IJON

Exploring Deep State Spaces via Fuzzing

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Ruhr University Bochum

Modern Fuzzers

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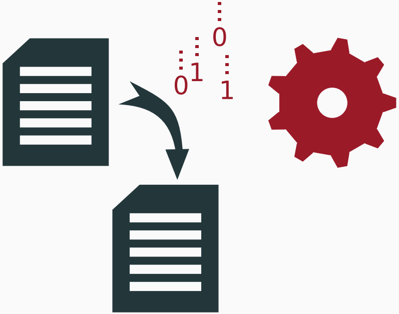
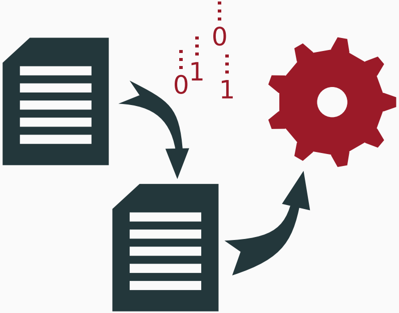


Modern Fuzzers



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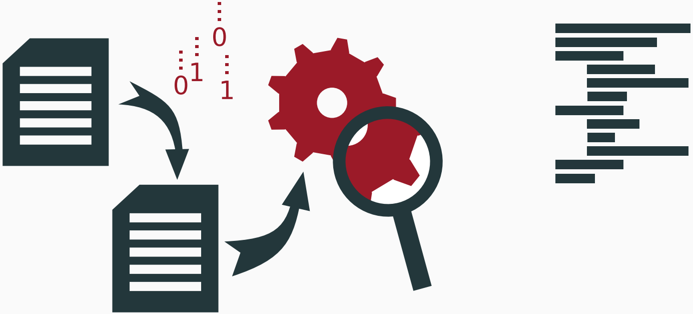

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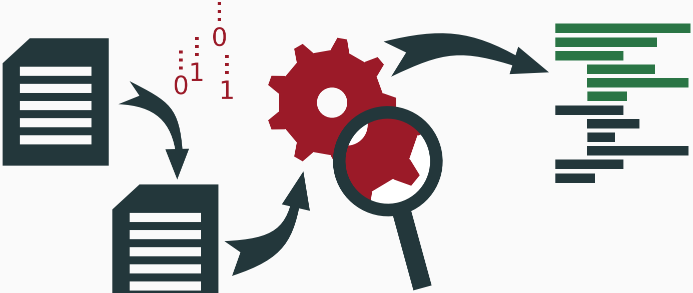

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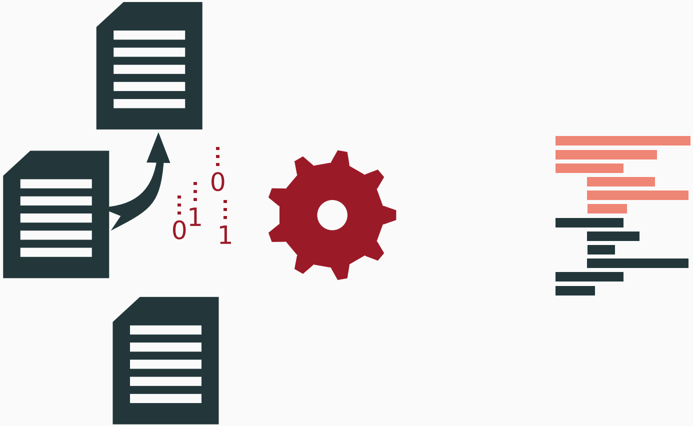

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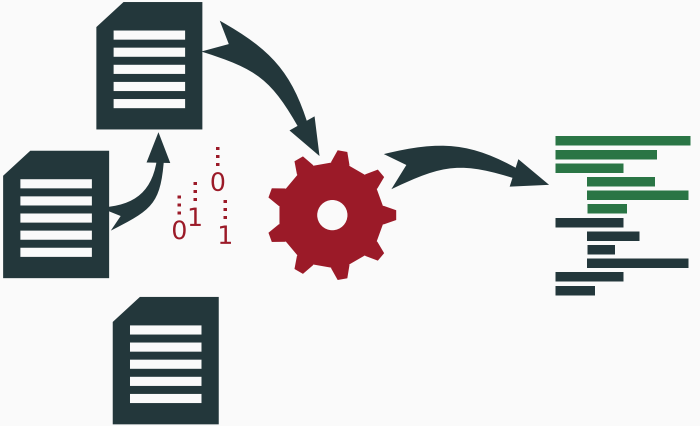

