

# Chlorophyll

Synthesis-Aided Compiler for  
GreenArrays

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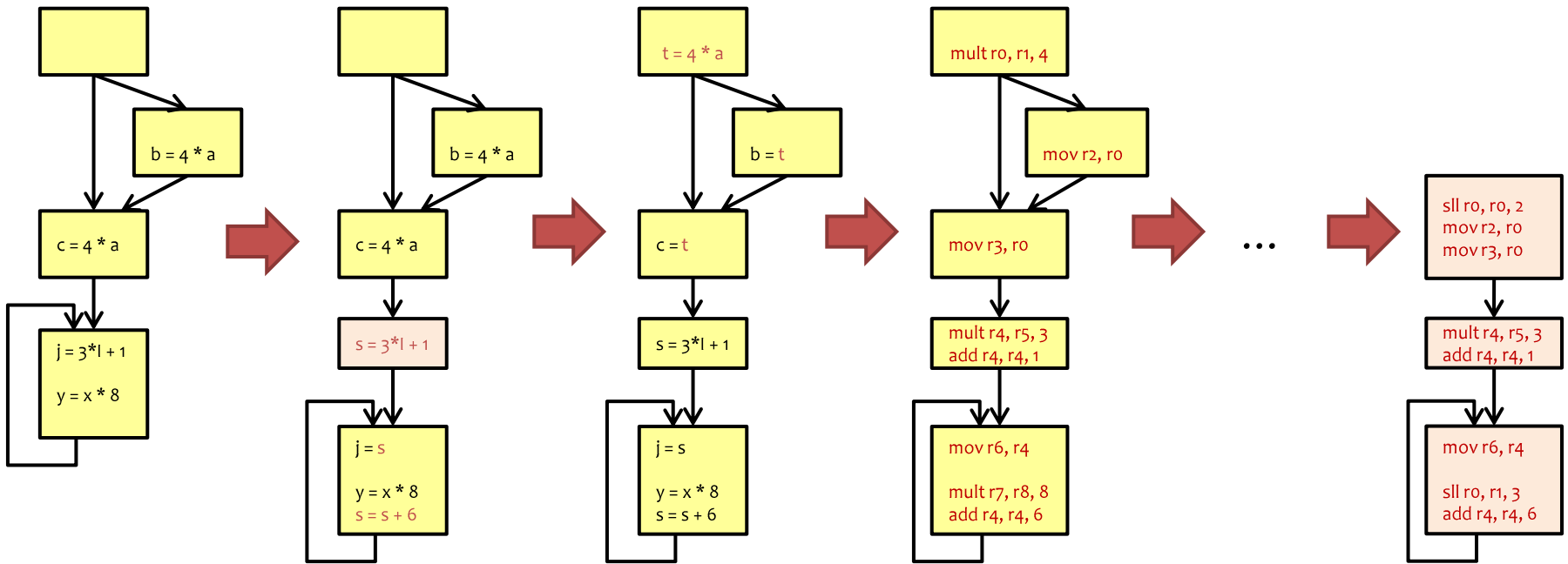
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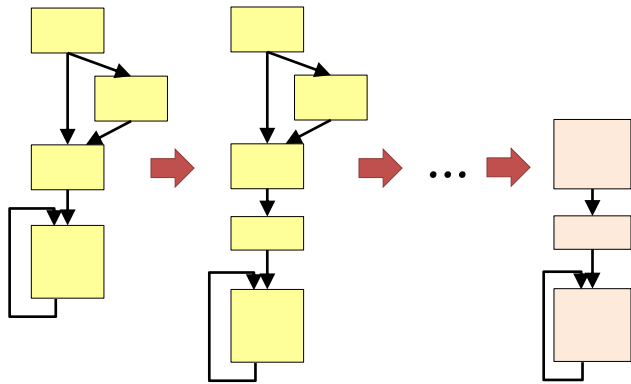
# Synthesis-Aided Compiler

