Augmenting Decompiler Output with Learned Variable Names and Types

USENIX Security Symposium

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Variable Naming is Essential

```
 1| void read(char *a1) {
 2|   int v1 = 0;
 3|   char v2;
 4|   while (1) {
 5|     v2 = getchar();
 6|     if (v2 == EOF || v2 == '\n') {
 7|       a1[v1] = '\0';
 8|       break;
 9|     } else {
10|       a1[v1] = v2;
11|     }
12|     v1++;
13|   }
14| }
```

Variable Naming is Essential

```
1| void read(char *out_buf) {
2|   int loc = 0;
3|   char cur;
4|   while (1) {
5|     cur = getchar();
6|     if (cur == EOF || cur == '\n') {
7|       out_buf[loc] = '\0';
8|       break;
9|     } else {
10|       out_buf[loc] = cur;
11|     }
12|     loc++;
13|   }
14| }
```

Variable Naming is Essential

```
1| void read(char *banana) {
2|   int str = 0;
3|   char moo;
4|   while (1) {
5|     moo = getchar();
6|     if (moo == EOF || moo == '\n') {
7|       banana[str] = '\0';
8|       break;
9|     } else {
10|       banana[str] = moo;
11|     }
12|     str++;
13|   }
14| }
```

DIRE

```
1| file *f_open(char **filename, char *mode, int create) {
2|   int fd;
3|   if (!create)
4|     return fopen(*filename, mode);
5|   if (*mode != 119)
6|     assert_fail("fopen");
7|   fd = open(*filename, 577, 384);
8|   if (fd >= 0)
9|     return reopen(fd, mode);
10|   else
11|     return 0;
12| }
```

Hex-Rays	Developer
a1	filename
a2	mode
a3	is_private

Types Are Also Useful

```
double func(int *a1, int *a2) {
  double v1, v2;
  v1 = pow((*a1 - *a2), 2);
  v2 = pow((a1[1] - a2[1]), 2);
  return sqrt(v1 + v2);
}
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```
typedef struct {
  int x;
  int y;
} point;

double func(point *a1, point *a2) {
  double v1, v2;
  v1 = pow((a1->x - a2->x), 2);
  v2 = pow((a1->y - a2->y), 2);
  return sqrt(v1 + v2);
}
```

Predicting Types should be easier than names!

```
typedef struct {
  int x;
  int y;
} point;

sizeof(char);   // 1
sizeof(int);    // 4
sizeof(float);  // 4
sizeof(point);  // 8
sizeof(int[2]); // 8
```

Constraints Experiment

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- Mine GitHub, creating the same dataset as for DIRE

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- Mine GitHub, creating the same dataset as for DIRE
- Also maintain a database of types including their substructure
- Train a model to predict a type based on its context and constrain by size
- Results: Quite Bad!

The Problem: Padding Bytes

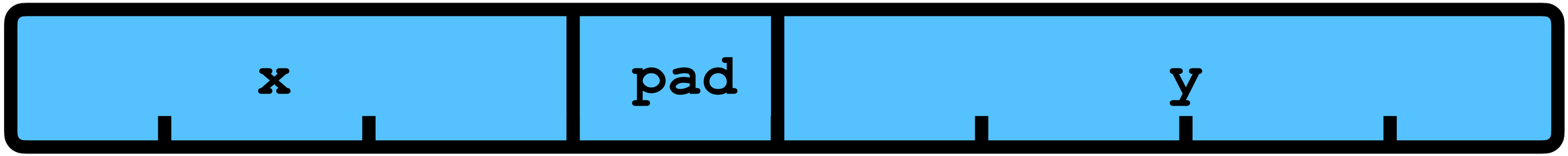
Original

```
void fun() {
  char x[3];
  int y;
  // ...
}
```

Decompiled

```
void fun() {
  char x[4];
  int y;
  // ...
}
```

Stack



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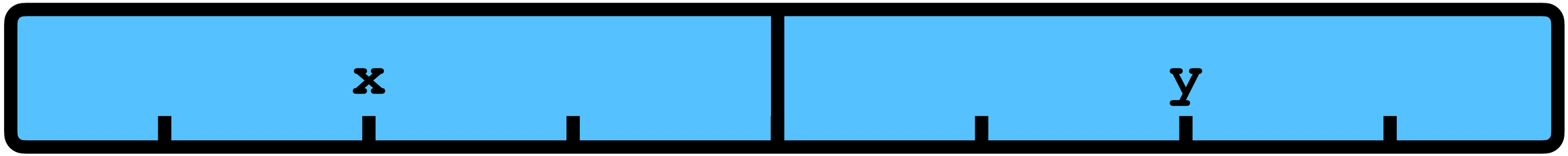

