Tail recursion in C

Take this C code:

```
int always_zero(i)
{
    if(i==0)
       return 0;
    return always_zero(i-1);
}

void main()
{
    always_zero(5);
}
```

Stack

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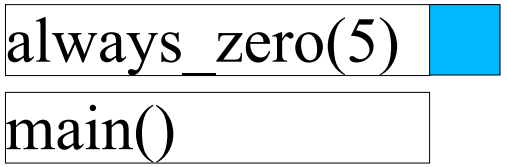


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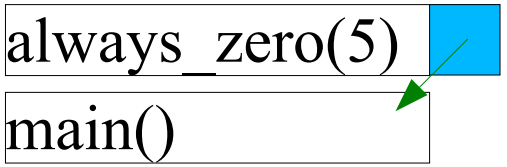


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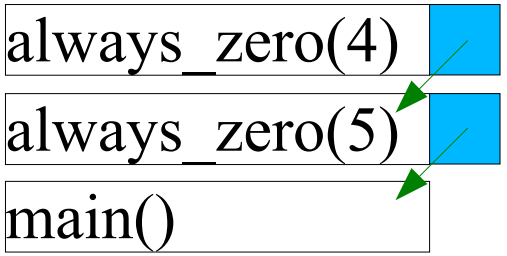


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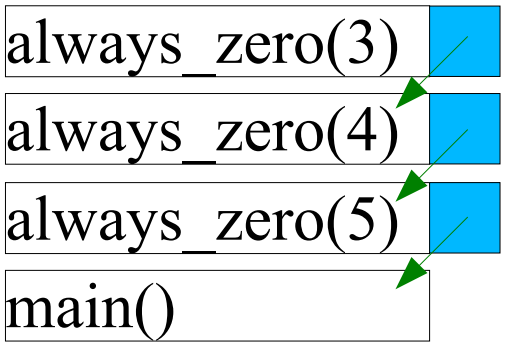


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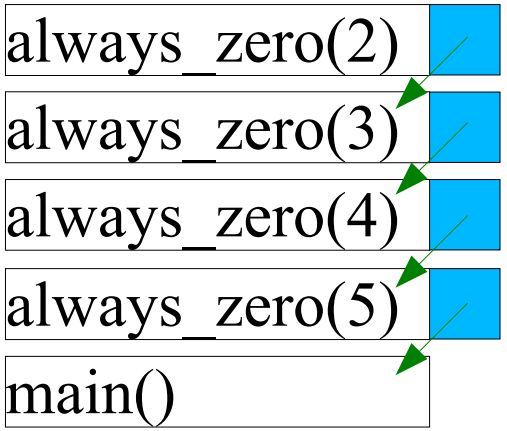


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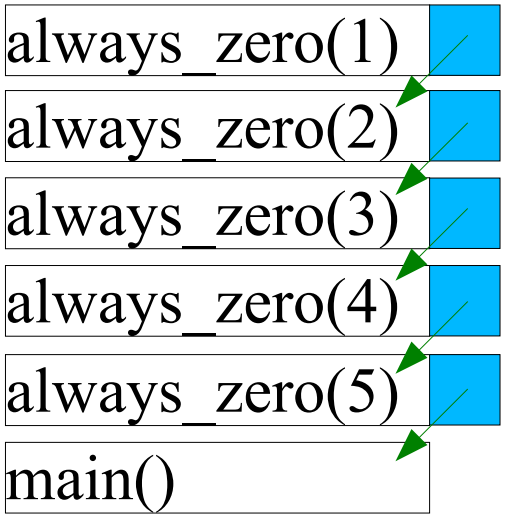


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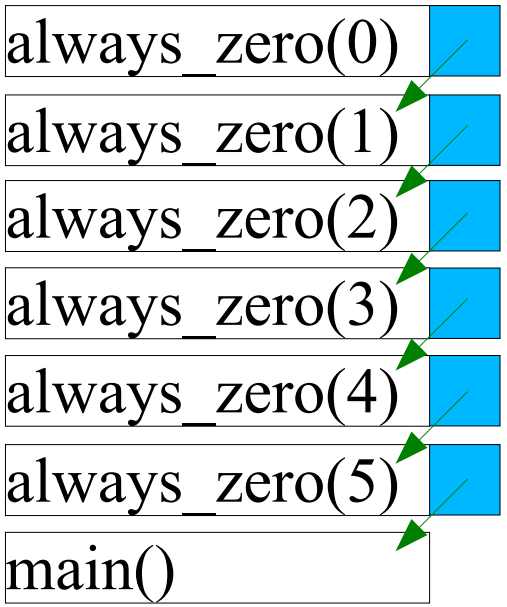


