The GA-FuL MATAB Toolbox

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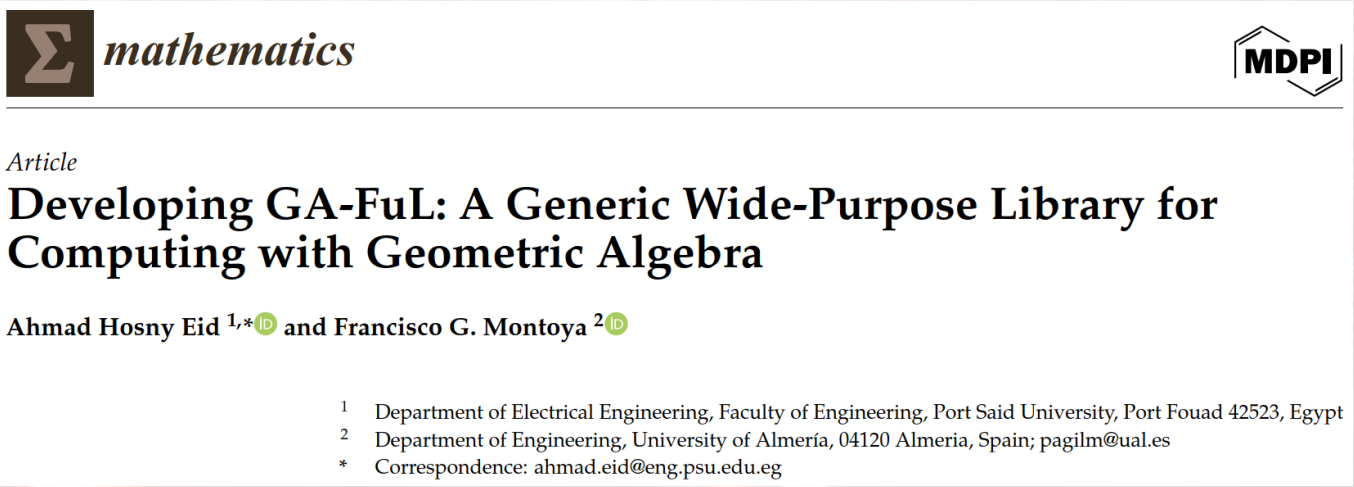
Recap: About GA-FuL

- **The Geometric Algebra Fulcrum Library (GA-FuL):**
  - A unified generic extensible C# library for GA-based geometric modeling.
  - Using any kind of scalars (floating point, rational, symbolic, etc.).
  - Can be used for prototyping geometric algorithms based on the powerful mathematics of geometric algebra.
  - API can be used to perform numeric computations, symbolic manipulations, visualizations, and optimized code generation.
- **Main Code Repo:**
  https://github.com/ga-explorer/GeometricAlgebraFulcrumLib



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Article

Developing GA-FuL: A Generic Wide-Purpose Library for Computing with Geometric Algebra

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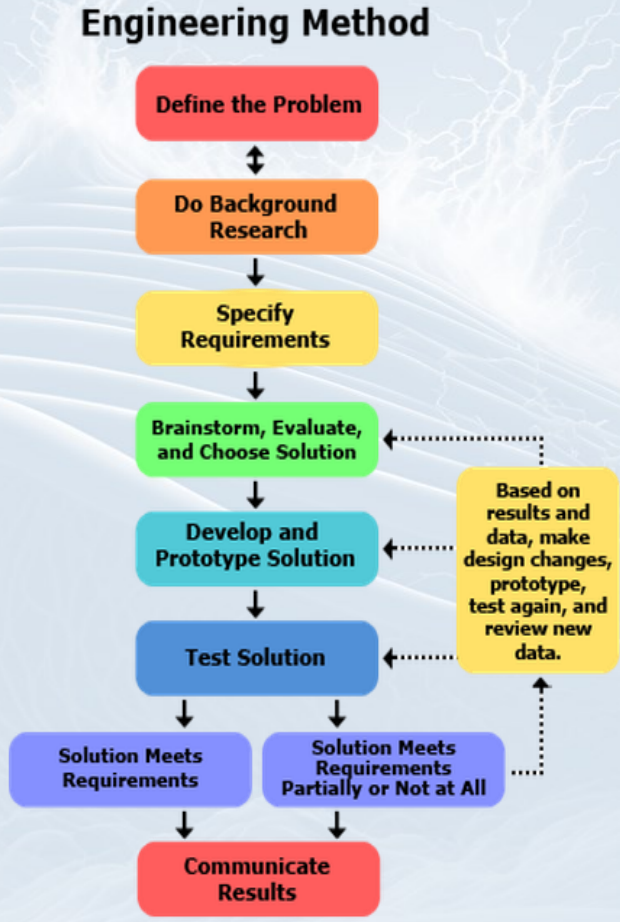
MATLAB: A Complete Modeling Environment