DecompIled variable ReTYper (DIRTY) Architecture

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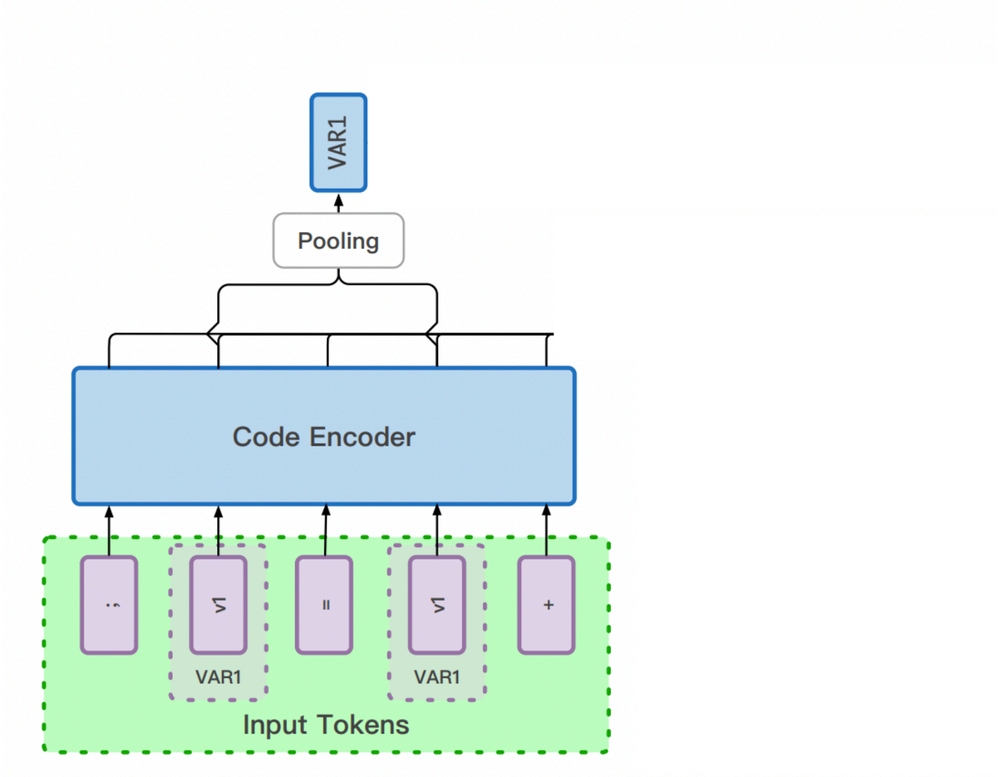

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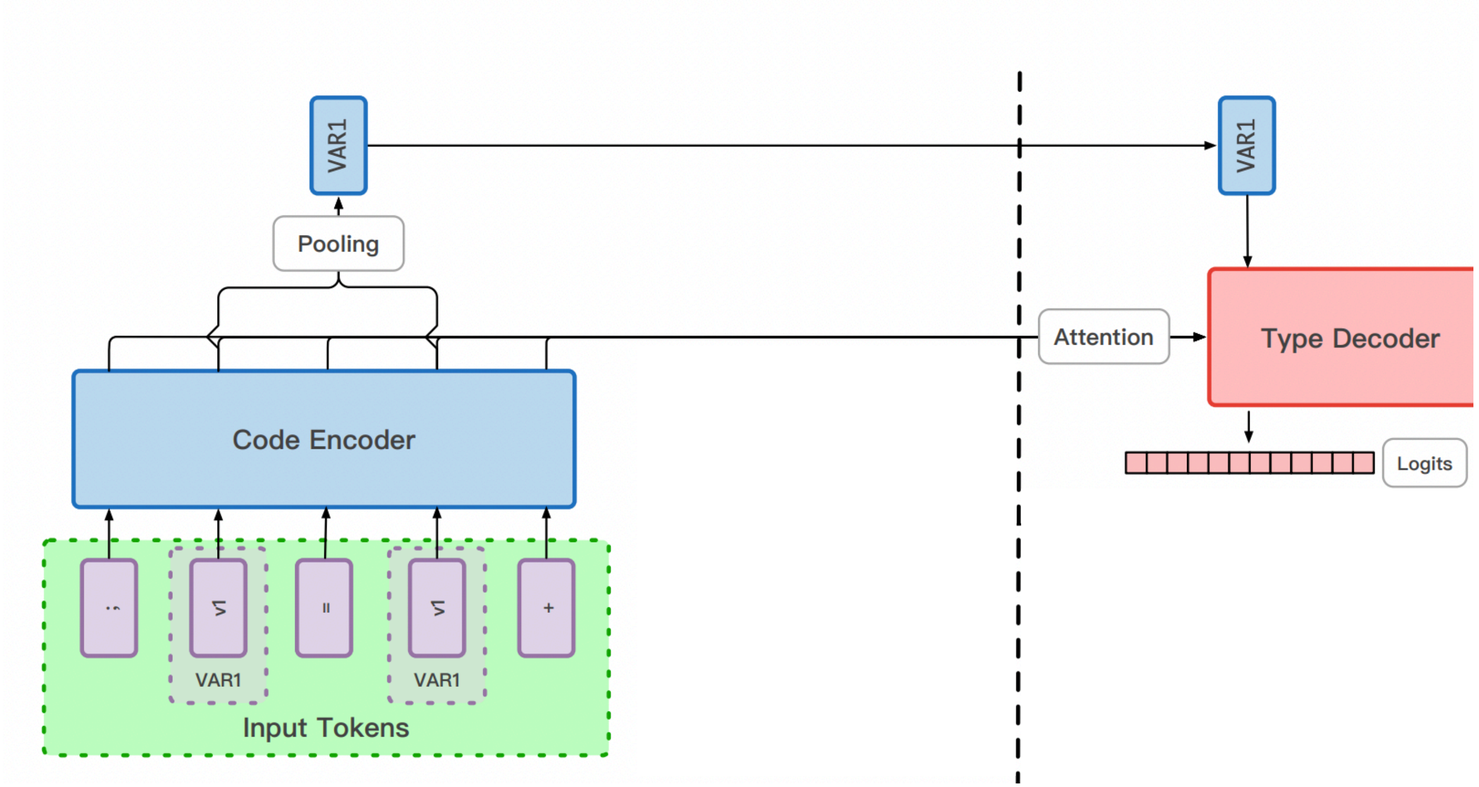