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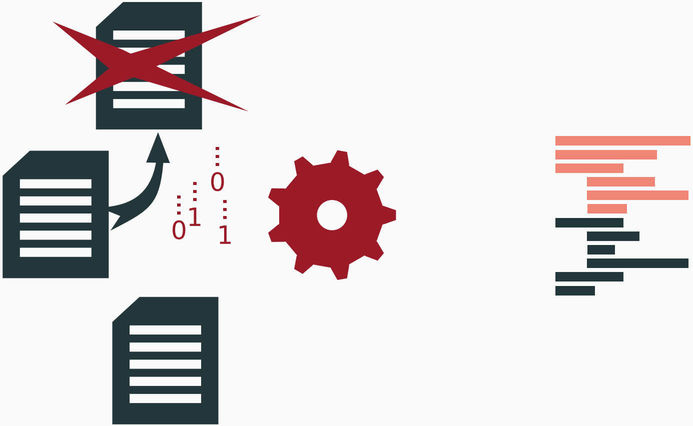

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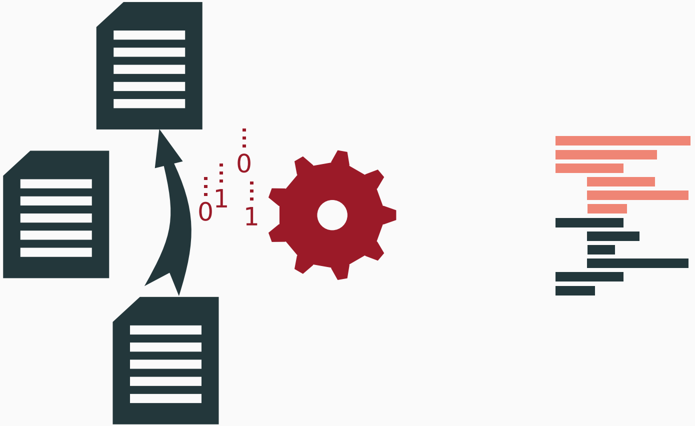

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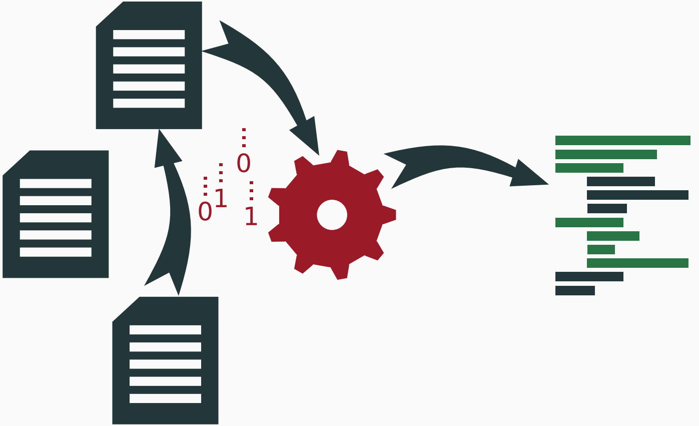

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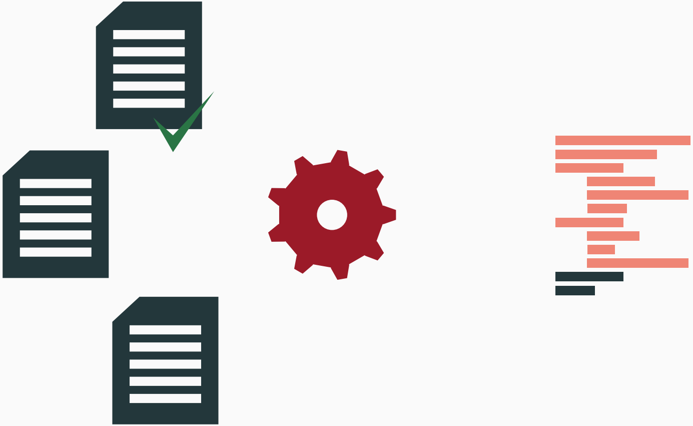
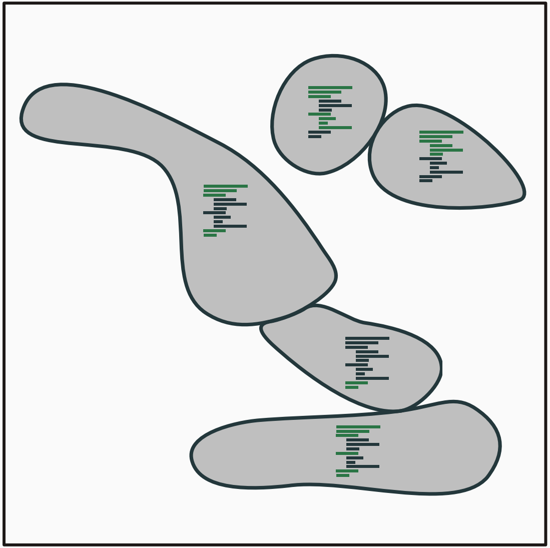


