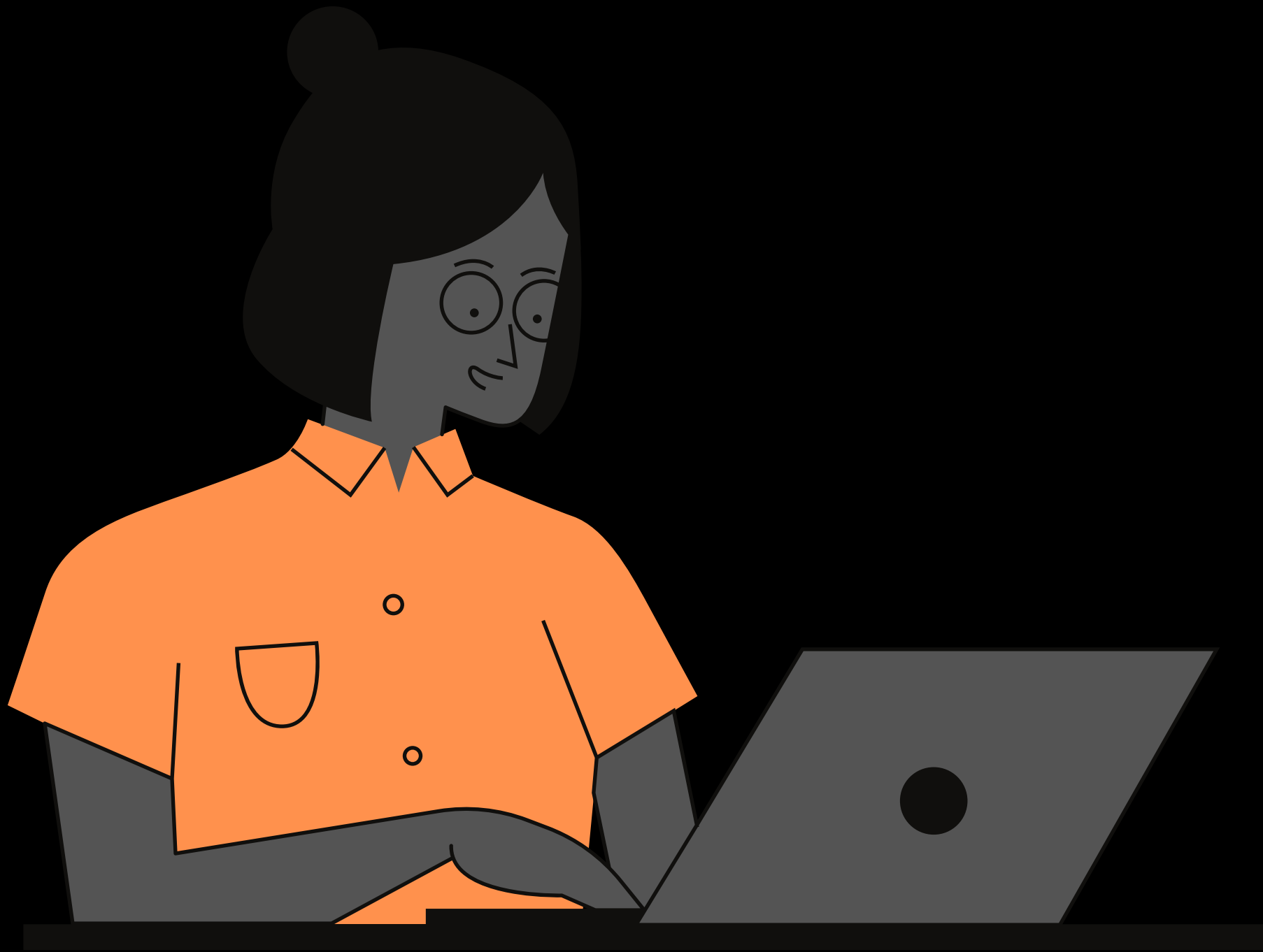# Introduction to LLVM

Transforming Code with Efficiency and Flexibility!

What is LLVM?