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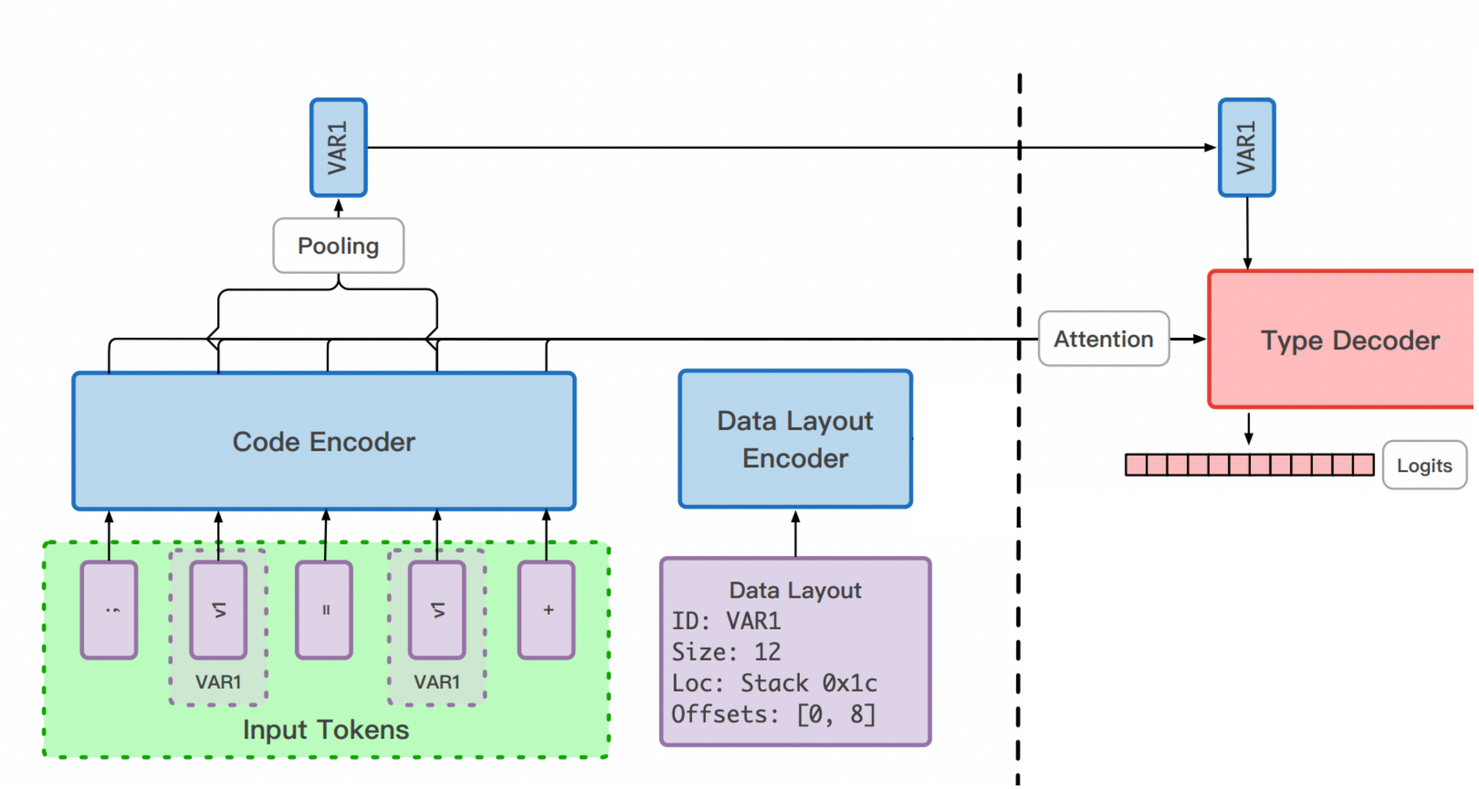