High-Level Mutation Fuzzing



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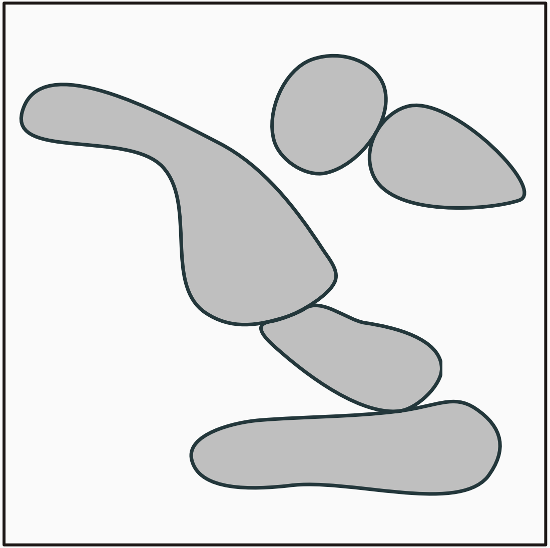

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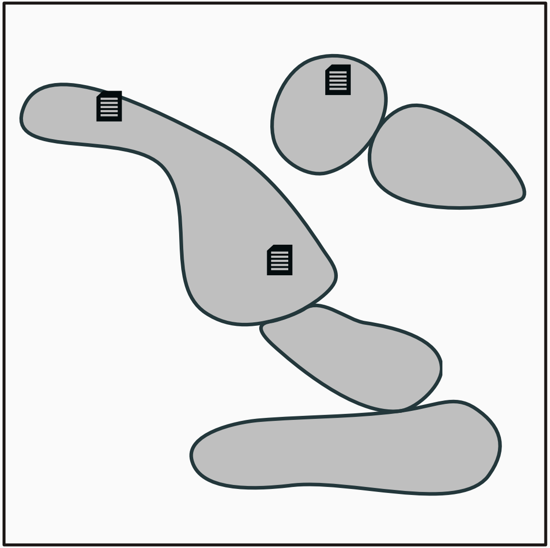

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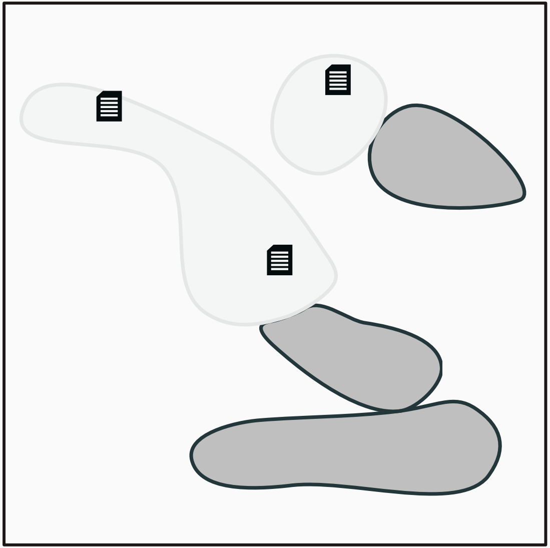

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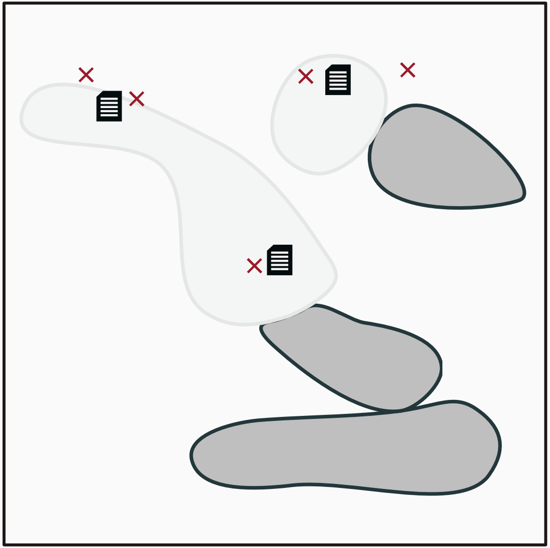