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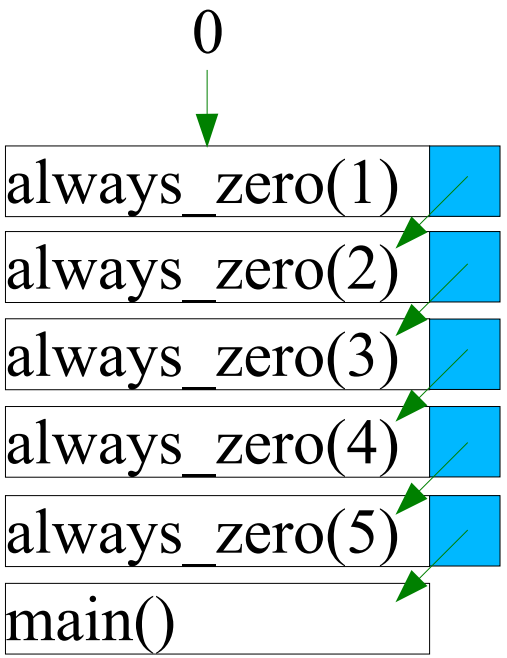


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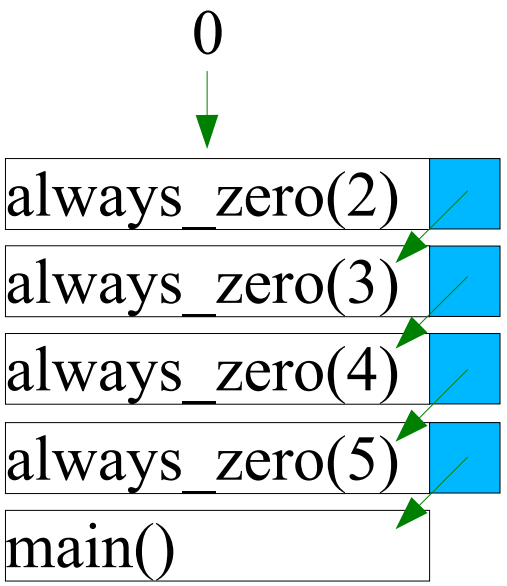


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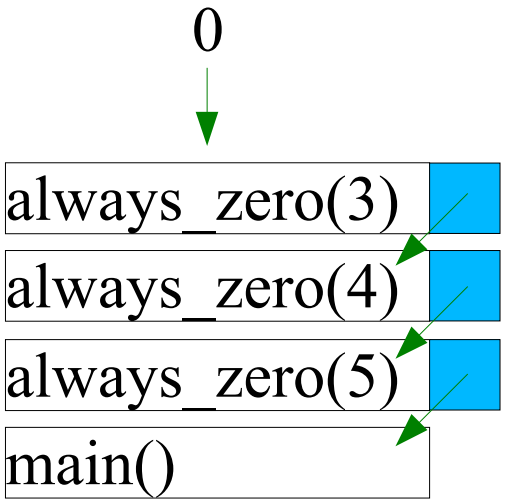


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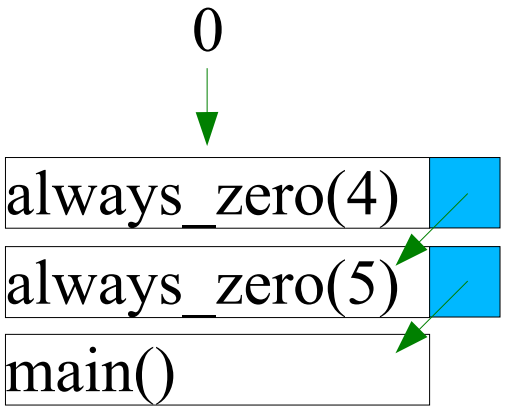


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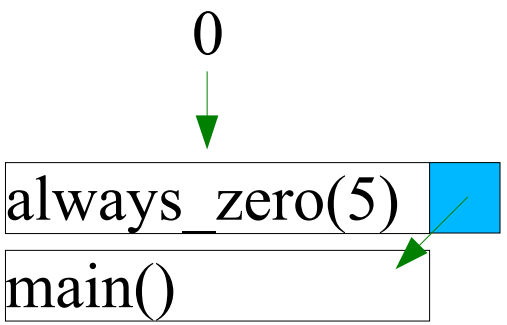