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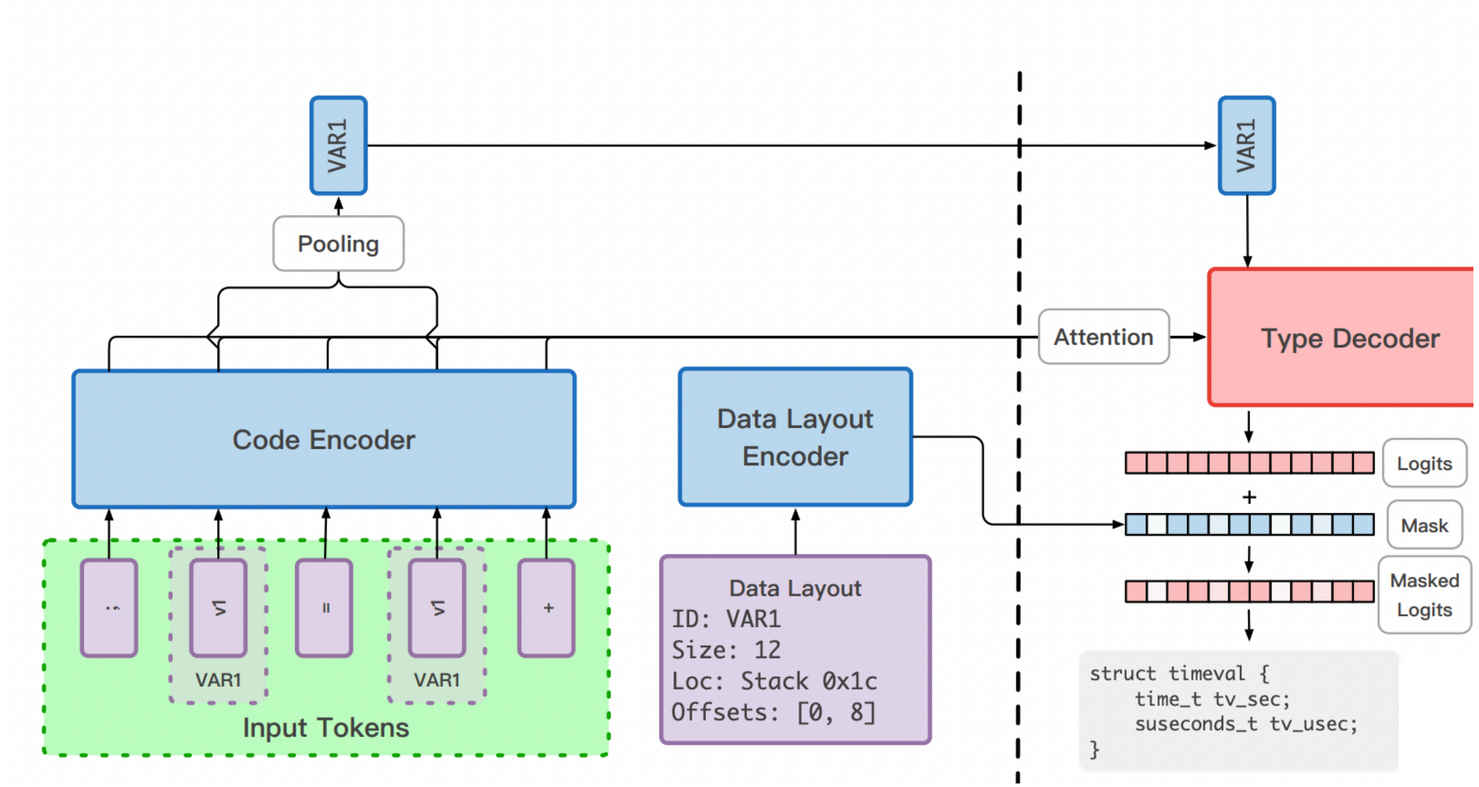