- **Why MATLAB is Popular Among Engineers:**
  - **Ease of Use for Technical Computing:** Intuitive syntax for matrix operations and numerical computations.
  - **Comprehensive Toolboxes:** Specialized tools for signal processing, control systems, image processing, and more.
  - **Powerful Visualization:** Built-in functions for 2D/3D plotting and data visualization.
  - **Simulation & Model-Based Design (Simulink):** Enables system-level modeling, simulation, and embedded system design.
  - **Industry & Academic Integration:** Widely used in both research and industry for rapid prototyping and algorithm development.

- **GA not yet fully exploited in MATLAB:**
  - MATLAB is based mainly on matrices, not multivectors.
  - Very few GA toolboxes were made



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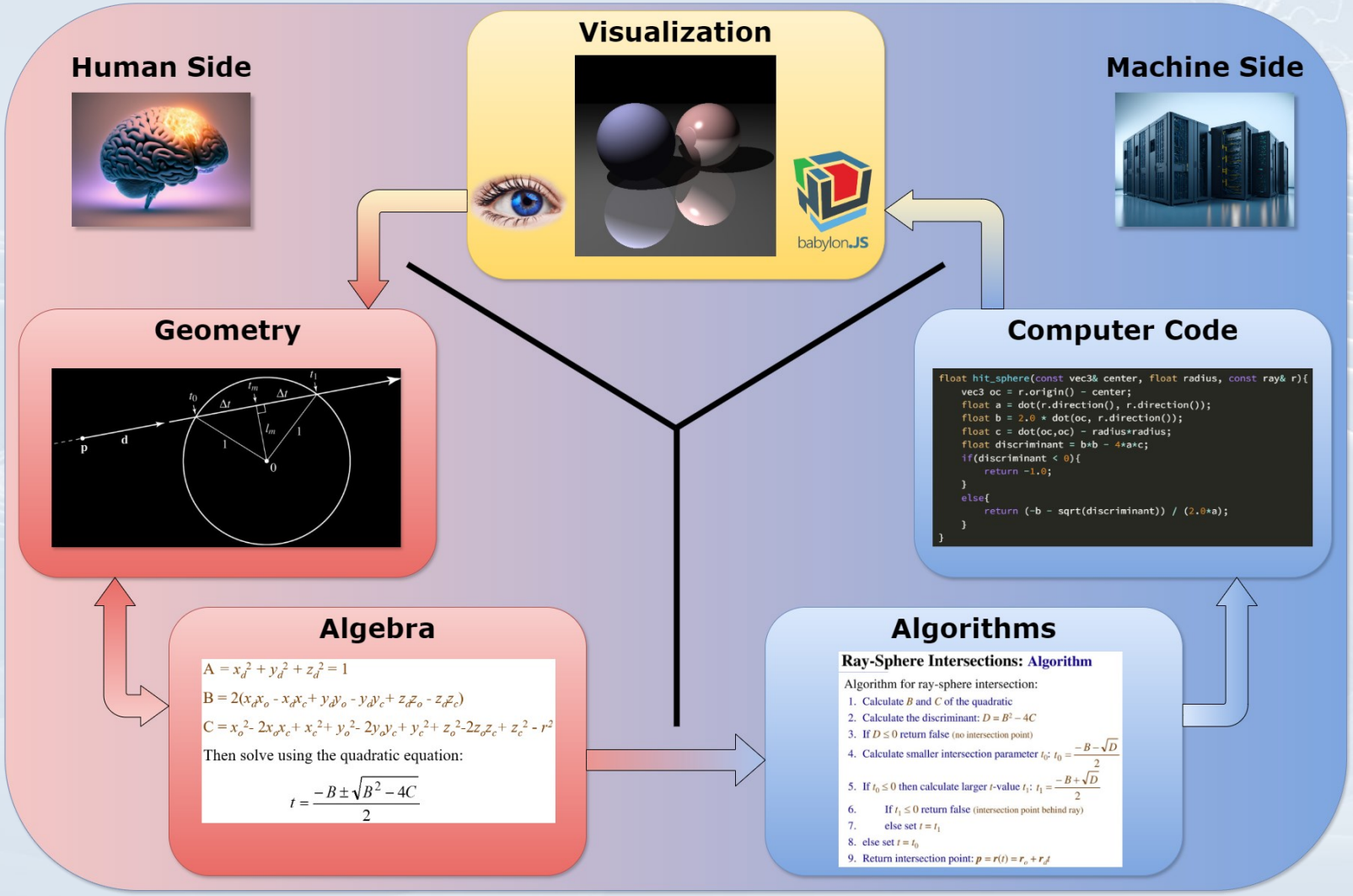
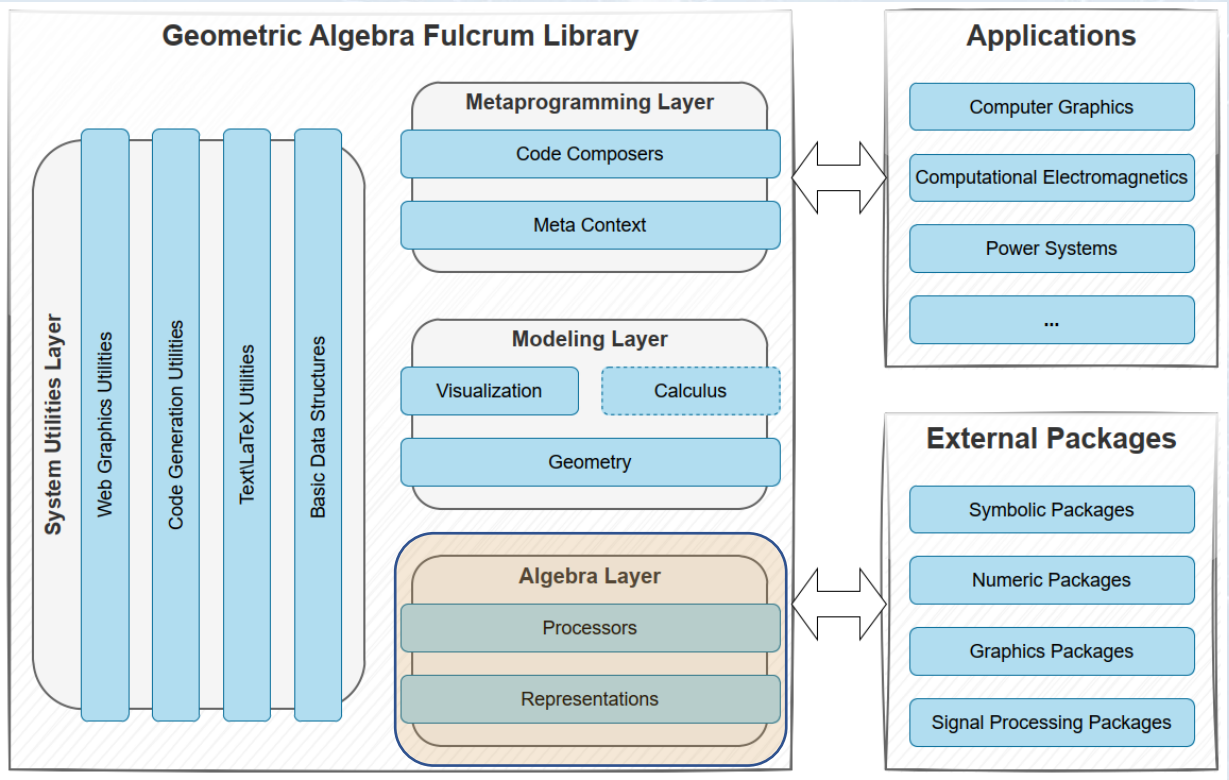
MATLAB: A Complete Modeling Environment



