Comprehensive Criteria to Understand & Compare Programming Languages

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1. Language Philosophy & Purpose

- **Creator(s) & History**
- **Main Motivation** (What problem does it solve?)
- **Primary Use Cases** (Web, mobile, system, scientific, etc.)
- **Programming Paradigm(s)** (OOP, functional, procedural, declarative, reactive, etc.)
- **Simplicity vs. Power Tradeoff**
- **Opinionated vs. Flexible Design**

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2. Language Design & Syntax

- **Type System** (Static, dynamic, strong, weak, gradual)
- **Memory Safety** (Manual, GC, ownership model)
- **Code Verbosity** (Concise vs. verbose)
- **Readability & Learnability**
- **Syntax Style** (Pythonic, C-like, Lisp-like, etc.)
- **Native Constructs for Modern Concepts** (e.g., async/await, null safety, pattern matching)

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3. Runtime & Execution Model

- **Compiled or Interpreted**
- **Target Format** (Bytecode, native binary, JS, IR)
- **Virtual Machine / Runtime** (e.g., JVM, CLR, CPython, Node.js)
- **Performance Characteristics**
- **Startup Time**
- **Execution Speed**
- **Garbage Collection Mechanism**
- **Just-In-Time (JIT) or Ahead-of-Time (AOT)**

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4. Language Toolchain & Ecosystem

- **Standard Library Quality**
- **Package Manager & Ecosystem Size** (`pip`, `npm`, `cargo`, etc.)
- **Tooling Support** (Formatter, Linter, Compiler, Debugger)
- **IDEs and Editor Support**
- **Testing Frameworks**
- **Build Tools / Dependency Management**
- **Error Reporting / Diagnostics**

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5. Concurrency & Parallelism

- **Concurrency Model** (Thread-based, event loop, coroutine, actor model)
- **Thread Safety & Isolation**
- **Built-in Support** (`async`, `await`, goroutines, tasks)
- **Synchronization Primitives** (Locks, channels, futures, etc.)
- **Scalability for Parallel Tasks**

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6. Error Handling & Safety

- **Error Handling Approach** (try/catch, result types, panic/recover)
- **Null Handling / Null Safety**

- **Exception Hierarchy**
- **Compile-time vs. Runtime Errors**
- **Type Safety Guarantees**

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7. Interoperability & Integration

- **C/FFI Support**
- **Call Java/.NET/C++/Python**
- **WebAssembly Target**
- **Cross-platform Support**
- **Mobile/Web Integration**
- **Third-party Tool/Library Interop**

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8. Meta-programming & Advanced Features

- **Reflection Support**
- **Annotations / Attributes**
- **Macros / Templates**
- **Code Generation**
- **DSL Creation**
- **Operator Overloading**
- **Compile-time Evaluation (CTFE, constexpr)**

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9. Memory Management & Low-Level Access

- **Garbage Collection**
- **Manual Allocation (malloc/free)**

- **RAII (Resource Acquisition Is Initialization)**
- **Ownership & Borrowing (e.g., Rust)**
- **Stack vs Heap Allocation Control**

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10. Developer Productivity

- **Feedback Loop Speed** (compile-run cycle)
- **Hot Reload / Live Code Updates**
- **REPL Availability**
- **Availability of Templates/Boilerplates**
- **Community Examples / Tutorials**

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11. Learning Curve & Community

- **Ease of Learning for Beginners**
- **Learning Resources**
- **Documentation Quality**
- **Community Activity**
- **Stack Overflow / GitHub Repositories**
- **Conference/Meetup Support**

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12. Testing & Quality Assurance

- **Testing Frameworks**
- **Code Coverage Tools**
- **Mocking & Stubbing Tools**
- **Static Analysis**
- **Type Checking (Optional vs. Enforced)**

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13. Deployment & Packaging

- **Packaging Tools**
- **Cross-platform Compilation**
- **Docker/CI/CD Integration**
- **Executable Size**
- **Binary Distribution / Portability**

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14. Security Considerations

- **Memory Safety Guarantees**
- **Sandboxing Capabilities**
- **Third-party Dependency Auditing**
- **Common Vulnerabilities (e.g., buffer overflows)**

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15. Real-world Adoption & Applications

- **Industry Usage**
- **Big Companies Using It**
- **Job Market Demand**
- **Domains It Dominates (AI, finance, mobile, etc.)**
- **Open-source Projects**

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16. Language Extensibility

- **Ability to Add Custom Syntax / Macros**
- **Support for Plugins or Extensions**
- **Embedding in Other Programs (e.g., Lua)**

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17. Versioning & Compatibility

- **Semantic Versioning (SemVer)**
- **Backward Compatibility**

- **Language Stability**
- **Long-term Support (LTS)**