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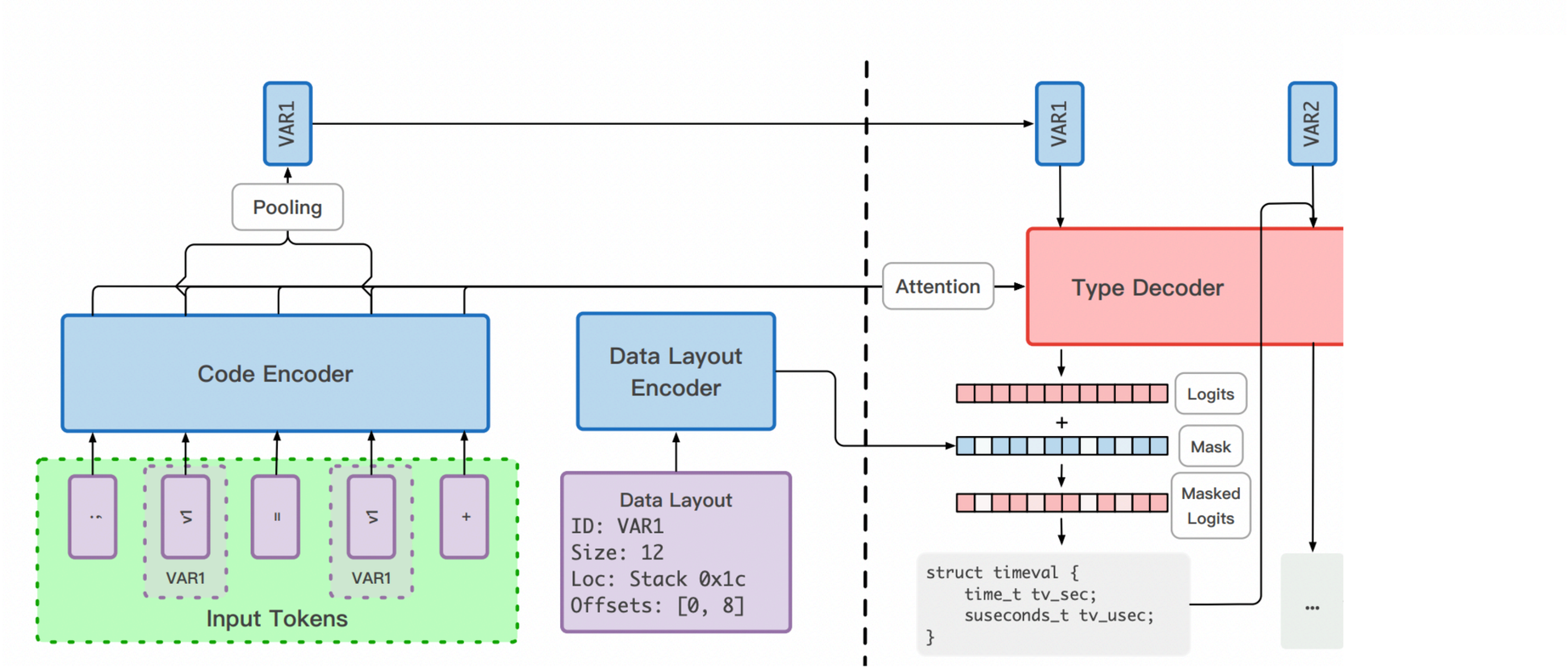