# Classical vs. Synthesis Compiler



Classical Compiler

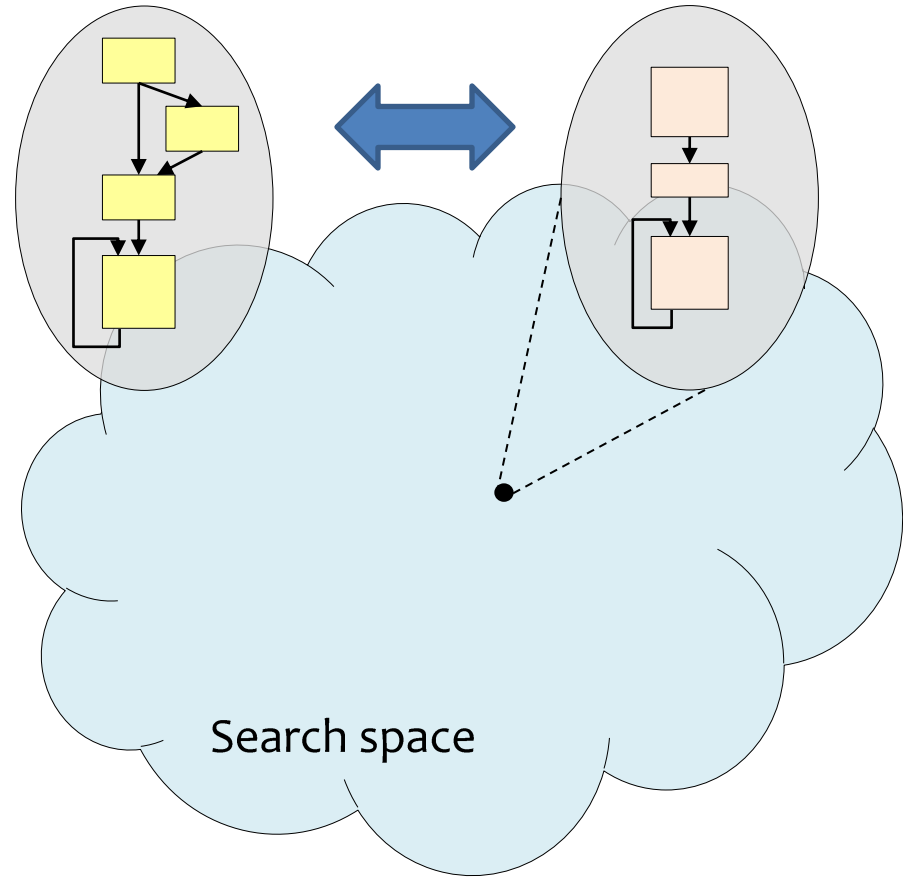
# Classical vs. Synthesis Compiler



Classical Compiler

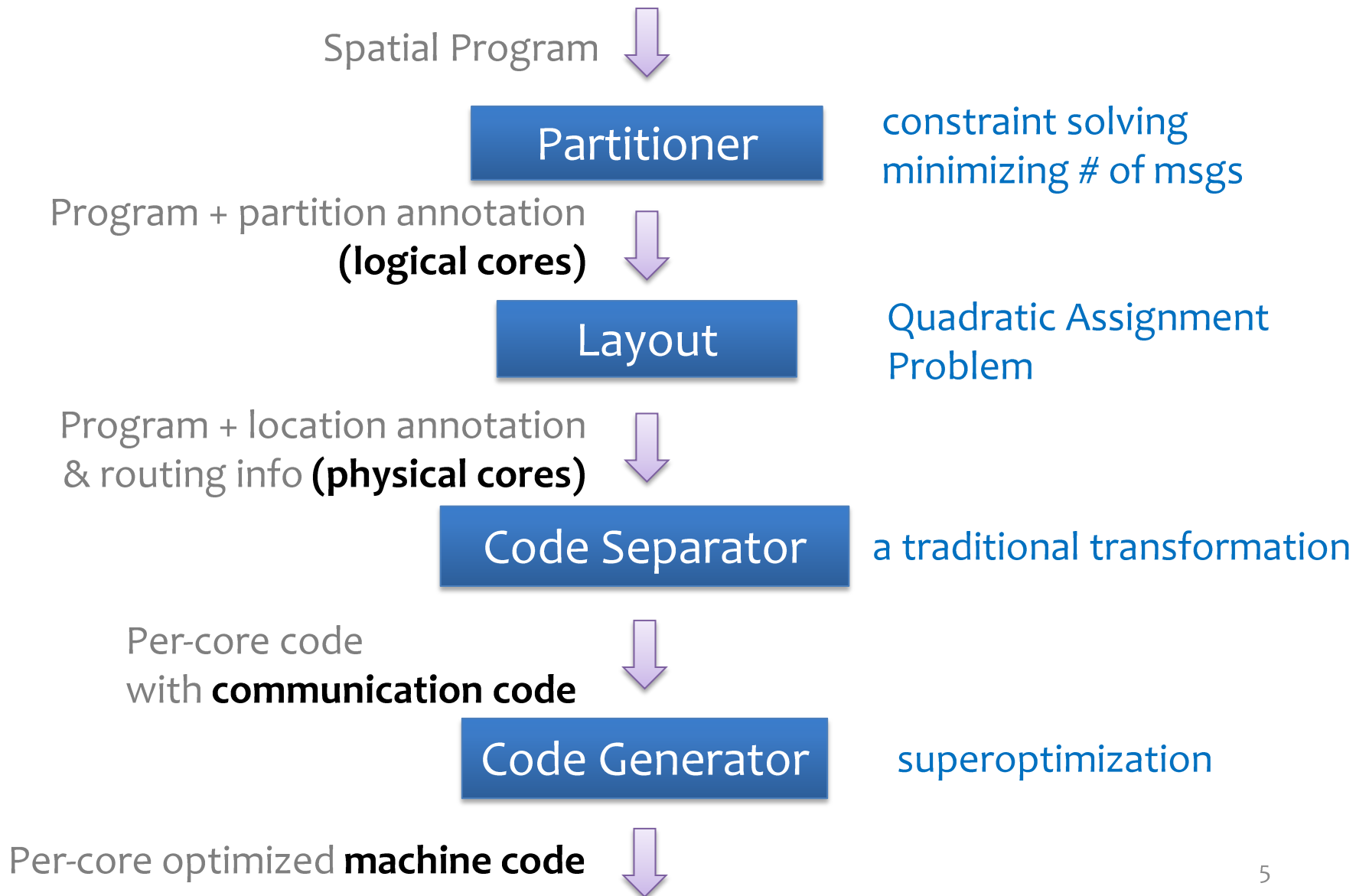
Input specification

Optimal program

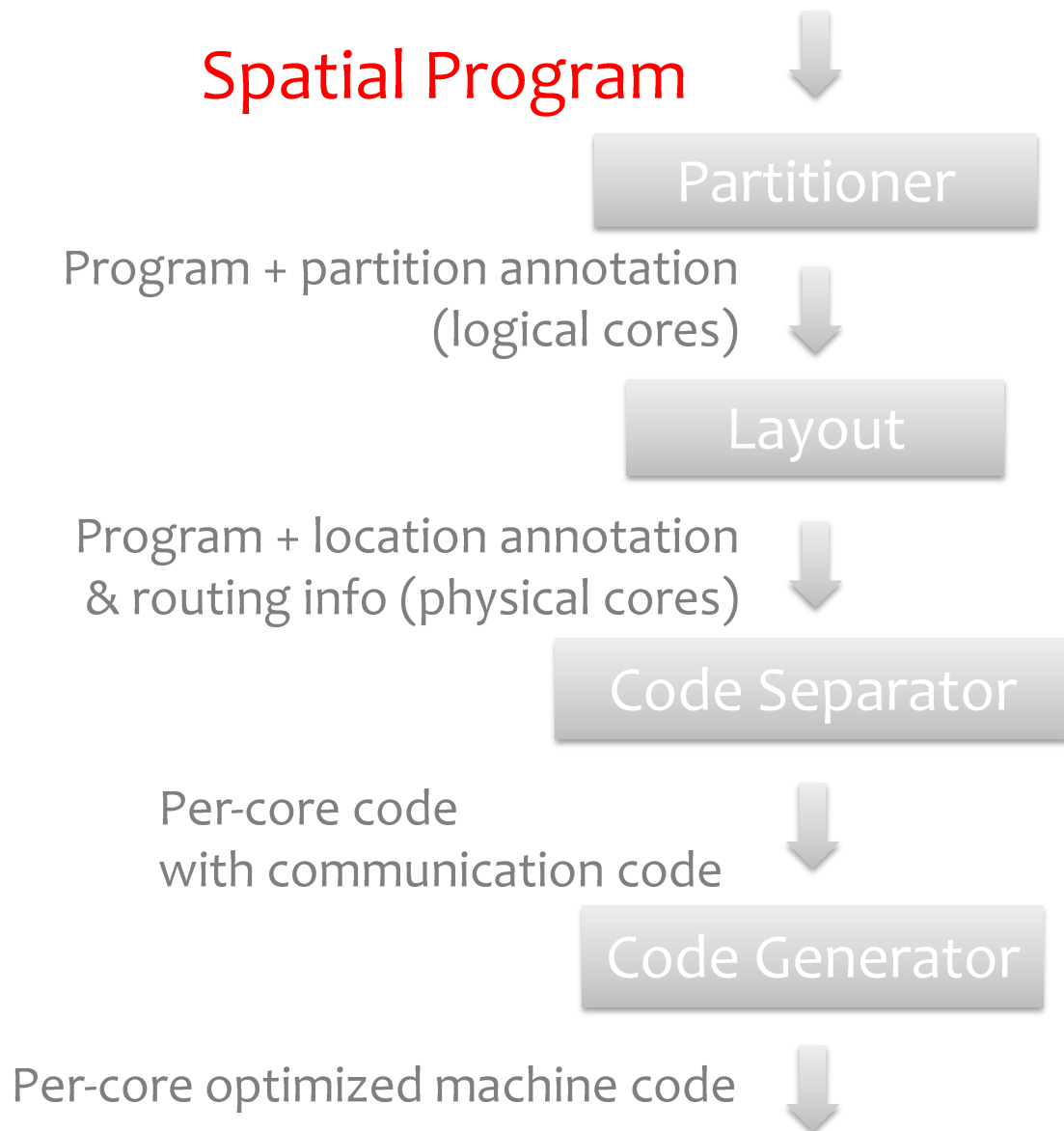


Synthesis-Aided Compiler