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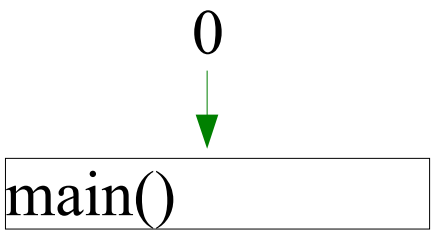


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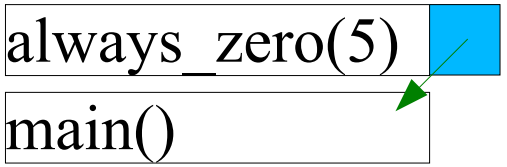
A lot of unnecessary work and storage! Can we do better?

Tail recursion

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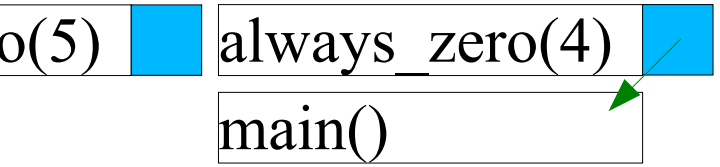


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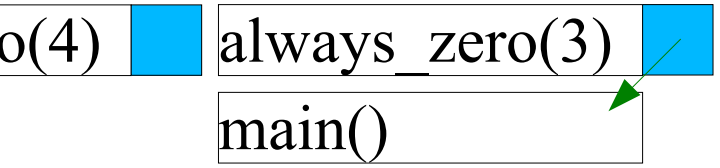


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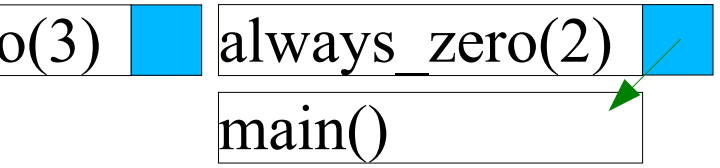


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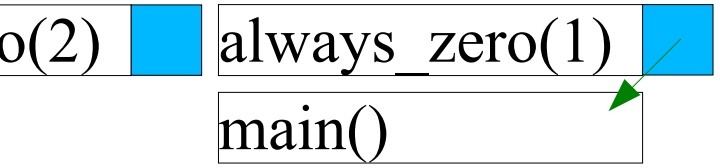


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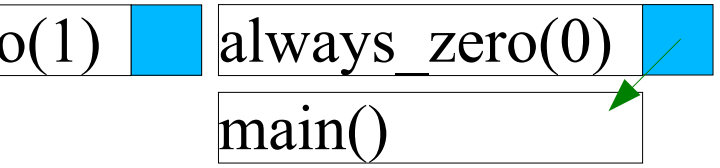


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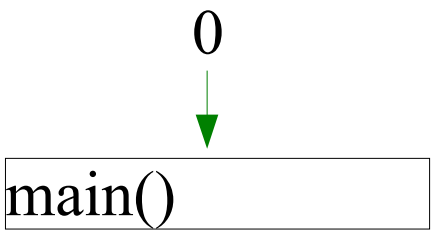


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Tail recursion

- Just discard unnecessary functions from the stack

- Same results
- O(1) space instead of O(n) space
- Faster too!

- Can we do this for all recursive algorithms?

Take this C code:

```
int always_zero(i)
{
    if(i==0)
       return 0;
    return 5*always_zero(i-1);
}

void main()
{
    always_zero(5);
}
```

Can we do the same trick?

- No! Results returned by always_zero(0) need to be further processed by always_zero(1)
- Results from always_zero(0) cannot be returned directly to main()
- Need to pass through always_zero(1), always_zero(2), always_zero(3), ...

Tail recursion only works when we need no further processing.

Terminology

Scheme

Iteration

Recursion

C

Iteration

```
for(i=0; i<100; i++) {
}
```

Tail recursion

```
int f(int i)
{
  if(i==0)
    return 0;
  return f(i-1);
}
```

Normal recursion

```
int f(int i)
{
 if(i==0)
   return 1;
 else
   return i*f(i);
}
```