C2HLSC

Leveraging LLMs to refactor C code into HLS-compatible C

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What do system architects do?

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1 Profile application

$f_C(f_A) + f_A(f_B)$

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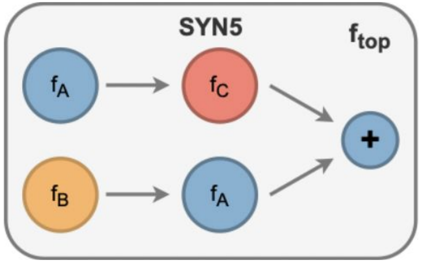
2 Construct DFG



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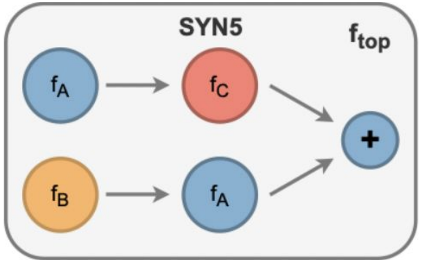

3 Model latency

$$f_{\text{top}} + \max(f_A + f_C, f_B + f_A)$$

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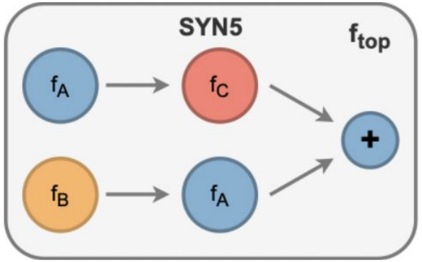

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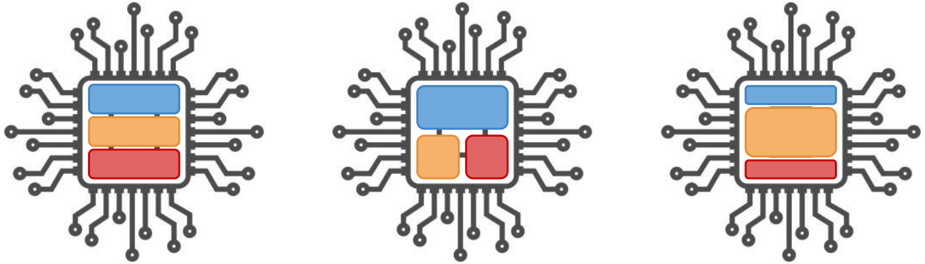
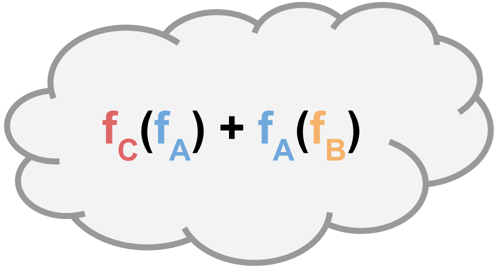
4 DSE to map kernels to hardware



Can LLMs replace system architects?

1 Profile application



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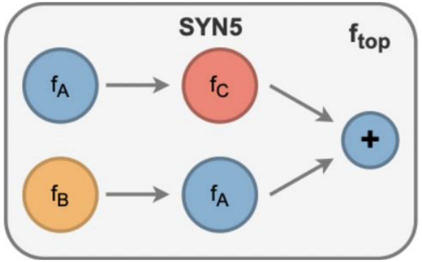

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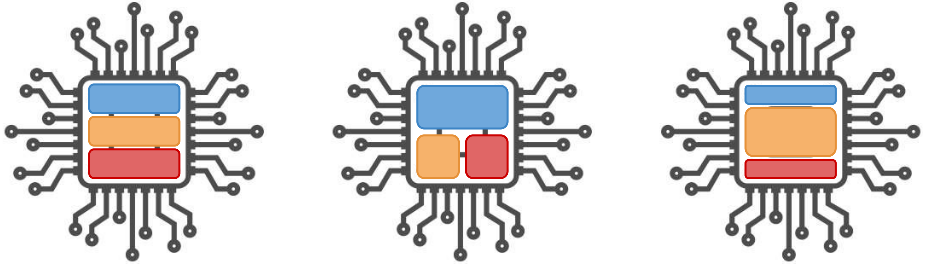
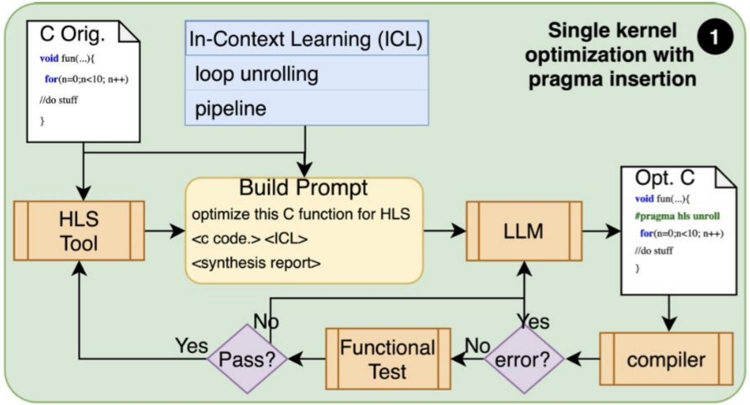


