

Lecture Overview

1. Definition of Compiler
2. Typical Architecture of a Compiler
3. Example Analysis
4. Environment of a Compiler

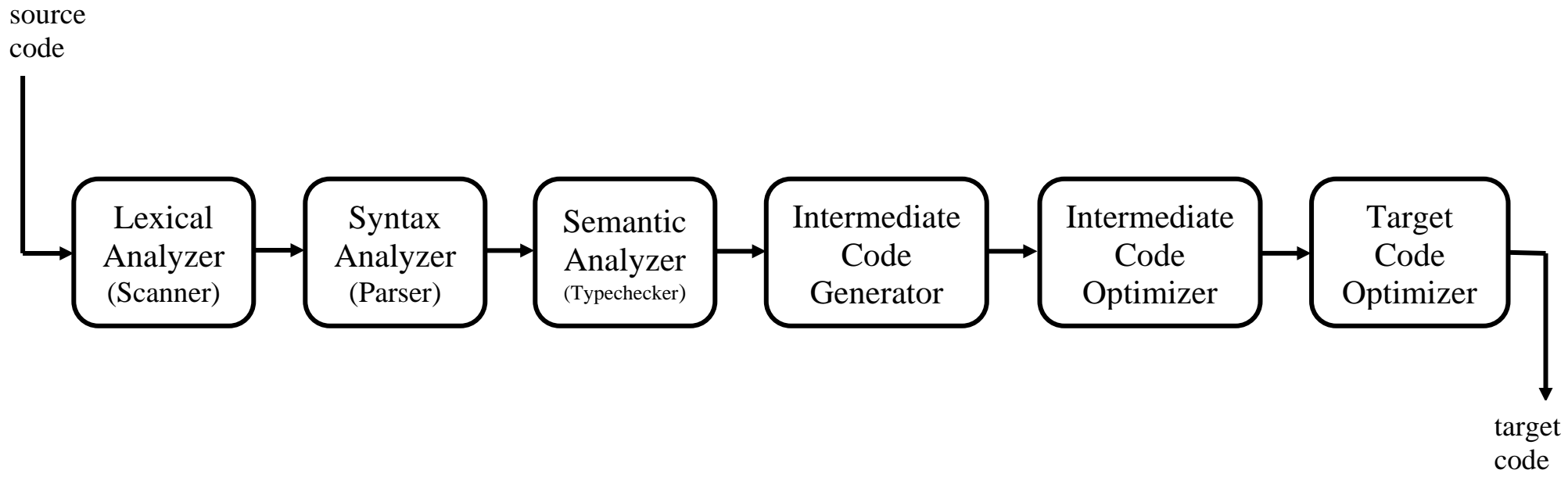
Compiler: a definition or two

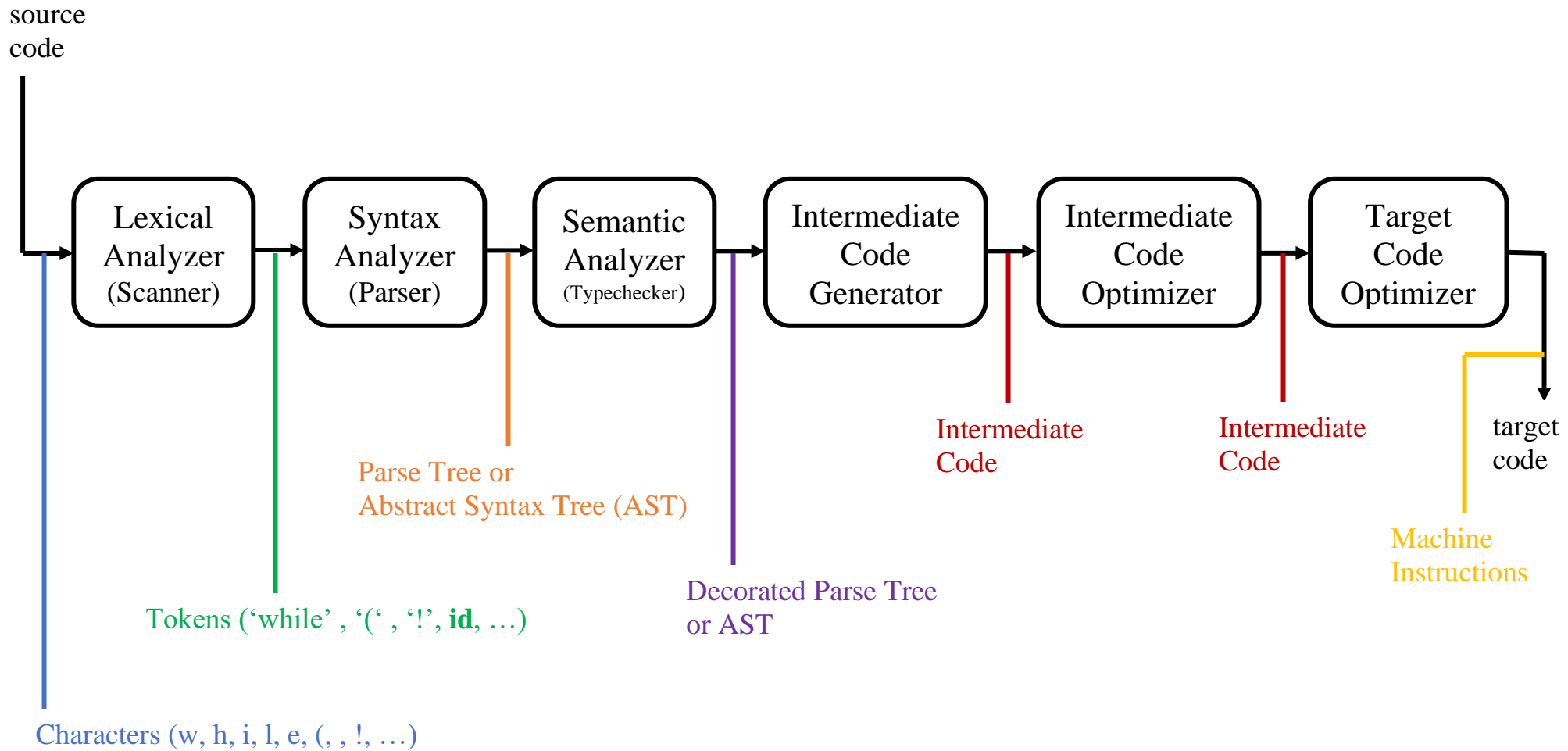
In general, a **compiler** is a program that converts one language to another. This is quite a broad definition. It includes natural-language translation, for instance, or a program to convert java to C++.

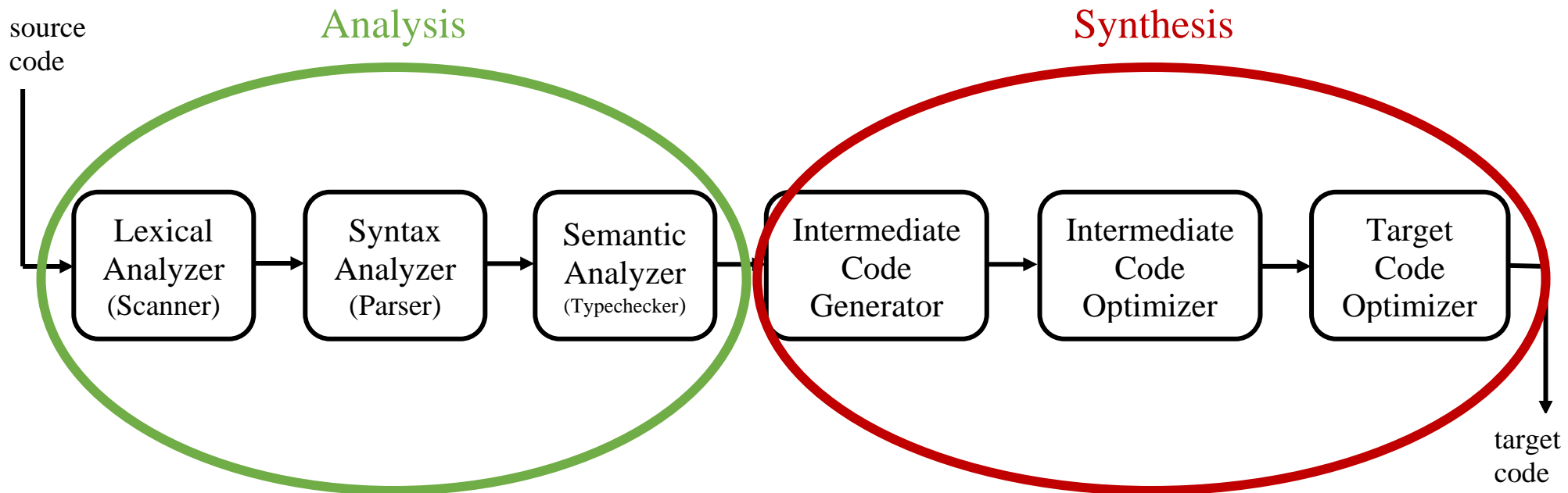