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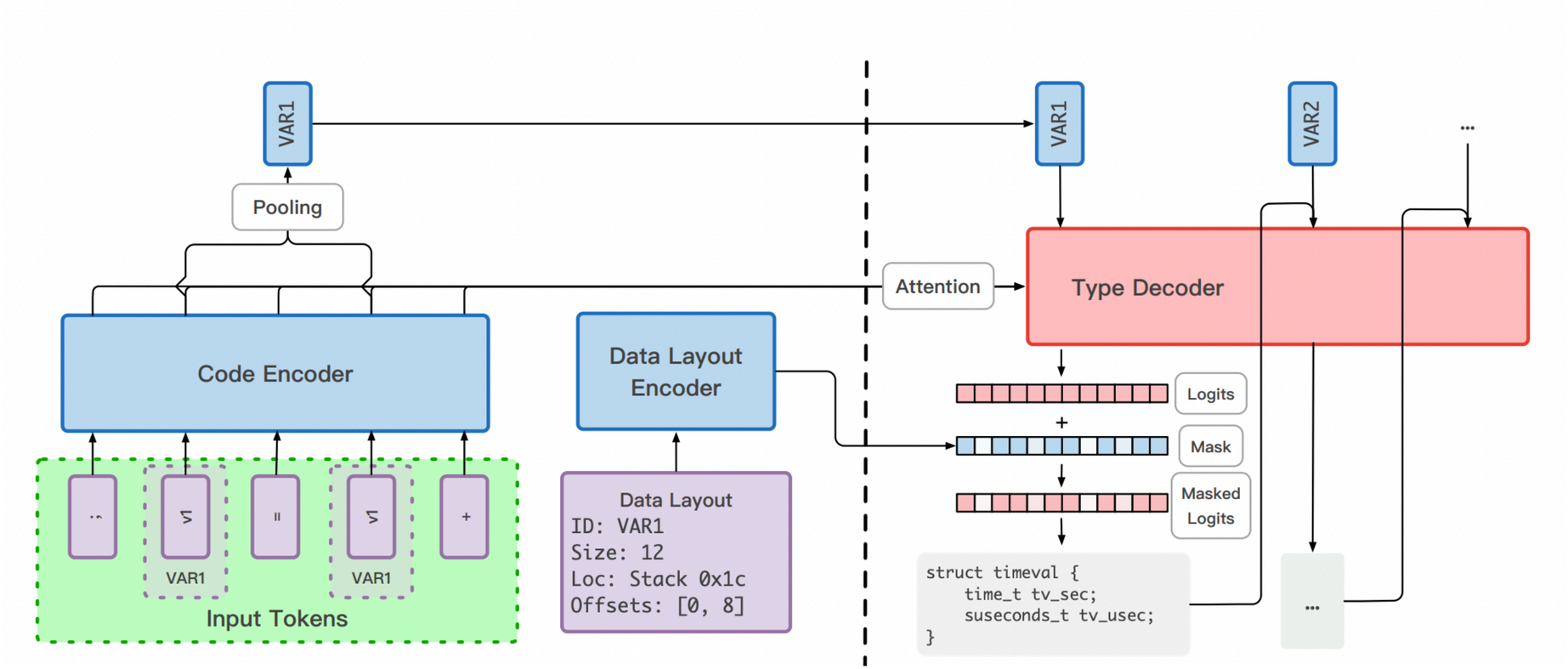

Evaluation

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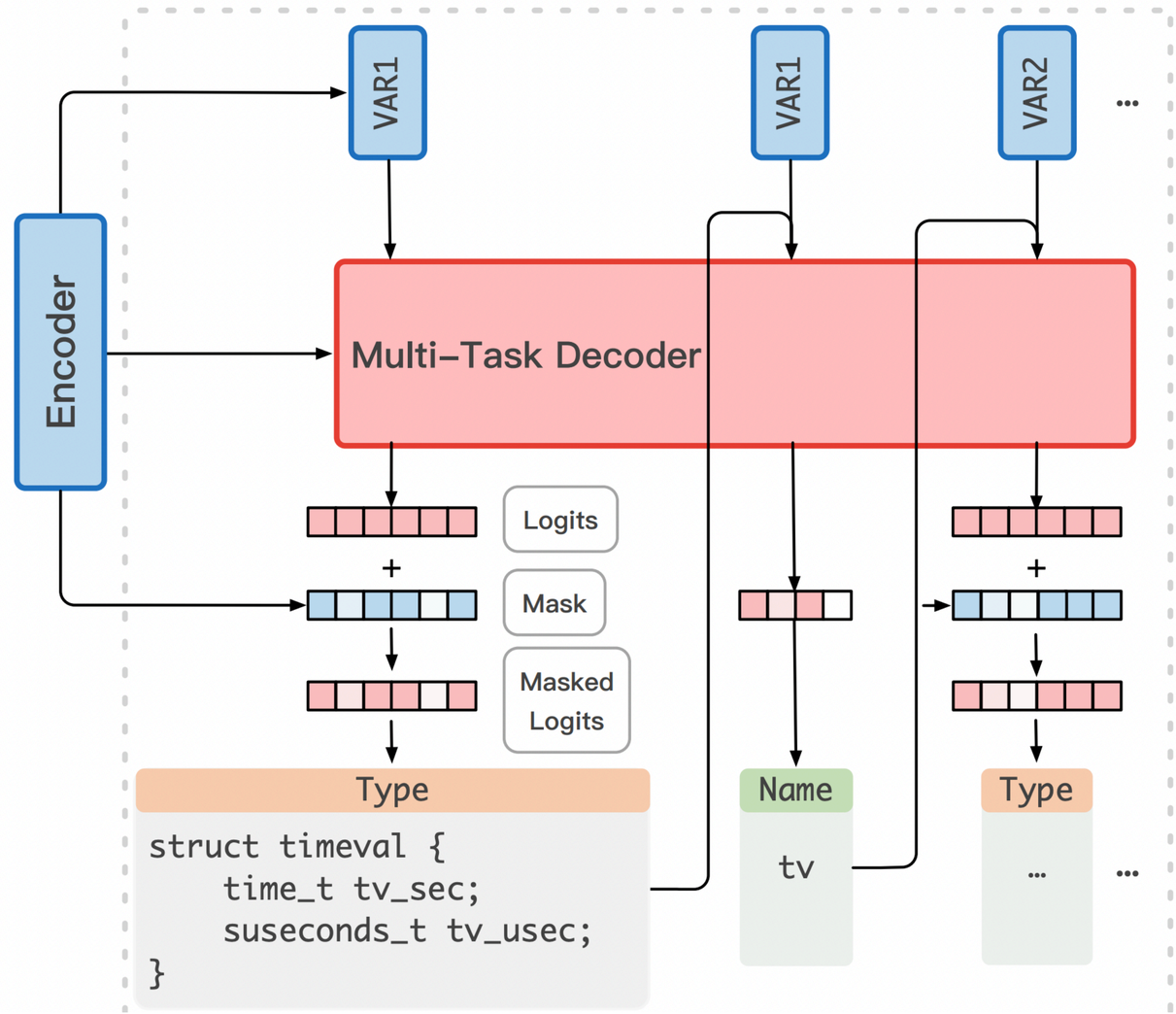
Method	All	Structures
Freq by Size	23.6	9.7
Hex-Rays	37.9	28.7
DIRTY	75.8	68.6

