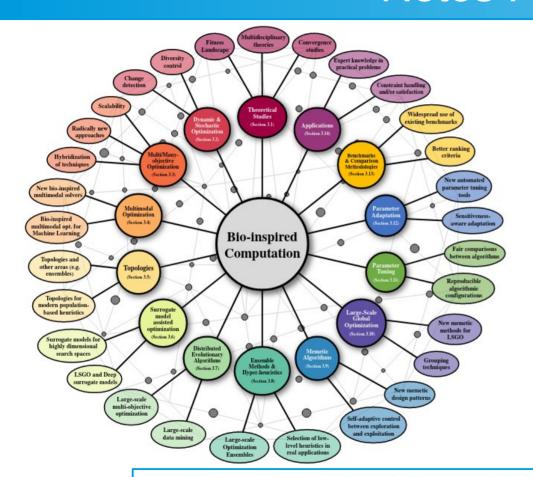


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Retos Futuros



- Múltiples aplicaciones.
- Más no implica mejor.
- Notación y Descripción unificada.
- Mayor comprensión comportamiento.
- Más enfoque en eficiencia.
- Integración con Machine Learning y Deep Learning.
- Mejor integración con paradigmas emergentes (Big Data, ...).

J. Del Ser, E. Osaba, D. Molina, Xin-She Yang, S. Salcedo-Sanz, D. Camacho, S. Das, P. N.Suganthan, C. A.Coello, F. Herrera. Bio-inspired computation: Where we stand and what's next. Swarm and Evolutionary Computation 48 (2019) 220-250. doi: 10.1016/j.swevo.2019.04.008