In formal language theory, a **language** is a set of strings. These strings are the valid sentences (say) in a natural language, or valid programs in a computer language.

A much more specific definition of compiler, and **the one we will use in this course**, is a program that converts from (a) a high-level general-purpose programming language to (b) a low-level machine or intermediate language.

A typical compiler architecture







```

main() {
    int i = 9;
    while( i != 1 ) {
        printf("%d\n", i);
        i = syracuse(i);
    }
}

int syracuse(int n) {
    if(n % 2 == 0)
        return n / 2;
    else
        return 3 * n + 1;
}

```

characters

```

m
a
i
n
(
)
space
{
newline
space
space
space
i
n
t
space
i
space
=
space
9
;
newline
space
space
space
w
h
i
l
e
(
space
i
space
!
=
...

```

tokens

```

main
(
)
{
int
i
=
9
;
while
(
i
!=
1
)
{
printf
(
"%d\n"
,
i
)
;
i
=
syracuse
(
i
)
;
}
int
syracuse
(
int
...

```

```

main() {
    int i = 9;
    while( i != 1 ) {
        printf("%d\n", i);
        i = syracuse(i);
    }
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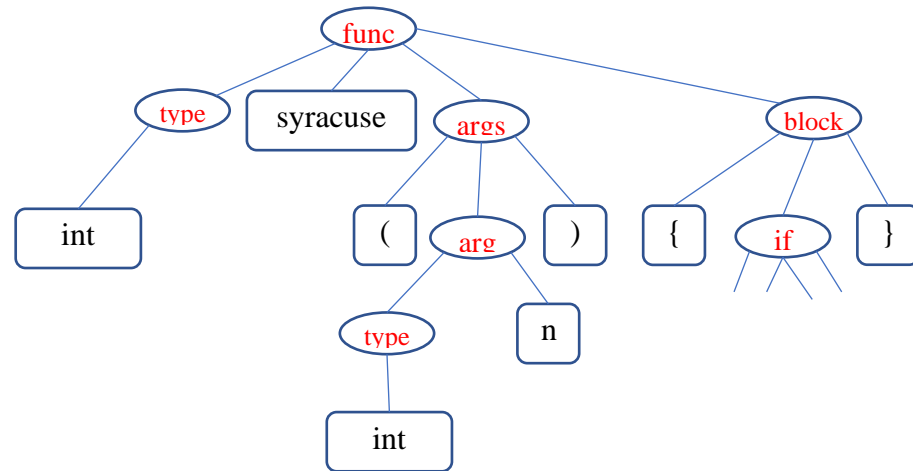
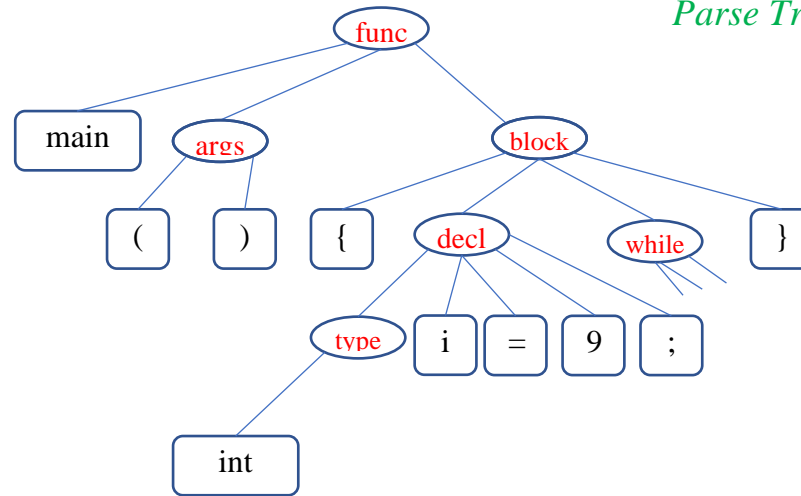
```

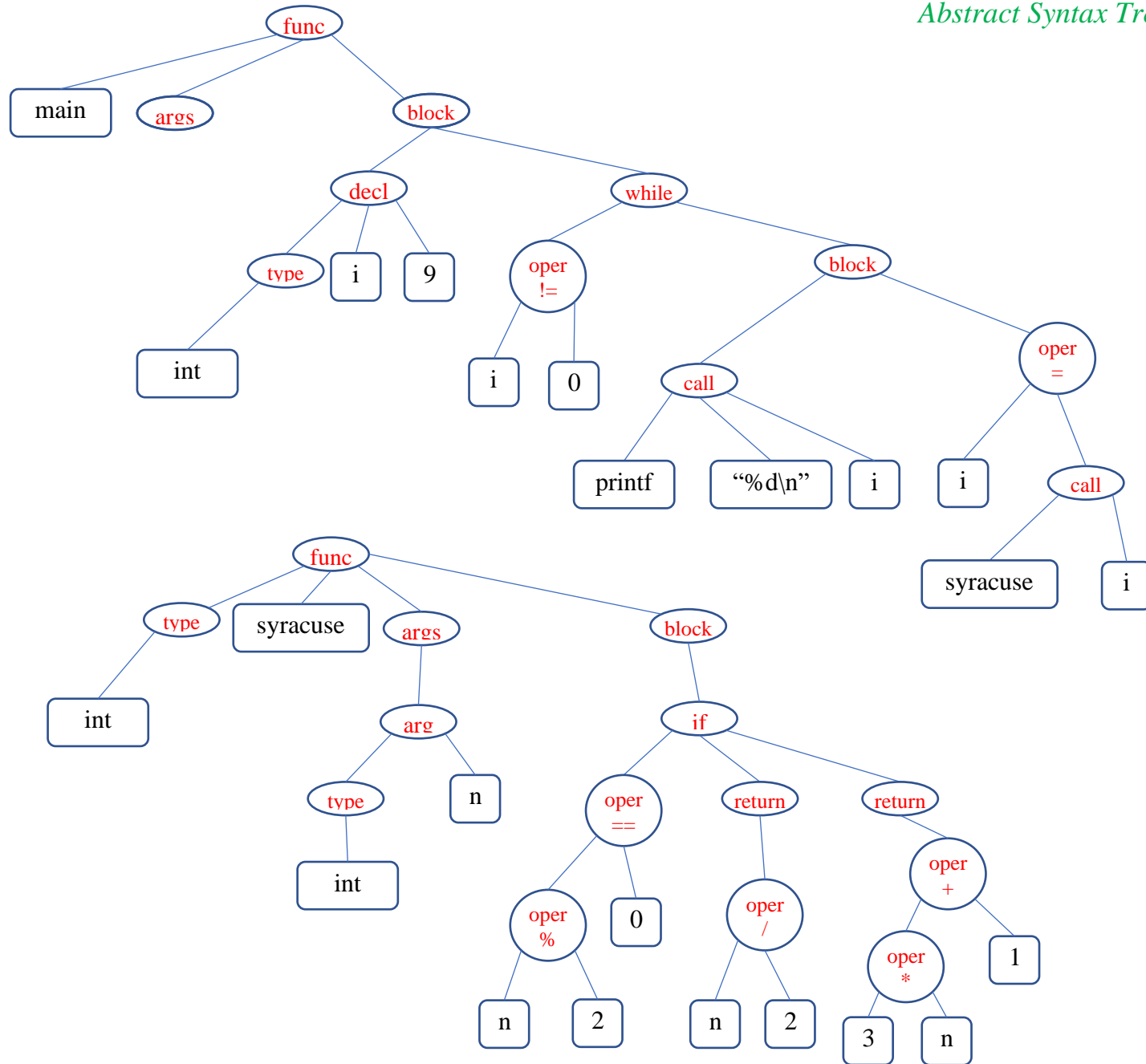
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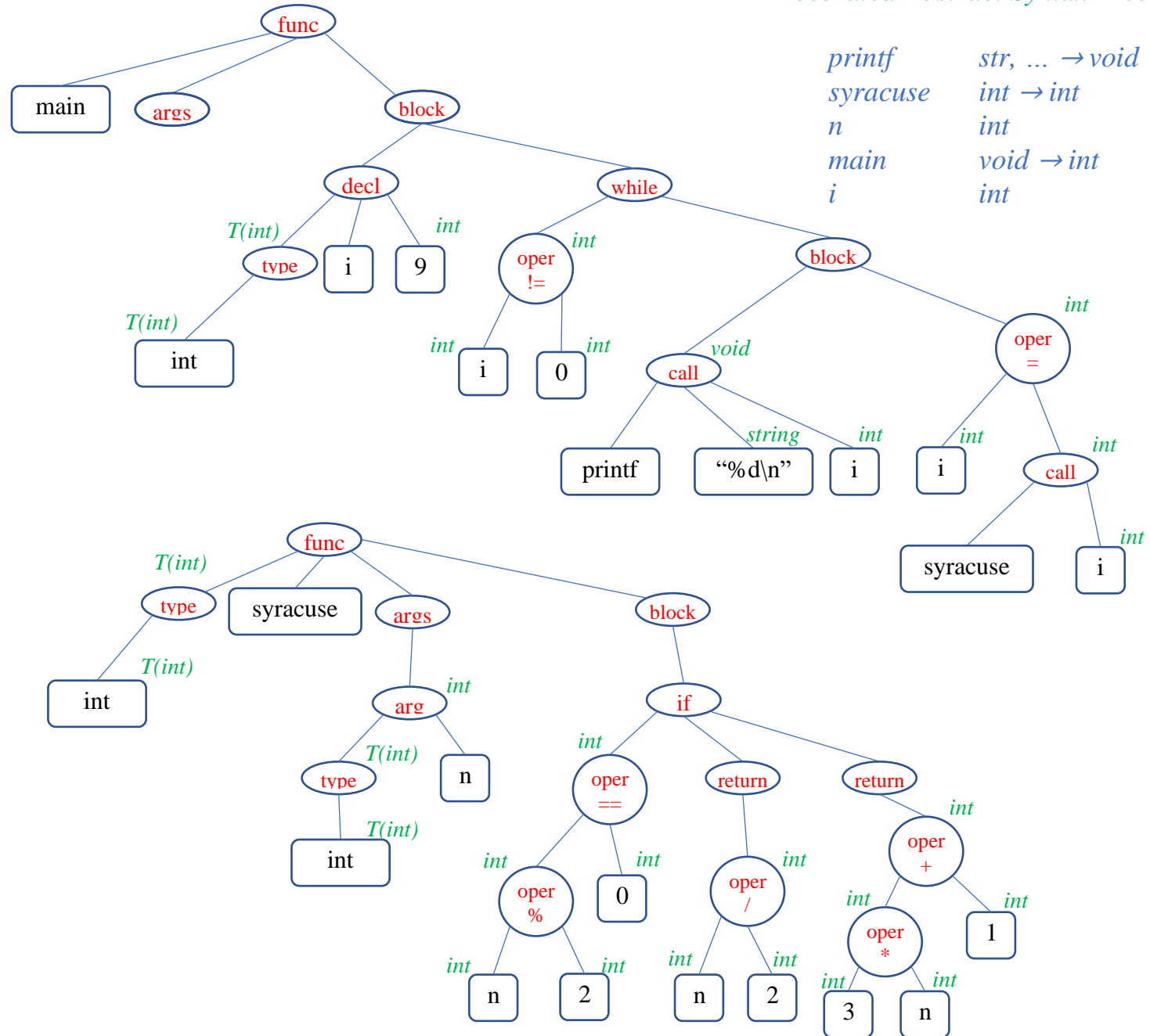
```

Parse Tree



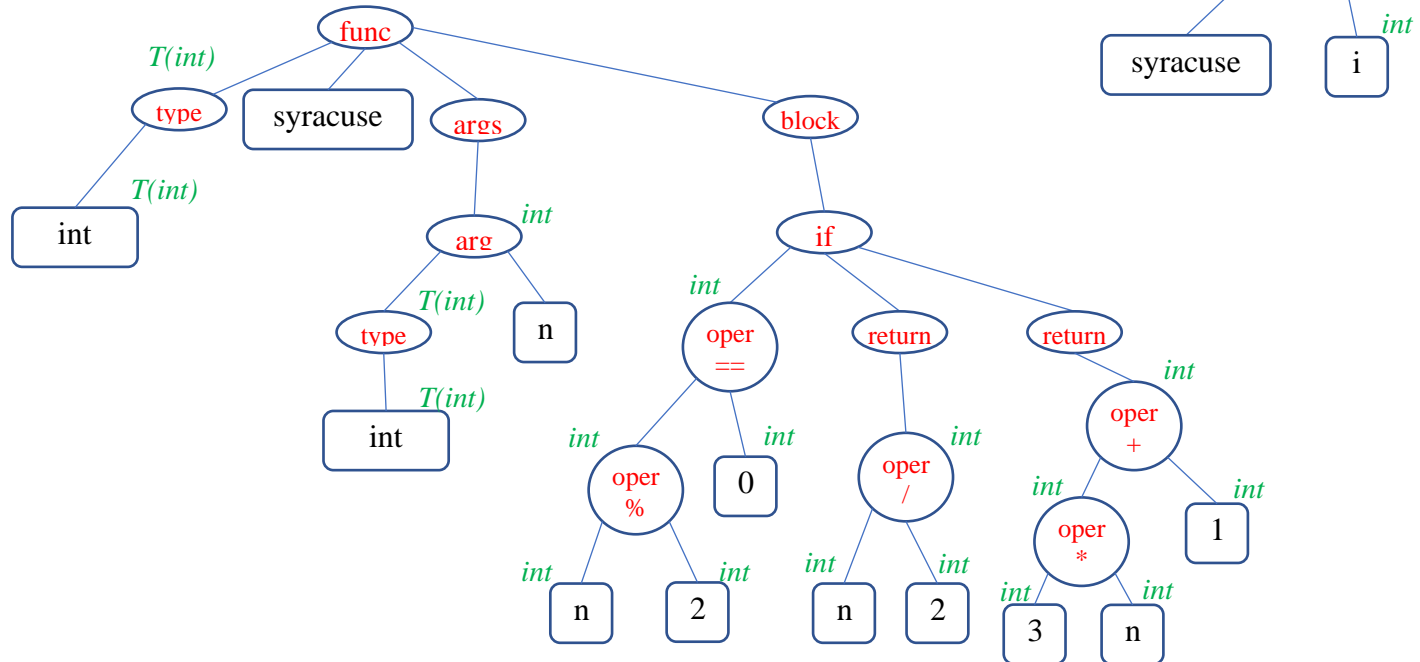
Abstract Syntax Tree

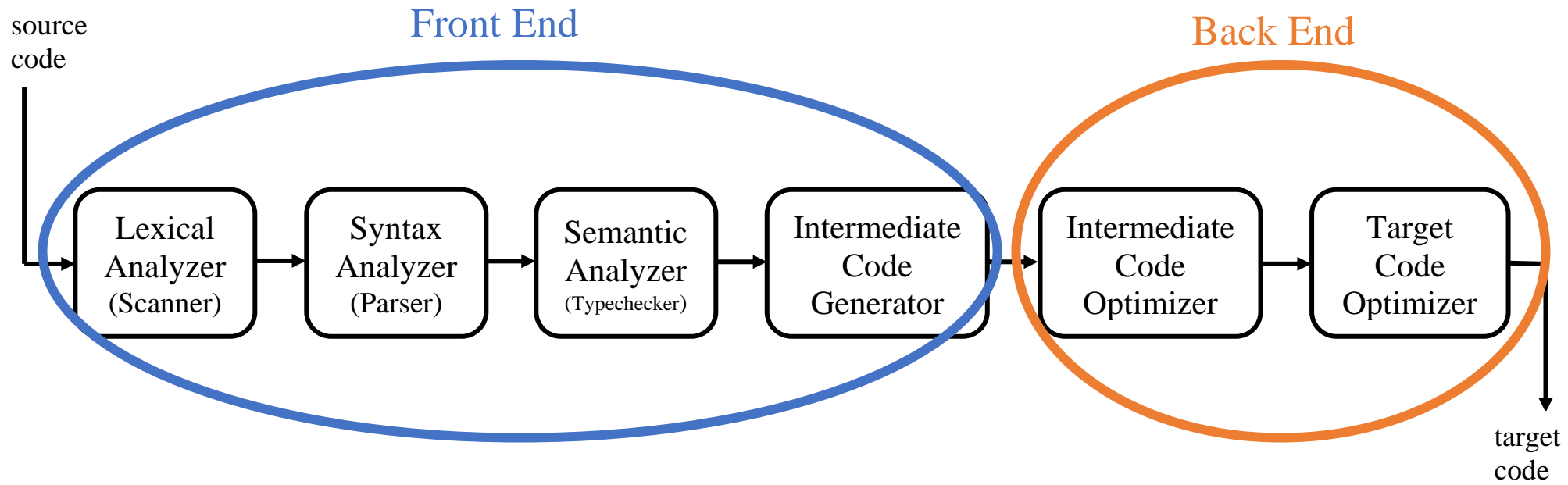