Overview of proposed flow



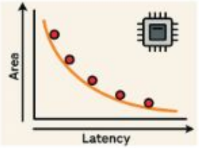
```
void fun(...){
  for(n=0;n<10; n++)
//do stuff
}
```

optimize this C function for HLS
<c code.> <ICL>
<synthesis report>

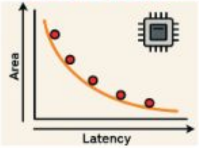
```
void fun(...){
#pragma hls unroll
  for(n=0;n<10; n++)
//do stuff
}
```

Single Kernel Optimization

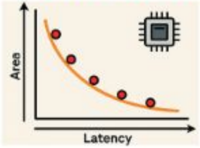
Kernel 1

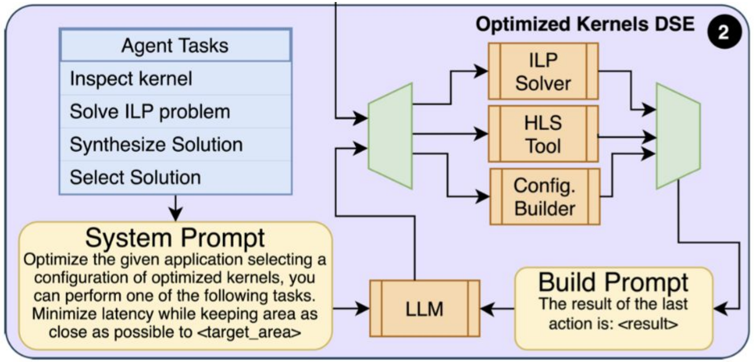


Kernel 2



Kernel *n*





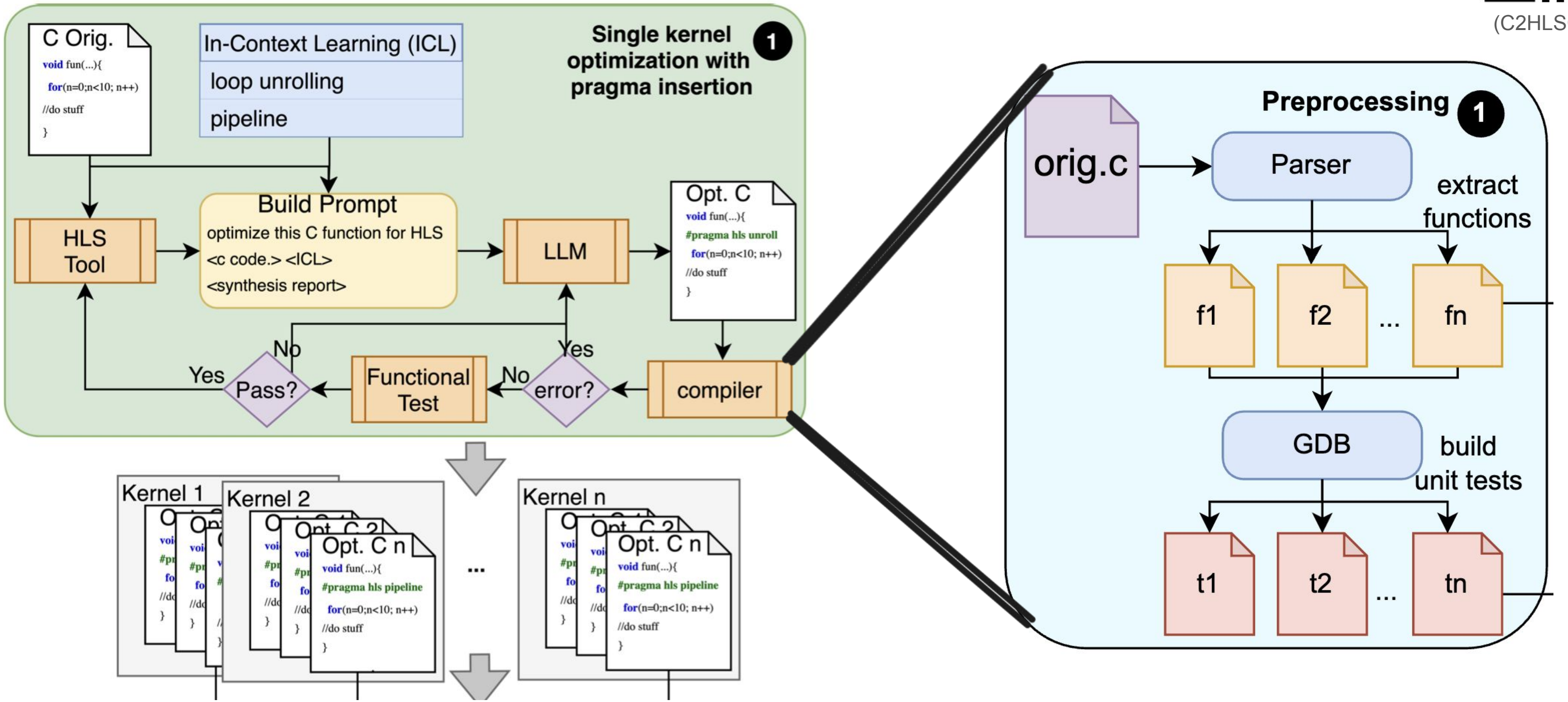
Optimize the given application selecting a configuration of optimized kernels, you can perform one of the following tasks. Minimize latency while keeping area as close as possible to <target_area>

