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pymwp: A Static Analyzer Determining Polynomial Growth Bounds


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```
void main(int X1, int X2, int X3)
{
    while(X1 < 10){
        X1 = X2 + X3;
    }
    // X1'   X2'   X3'
}
```

Does there exist a polynomially
bounded data-flow relation
between variables'
initial and **final** values?

$\forall n$, is $X_n \rightsquigarrow X'_n$
polynomially bounded?



```
void main(int X1, int X2, int X3)
{
    while(X1 < 10){
        X1 = X2 + X3;
    }

    // X1'  X2'  X3'

}
```

Yes, here is a bound:

$$X1' \leq \max(X1, X2+X3)$$

$$\wedge X2' \leq X2$$

$$\wedge X3' \leq X3$$

mwp-flow analysis

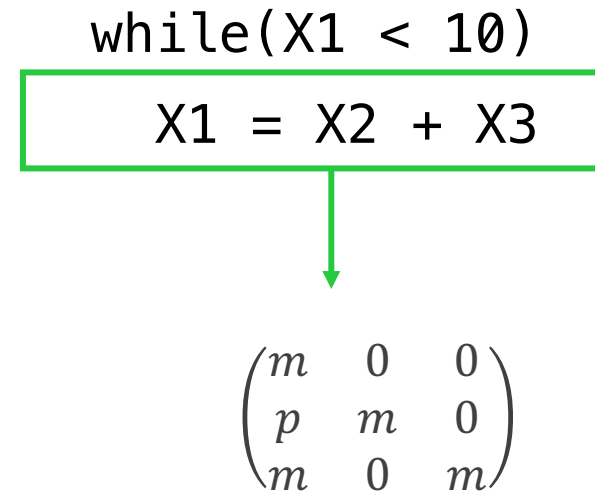
Calculus for resource analysis of imperative programs.

0 – no dependency

m – maximal (of linear)

w – weak polynomial

p - polynomial



mwp-flow analysis

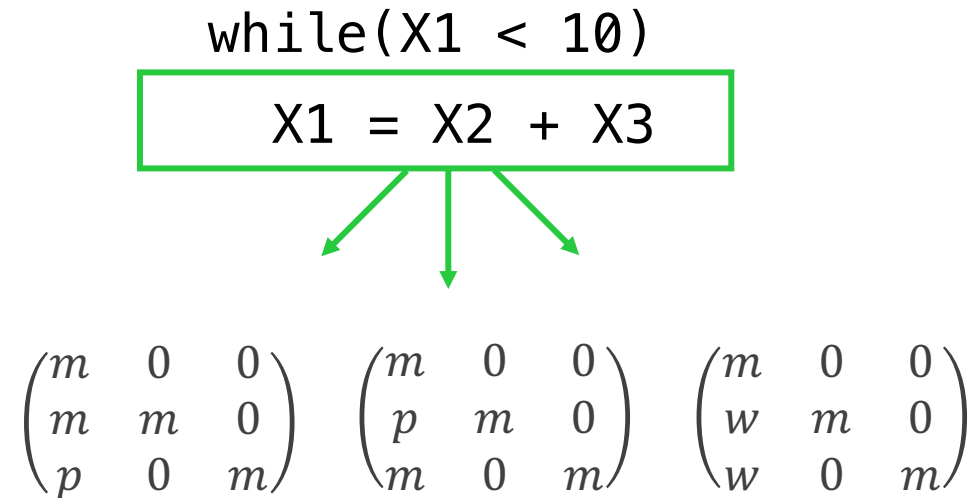
Calculus for resource analysis of imperative programs.

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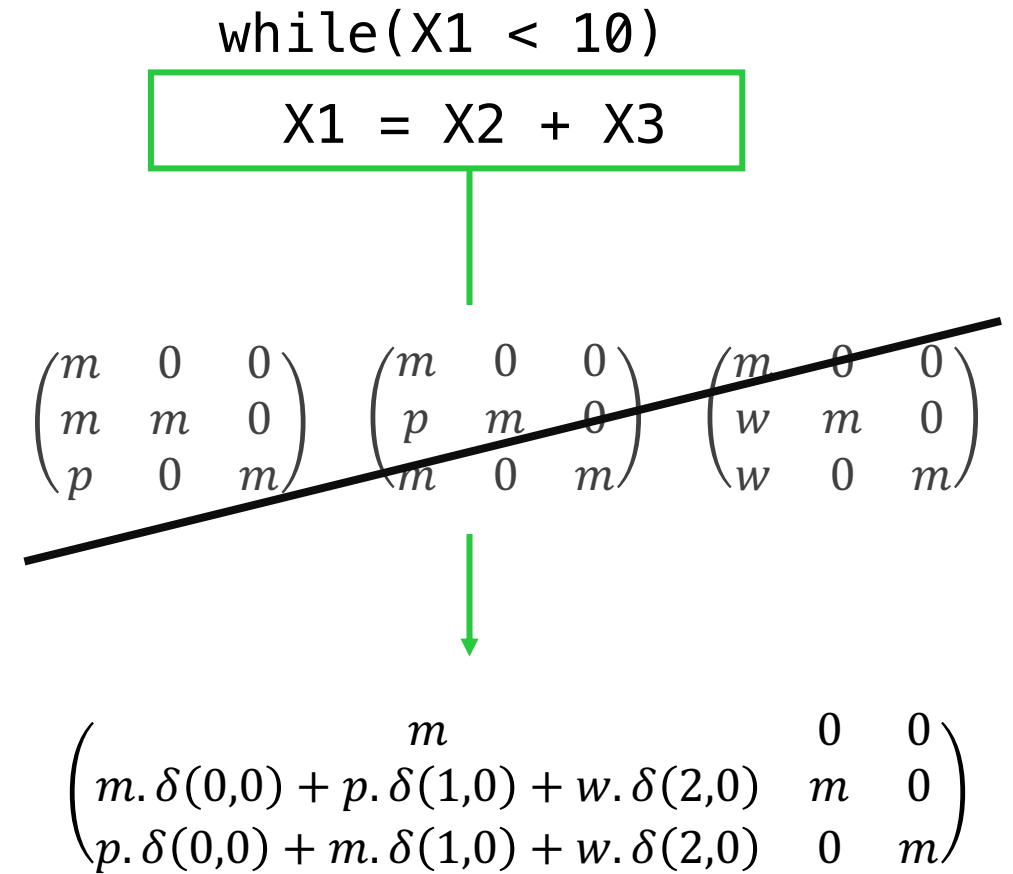
w – weak polynomial

p - polynomial



Automating mwp

Internalize non-determinism



Automating mwp

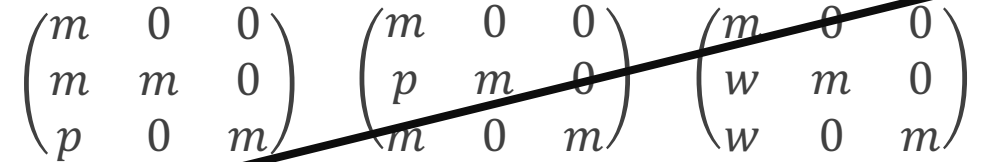
Internalize non-determinism

Handle derivation failure

$0, m, w, p, \infty$

∞ - non-polynomial / failure