# Compiler Workflow



# Spatial programming model



# Spatial programming model

```
int a, b;
```

```
int ans = a * b;
```

# Spatial programming model

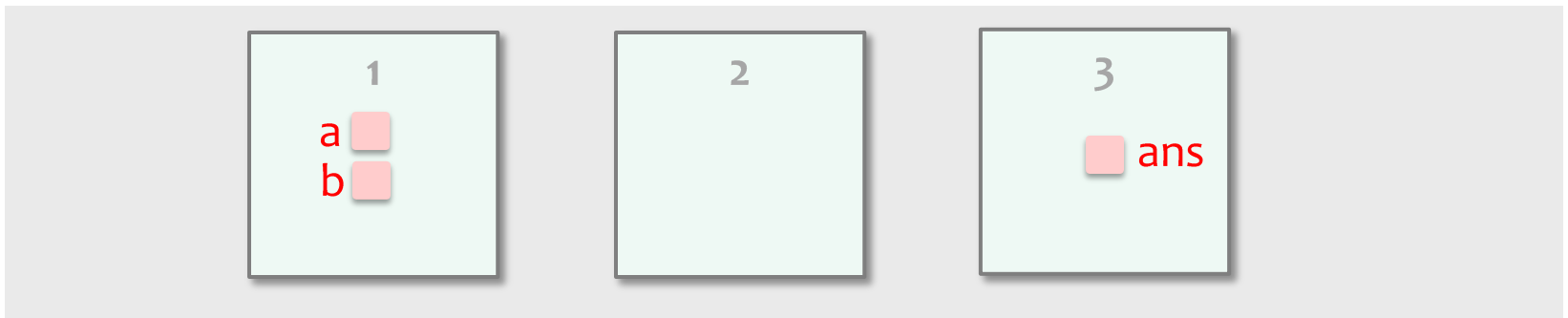
```
int@1 a, b;
```

```
int@3 ans = a * b;
```

## Partition Type

*pins data and operators to specific partitions (logical cores)*

Similar to [Chandra et al. PPOPP'08]





# Spatial programming model

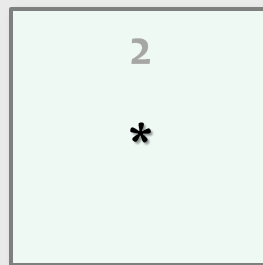
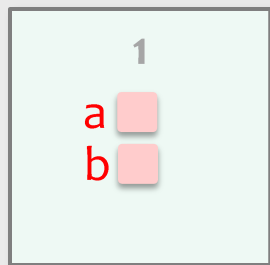
```
int@1 a, b;
```

```
int@3 ans = a * @2 b;
```

## Partition Type

*pins data and operators to specific partitions (logical cores)*

Similar to [Chandra et al. PPOPP'08]