- LLVM stands for Low-Level Virtual Machine
- It is an open-source compiler infrastructure project
- Designed to optimize and transform programs at various stages of compilation
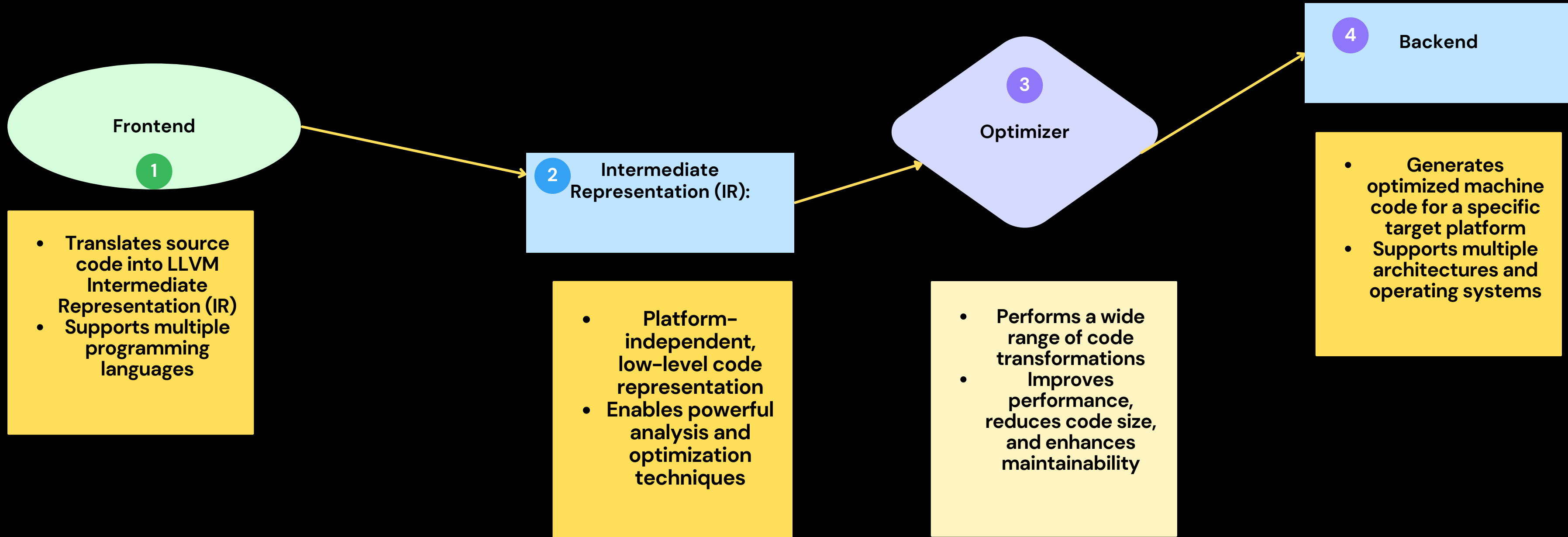
LET'S BEGIN!

Key Component of LLVM

Frontend

1

- **Translates source code into LLVM Intermediate Representation (IR)**
- **Supports multiple programming languages**

2 Intermediate Representation (IR):

- **Platform–independent, low–level code representation**
- **Enables powerful analysis and optimization techniques**

3 Optimizer

- **Performs a wide range of code transformations**
- **Improves performance, reduces code size, and enhances maintainability**

4 Backend

- **Generates optimized machine code for a specific target platform**
- **Supports multiple architectures and operating systems**

LLVM IR: The Common Language

- **LLVM IR is a static single assignment (SSA)-based representation**
- **Supports both high-level and low-level constructs**
- **Allows fine-grained control over code optimizations**

LLVM Optimizations

- LLVM offers an extensive set of optimizations for both front end and backend
  Common optimizations include:
  Dead code elimination
  Constant propagation
  Loop optimizations
  Function inlining
  Register allocation

Just-in-Time Compilation (JIT)

- **LLVM provides a powerful JIT compilation framework**
- **Enables dynamic compilation and execution of code at runtime**
- **Used in various applications, such as dynamic language implementations and code profiling**