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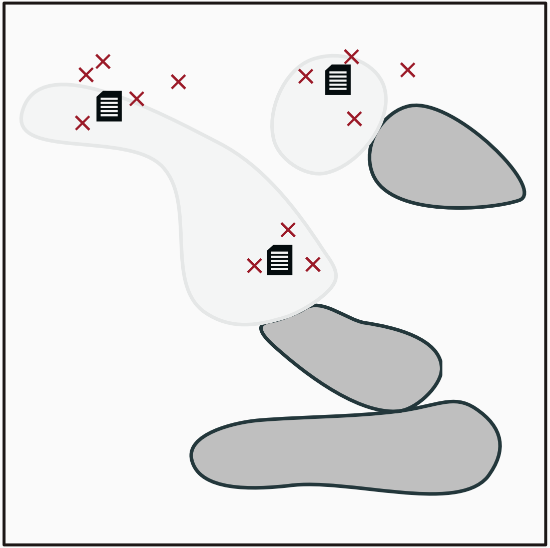

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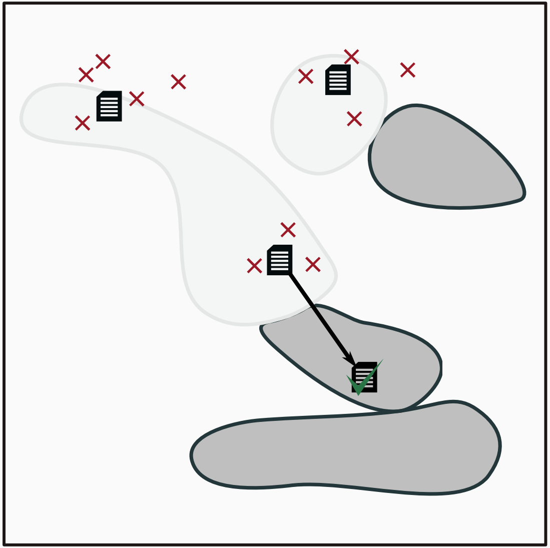

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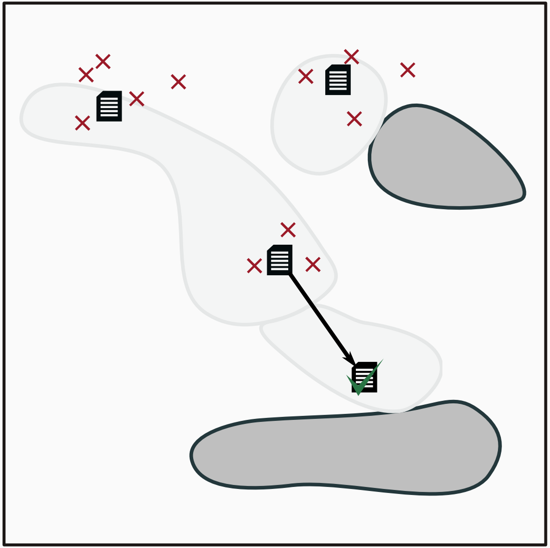

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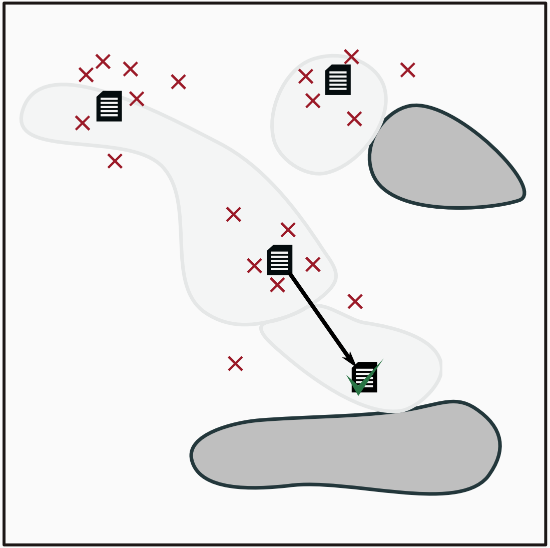