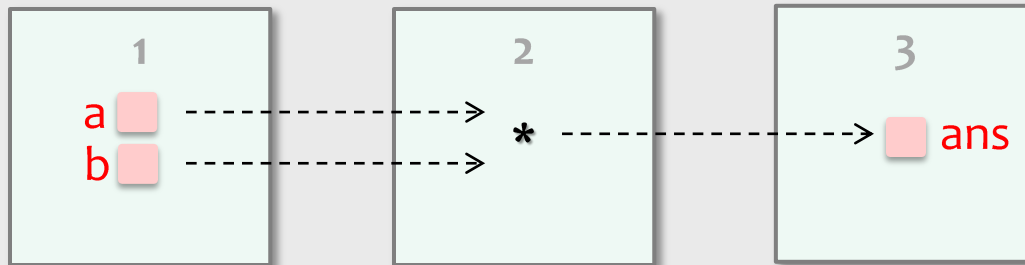


# Spatial programming model

```
int@1 a, b;
```

```
int@3 ans = a * @2 b;
```

Do not need to handle data routing and communication code



# Unspecified Partitions

**How to compile a partially annotated program?**

```
int a, b;
```

```
int@3 ans = a * b;
```

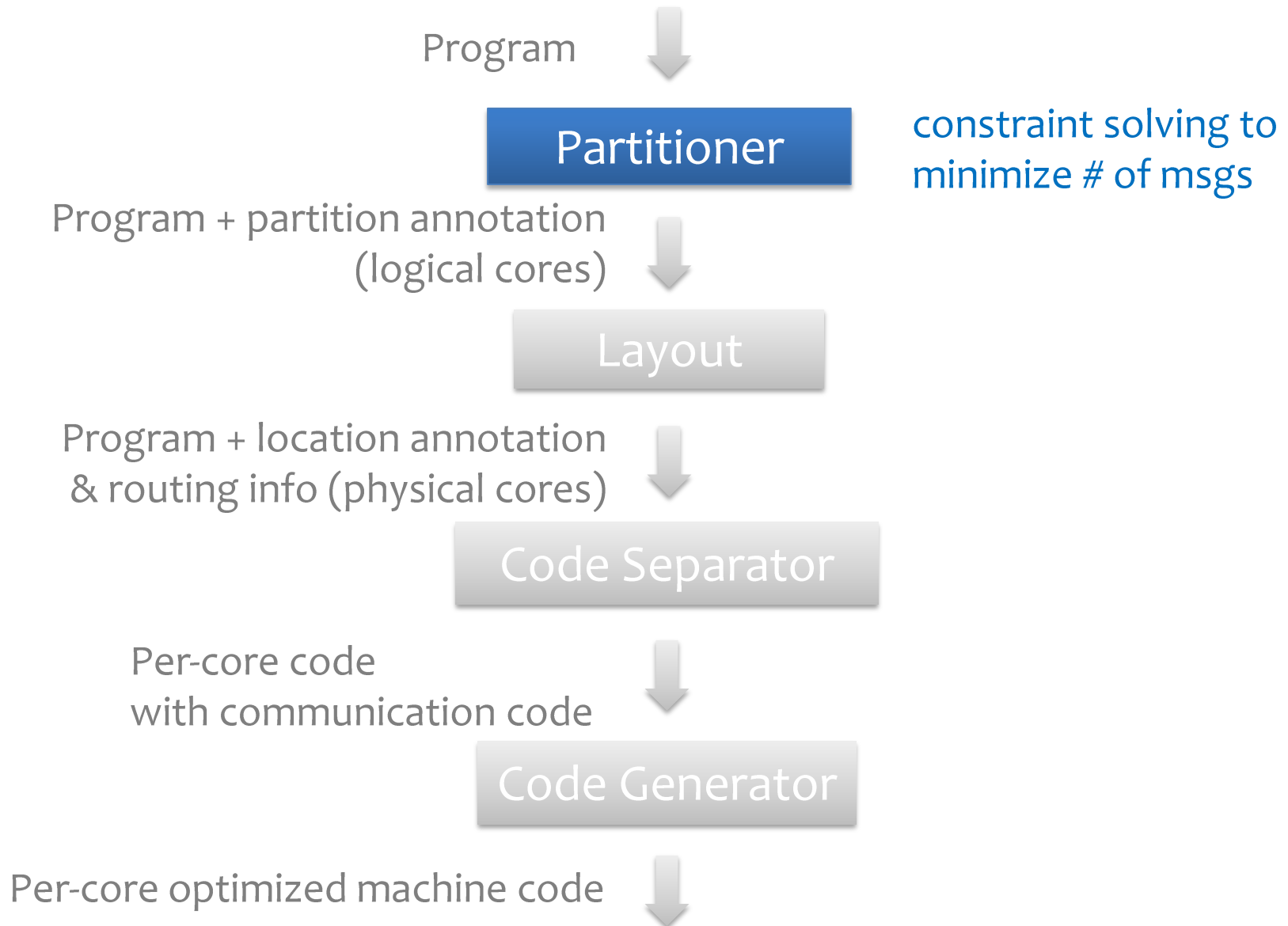
# Unspecified Partitions

How to compile a partially annotated program?

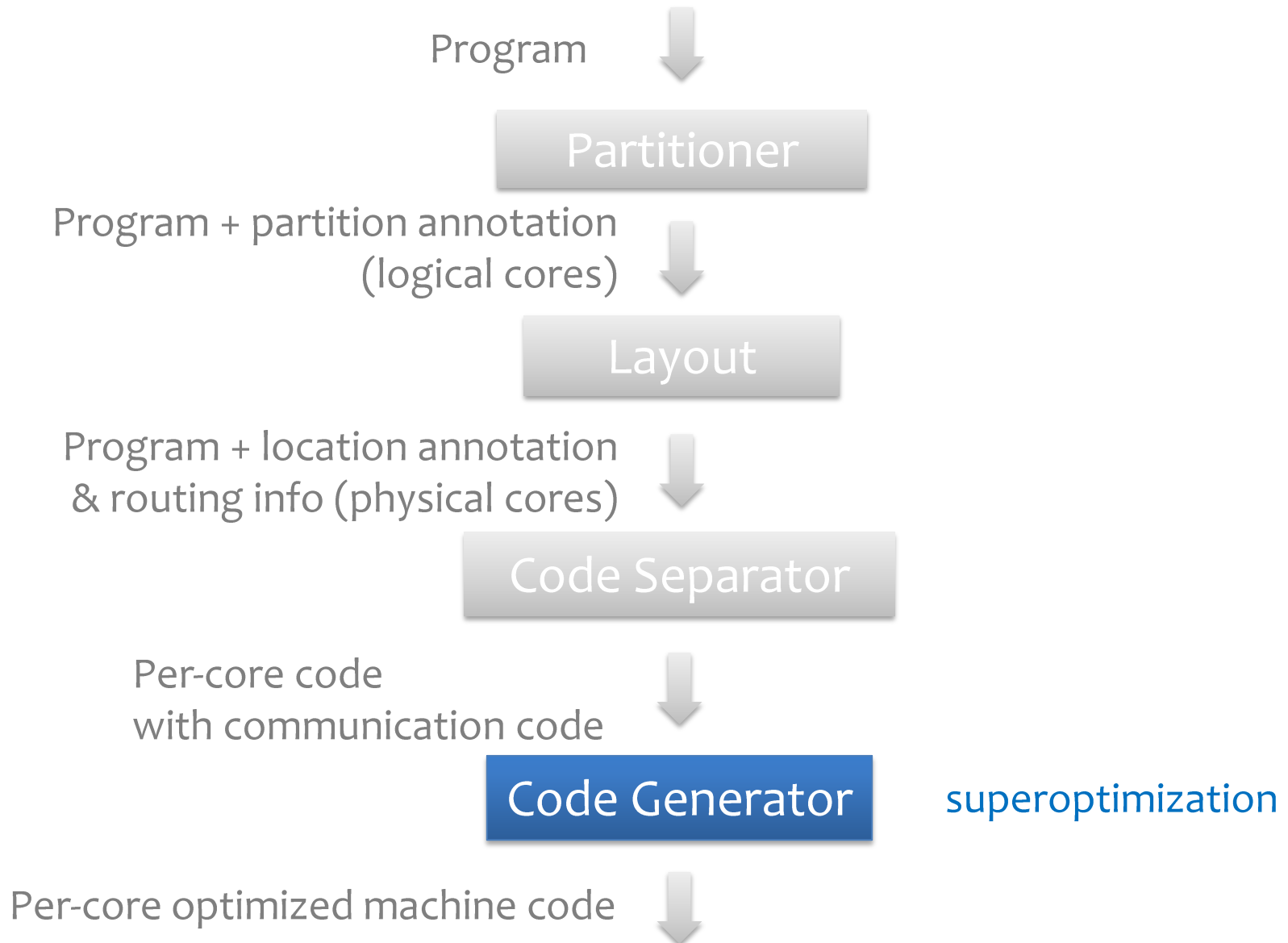
```
int@?? a, b;
```

```
int@3 ans = a * @?? b;
```