Decorated Abstract Syntax Tree

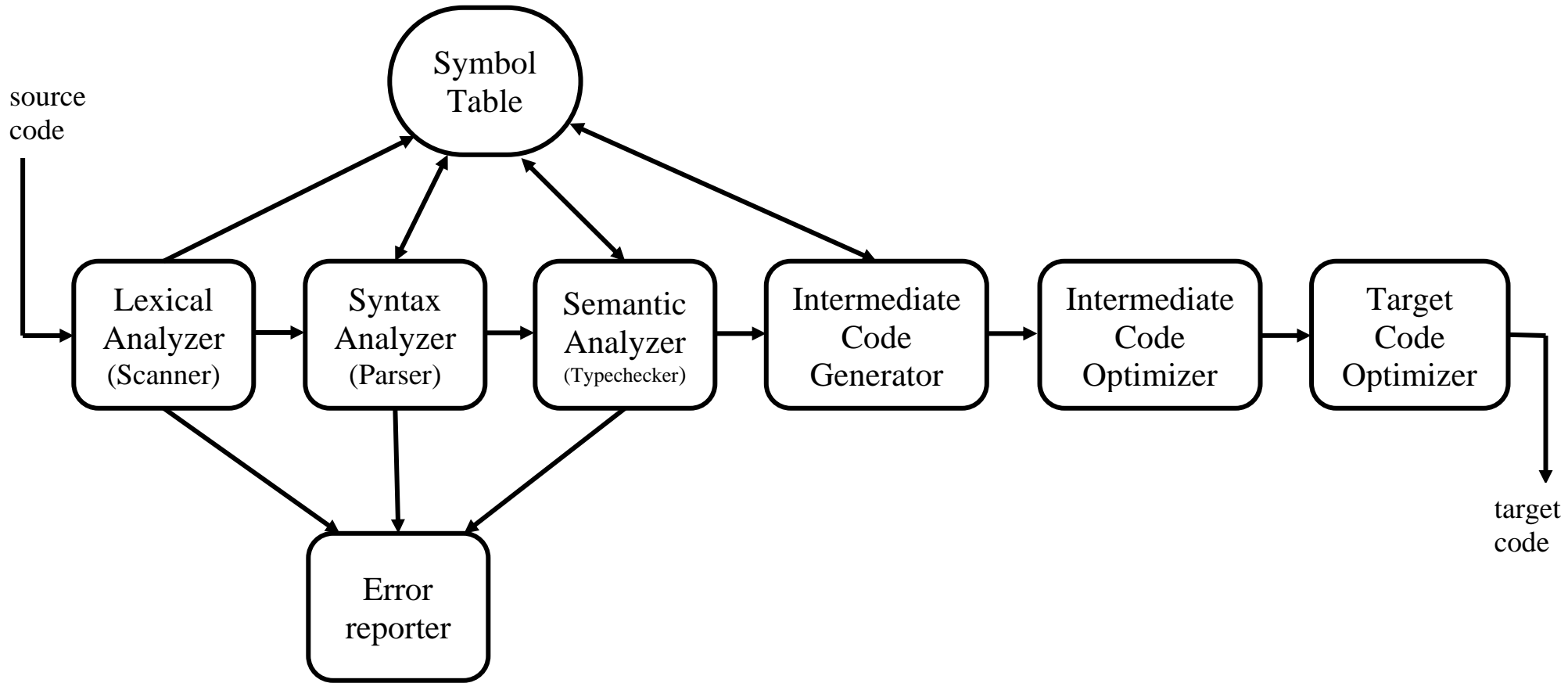


`printf`
`syracuse`
`n`
`main`
`i`

`str, ... → void`
`int → int`
`int`
`void → int`
`int`







The environment of a compiler

An **interpreter** is like a compiler, except that it executes the actions specified by the source program rather than creating target code. Interpreted programs tend to be slower than compiled ones.

An **assembler** is a (broad-sense) compiler that translates from an assembly language to machine language.

A **linker** is a program that takes a target-language portion of a program and combines it with other portions of the program that were compiled separately. These separately-compiled portions include **libraries**.

A **loader** is a program that takes a target-language program out of a file and places it into the memory of a computer, then starts it running.

A **debugger** is a program that allows a programmer to step through their program and inspect what is happening along the way.

An **integrated development environment (IDE)** is typically a compiler, linker, loader, debugger, and an editor combined and working with each other.

When something happens while the compiler is running, we call it compile-time or **static**.

When something happens while the program the compiler produced is running, we call it run-time or **dynamic**.

There are -time terms for linking and loading, too: link-time and load-time.

For example, we may link a program together with all its parts and libraries right after the compiler finishes (often as part of the compiler) and this is called **static linking**.

If we link the program together when loading it, it's **load-time linking**.

If we link parts of the program together while the program is running, it's **dynamic linking**. This is accompanied by **dynamic loading**, which pulls in some parts of the program off of a long-term storage medium while the program is running.