The result of the last action is: <result>

Full System Composition

Single kernel optimization via pragma insertion

(C2HLSC, TODAES)



C Orig.:

```
void fun(...){
  for(n=0;n<10; n++)
 //do stuff
 }
```

Opt. C:

```
void fun(...){
#pragma hls unroll
  for(n=0;n<10; n++)
//do stuff
}
```

Opt. C n:

```
void fun(...){
#pragma hls pipeline
  for(n=0;n<10; n++)
//do stuff
}
```

Design points for DSE

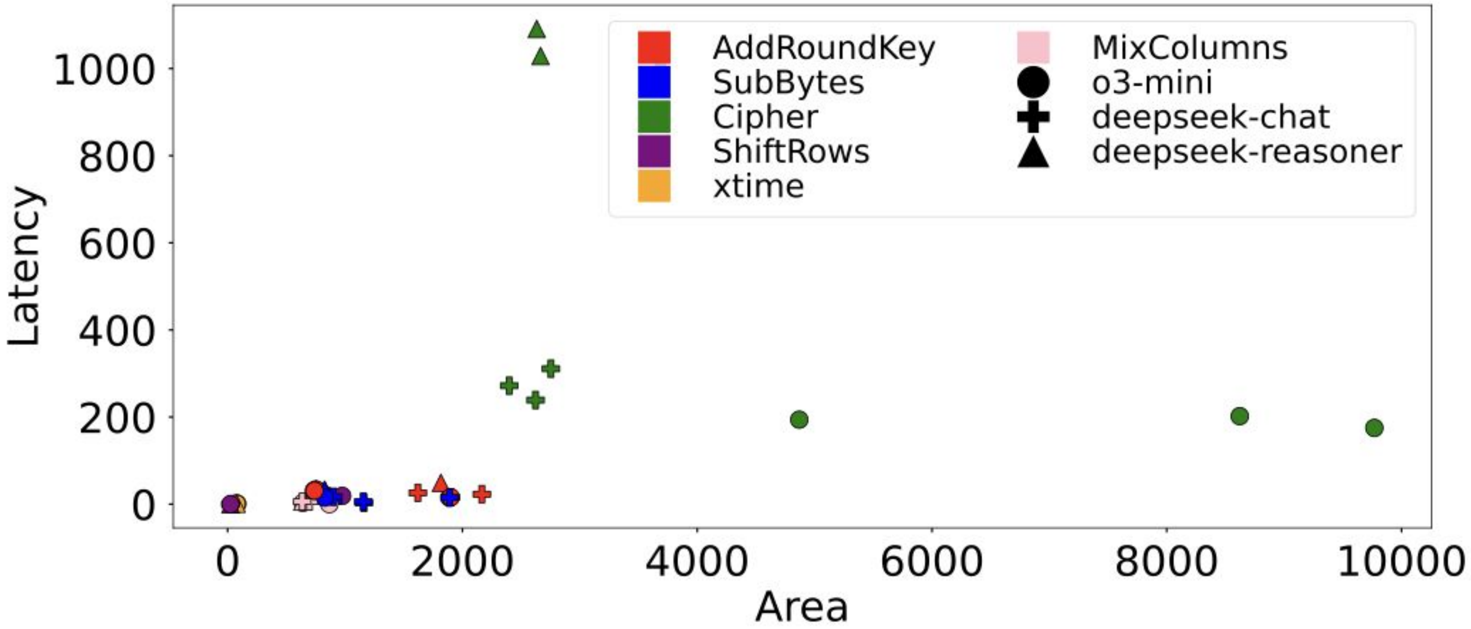
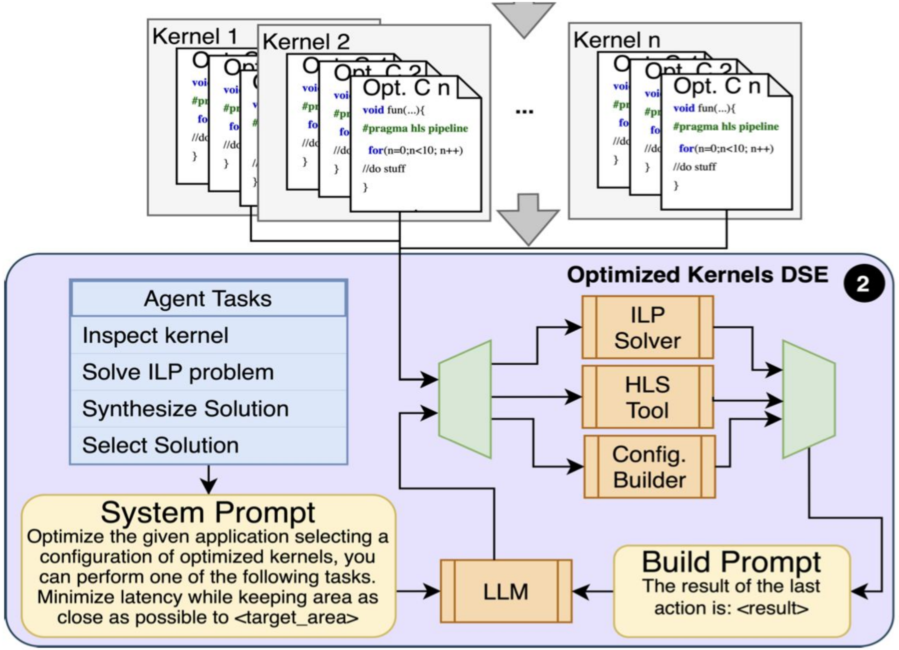


Fig. 4: Solutions for AES sub-kernels for each model.

DSE of optimized kernels