# Partitioning Synthesizer

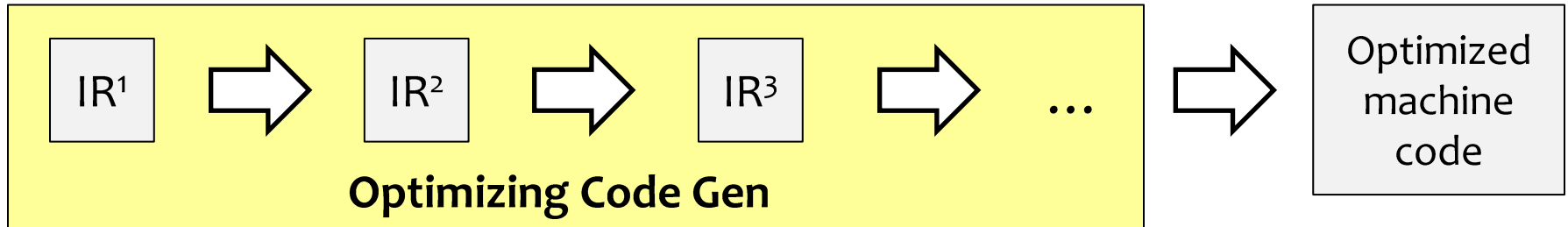


# Code Generator

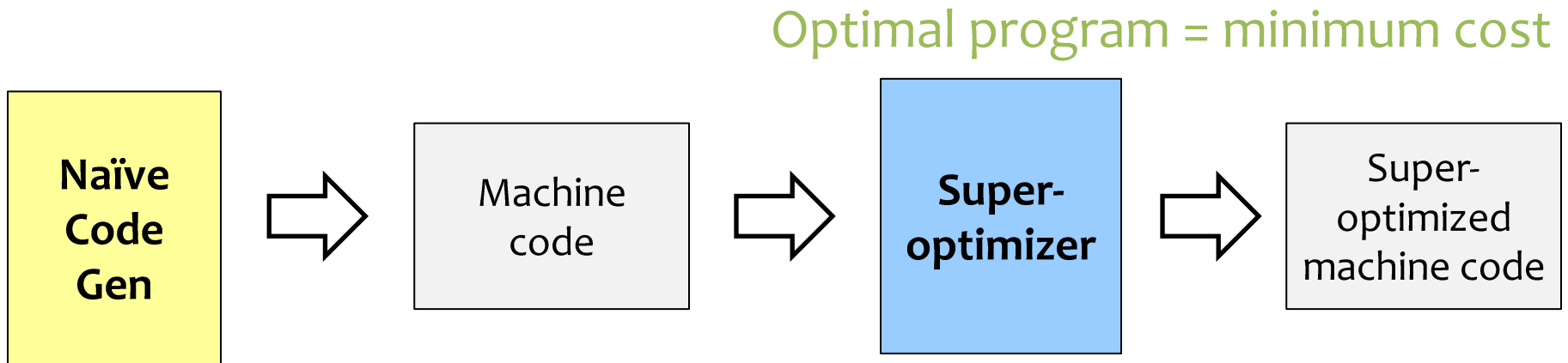


# Code Generator

## Classical compiler backend



## Our compiler backend



[Massalin et al. ASPLOS'87,  
Bansal et al. ASPLOS'06,  
Gulwani et al. PLDI'11, ...]

# Empirical Evaluation

**Our compiler produces code comparable to the expert's code.**

On a largest benchmark (MD5), Chlorophyll was

- 19% slower
- 31% less energy-efficient

On 3 critical functions, Chlorophyll found

Func	Charley's	Chlorophyll
f	push over - push and pop pop and over \$ffff or and or [19 slots]	dup push or and pop or [7 slots]
g	a! push a and pop a - and over \$ffff or and or [19 slots]	a! over or dup a and or nop or [9 slots]
i	a! push a - over \$ffff or and or pop or [18 slots]	a! over - \$ffff a or and or or [14 slots]