Compiler Optimization Performance

Percent accuracy on 101 GNU Coreutils Programs

-O0	-O1	-O2	-O3
48.20	46.01	46.04	46.00

Predicting types and names simultaneously



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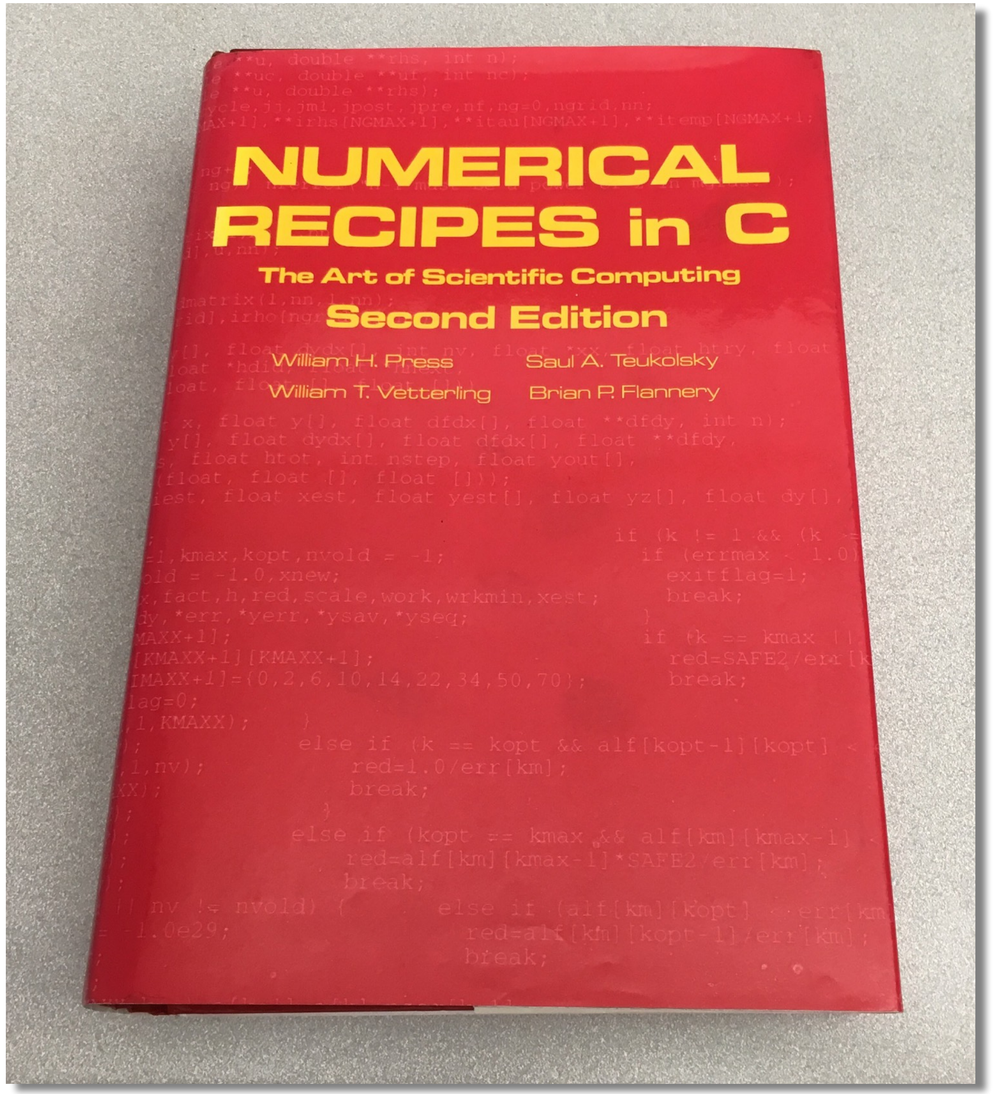
Method	DIRE Data	DIRT
DIRE	72.8	57.5
DIRTY	81.4	66.4

```
int find_unused_picture(int a1, int a2, int a3) {
  int i, j, v1;
  if (a3) {
    for (i = <NUM>;; ++i) {
      if (i > <NUM>)
        goto LABEL_13;
      if (!*(*(<NUM> * i + a2) + <NUM>))
        break;
    }
    v1 = i;
  } else {
    for (j = <NUM>;; ++j) {
      if (j > <NUM>) {
      LABEL_13:
        av_log(a1, <NUM>, <STR>);
//...
```