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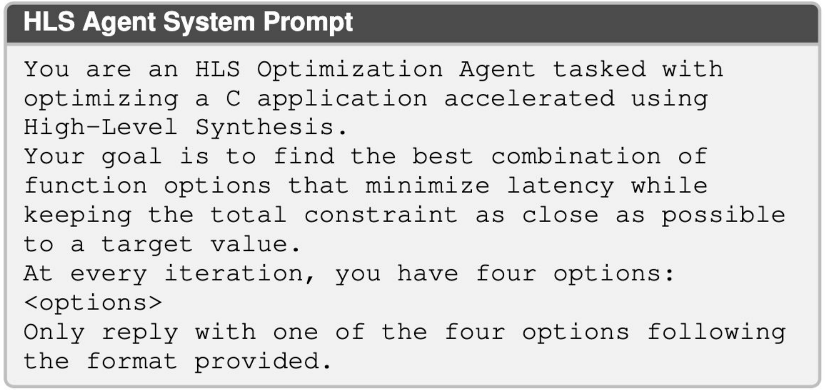

HLS Agent System Prompt

```
You are an HLS Optimization Agent tasked with
optimizing a C application accelerated using
High-Level Synthesis.
Your goal is to find the best combination of
function options that minimize latency while
keeping the total constraint as close as possible
to a target value.
At every iteration, you have four options:
<options>
Only reply with one of the four options following
the format provided.
```

Thank you!

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