GA-FuL MATLAB Toolbox

- **GA-FuL Layers:** Algebra, Modeling, Metaprogramming, Utilities.
- Only the Algebra layer is exposed in the MATLAB toolbox.
- All code is still in C#, but exported to MATLAB via .NET interface.
- Initially tried to use **.NET Core** for portability to all systems (Windows, Linux, Mac OS, etc.), but didn't work.
- Had to use **.NET Framework**:
  - Only works on Windows
  - 4 times slower than .NET Core
  - Will try .NET Core again in the future



GA-FuL MATLAB Toolbox

- **Toolbox Capabilities:**
  - **Clifford Algebras:** Any signature, any number of dimensions, multiple GAs at once.
  - **Multivector Initialization:** Can initialize a multivector from MATLAB arrays or simple text expressions.
  - **Array conversion:** Can express a GA vector\bivector\k-vector\multivector as a standard 1-dimensional MATLAB array.
  - **Basic Multivector Operations:** Negative, addition, subtraction, times\divide scalars, norm, grade-involution, reverse, Clifford conjugate, dual\un-dual, k-vector extraction, 2-blade exponentiation (simple rotor).
  - **Common products:** Geometric, Outer, Left\Right Contraction, Inner, Dot, Scalar, Commutator, Anti-Commutator.
  - **Subspace operations:** Subspace reflections (direct and dual) and projections.
  - **More to come soon ..**

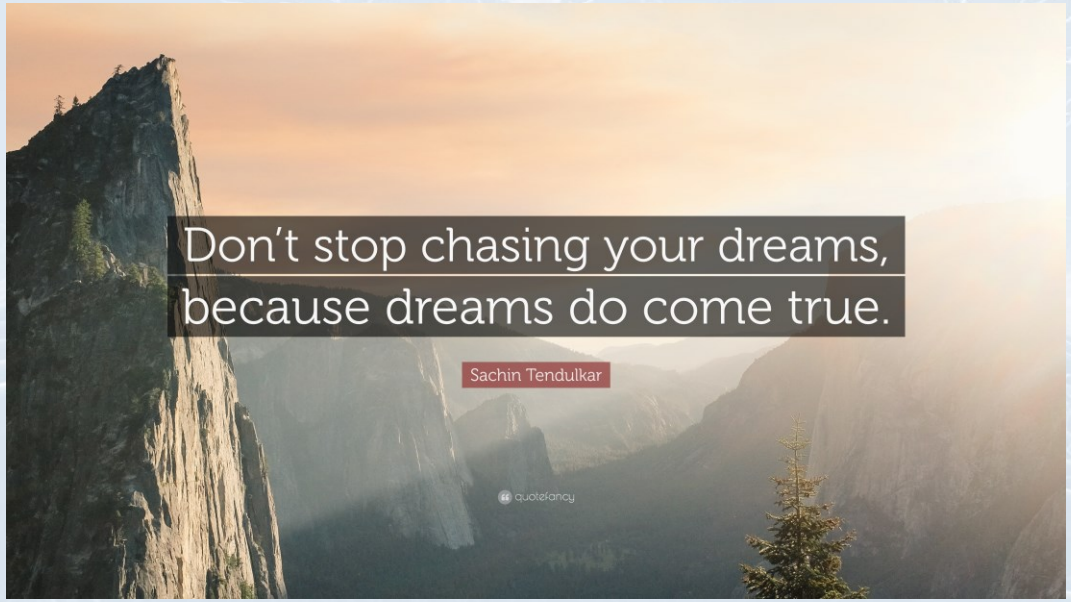
- **Where to download?** Soon .. Just fixing a few bugs and making some samples

GA-FuL MATLAB Toolbox

- **Showcase**

Future Developments

- Try .NET Core again.
- Compare with other GA MATLAB toolboxes.
- Add more computational and modeling features (CGA, PGA, Geometric Calculus, etc.).
- Develop practical applications to promote GA using the toolbox.



Thank You