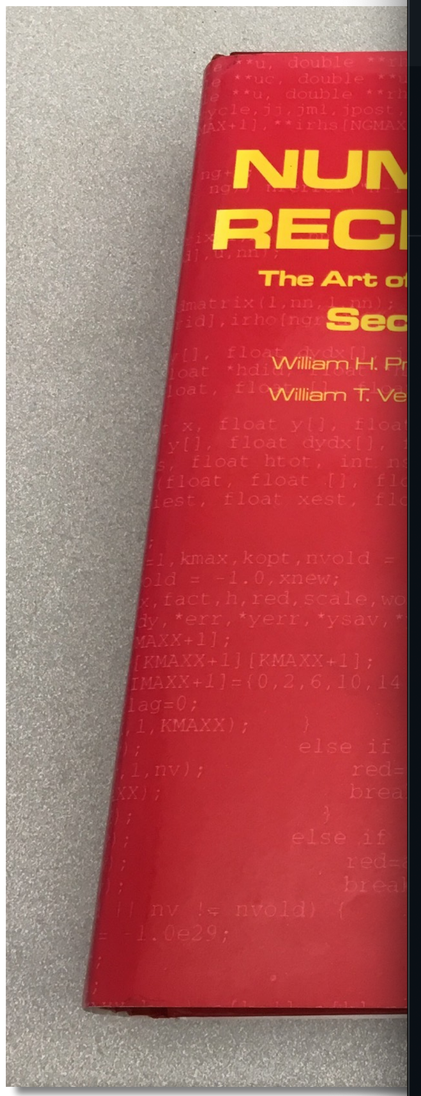
ID	Developer	DIRTY
a1	AVCodecContext *avctx	MpegEncContext *s
a2	Picture *picture	Picture *pic
a3	int shared	int shared
v1	int result	int result

BONUS SLIDES




```
void scrsho(float (*fx)(float))
For interactive CRT terminal use.  Produce a crude graph of th
for interval x1,x2.  Query for another plot until the user sign
{
    int jz,j,i;
    float ysml,ybig,x2,x1,x,dyj,dx,y[ISCR+1];
    char scr[ISCR+1][JSCR+1];

    for (;;) {
        printf("\nEnter x1 x2 (x1=x2 to stop):\n");
        scanf("%f %f",&x1,&x2);
        if (x1 == x2) break;
        for (j=1;j<=JSCR;j++)                          Fill ver
            scr[1][j]=scr[ISCR][j]=YY;
        for (i=2;i<=(ISCR-1);i++) {
            scr[i][1]=scr[i][JSCR]=XX;                 Fill top
            for (j=2;j<=(JSCR-1);j++)                  Fill int
                scr[i][j]=BLANK;
        }
        dx=(x2-x1)/(ISCR-1);
```



books/scrsho.cpp at master · b

github.com/burakbayramli/books/blob/master/NumericalRecipes2/recipes/scrsho.cpp

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master books / NumericalRecipes2 / recipes / scrsho.cpp

BB Initial commit — Latest commit d32c78b on Jan 3, 2017 — History

0 contributors

55 lines (53 sloc) | 1.25 KB — Raw Blame

```
#include <string>
#include <iostream>
#include <iomanip>
#include "nr.h"
using namespace std;

void NR::scrsho(DP fx(const DP))
{
        const int ISCR=60, JSCR=21;
        const char BLANK=' ', ZERO='-', YY='l', XX='-', FF='x';
        int jz,j,i;
        DP ysml,ybig,x2,x1,x,dyj,dx;
        Vec_DP y(ISCR);
        string scr[JSCR];

        for (;;) {
                cout << endl << "Enter x1 x2 (x1=x2 to stop):" << endl;
                cin >> x1 >> x2;
                if (x1 == x2) break;
                scr[0]=YY;
```