Extensibility and Tooling

- **LLVM's modular architecture enables easy extensibility**
- **Users can develop custom passes and tools to analyze or transform code**
- **Numerous LLVM-based tools and frameworks available, such as Clang (C/C++ frontend) and Rust compiler**
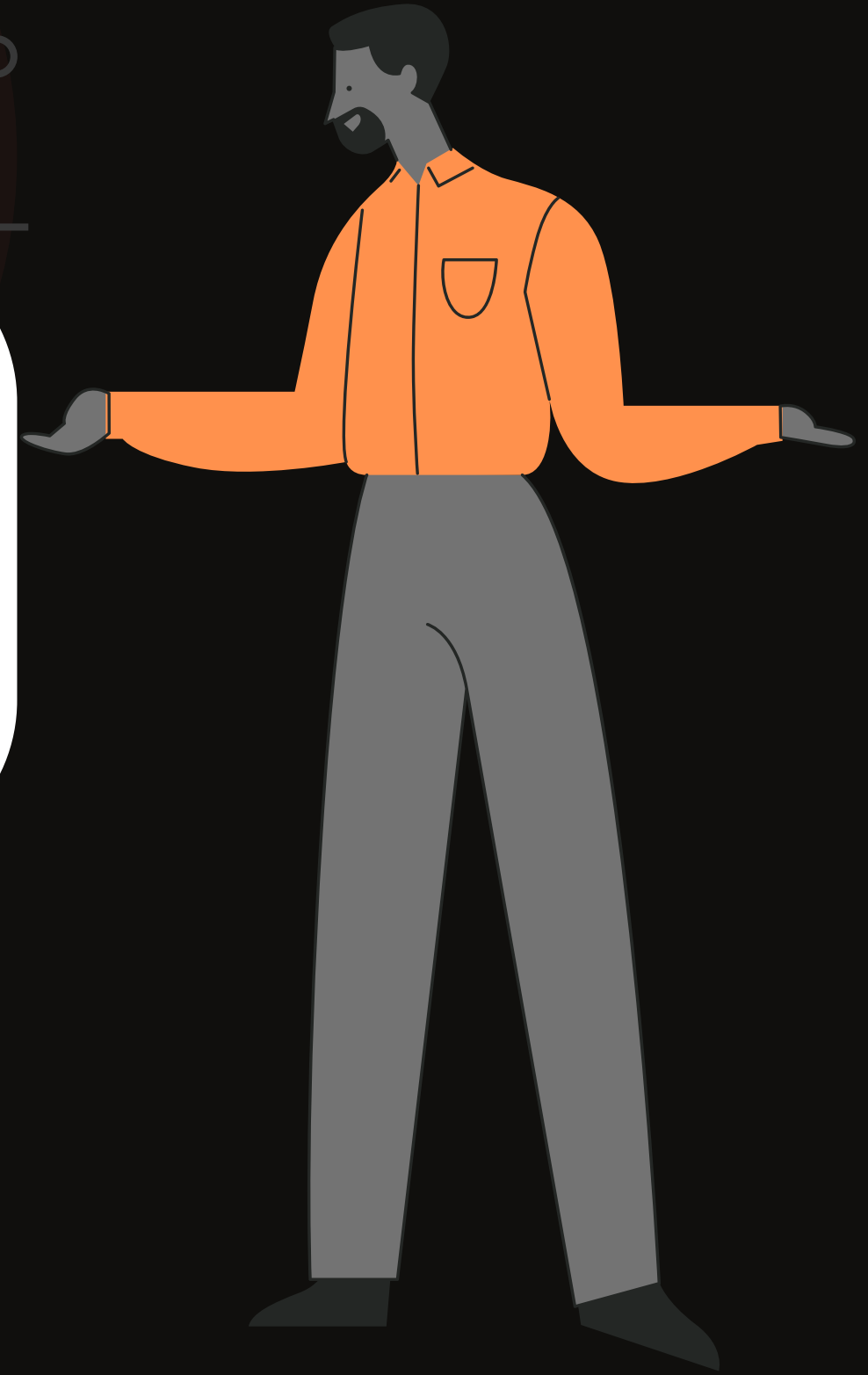
Adoption and Industry Support

- LLVM has gained significant adoption and industry support
- Used by major companies and organizations for diverse purposes:
- **Apple**: LLVM is the foundation for their Swift programming language
- **Google**: Utilizes LLVM in Android, Chrome, and more
- NVIDIA: Incorporates LLVM in GPU programming frameworks

Conclusion

- **LLVM is a versatile and powerful compiler infrastructure**
- **Offers a wide range of optimizations and flexibility**
- **Continues to evolve and drive advancements in compiler technology**

We will discuss SSA innext seesion

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