```
while(X1 < 10)
  X1 = X2 + X3
```


$$\begin{pmatrix} m & 0 & 0 \\ m & m & 0 \\ p & 0 & m \end{pmatrix} \quad \begin{pmatrix} m & 0 & 0 \\ p & m & 0 \\ m & 0 & m \end{pmatrix} \quad \begin{pmatrix} m & 0 & 0 \\ w & m & 0 \\ w & 0 & m \end{pmatrix}$$

$$\begin{pmatrix} m + \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) & 0 & 0 \\ \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) + w \cdot \delta(2,0) & m & 0 \\ \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) + w \cdot \delta(2,0) & 0 & m \end{pmatrix}$$



```
void main(int X1, int X2, int X3)
{
    while(X1 < 10){
        X1 = X2 + X3;
    }

    // X1'   X2'   X3'

}
```

We were here

$$\begin{pmatrix} m + \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) & 0 & 0 \\ \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) + w \cdot \delta(2,0) & m & 0 \\ \infty \cdot \delta(0,0) + \infty \cdot \delta(1,0) + w \cdot \delta(2,0) & 0 & m \end{pmatrix}$$

But we want

$$\begin{aligned} X1' &\leq \max(X1, X2+X3) \\ \wedge X2' &\leq X2 \quad \wedge X3' \leq X3 \end{aligned}$$



```
void main(int X1, int X2)
{
    X1 = X2 + X2;
    while(X1 < 10){
        X1 = X1 * X1;
    }
}
```

When derivation fails

Problematic flows:

$X1 \rightarrow X1 \parallel X2 \rightarrow X1$

pymwp is an automatic static analyzer for subset of C code, to determine if variables' value growth is polynomially bounded.

run in terminal



```
pip install pymwp  
pymwp file.c
```

run in browser

statycc.github.io/pymwp/demo



statycc/pymwp