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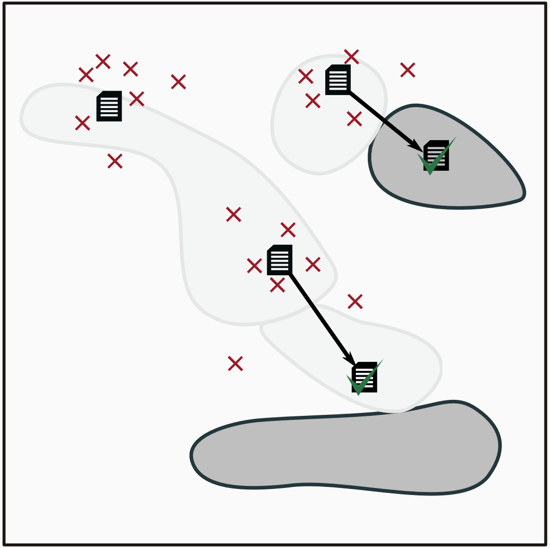

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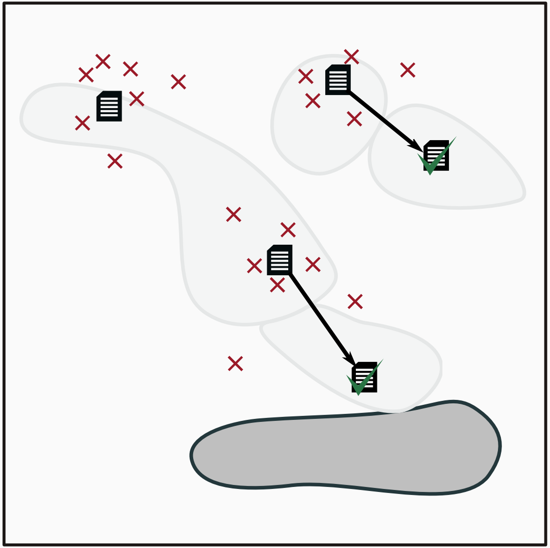

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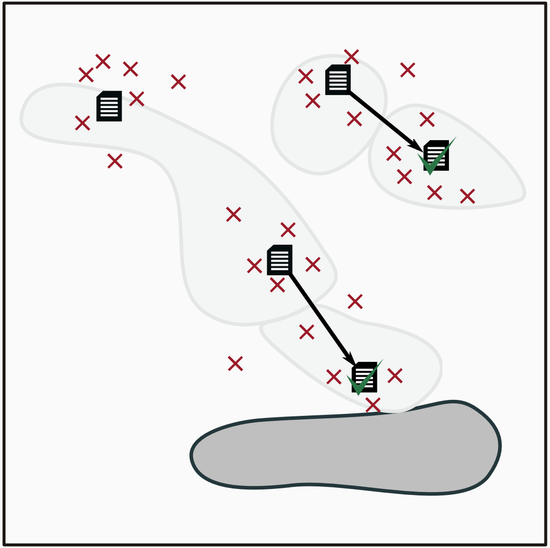

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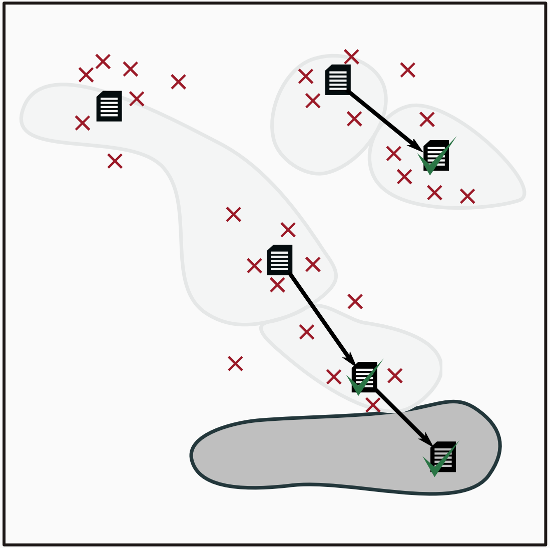

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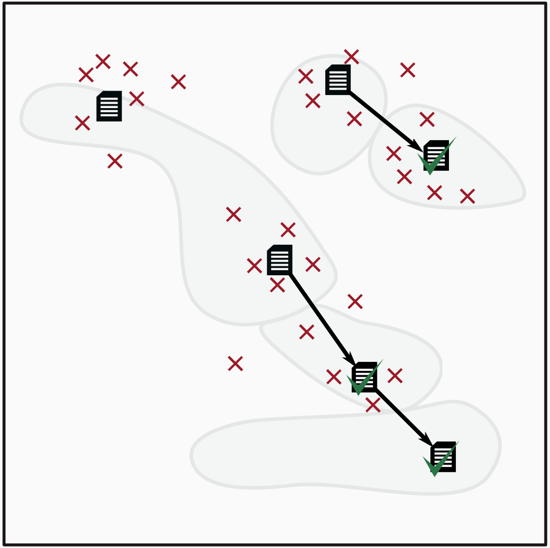

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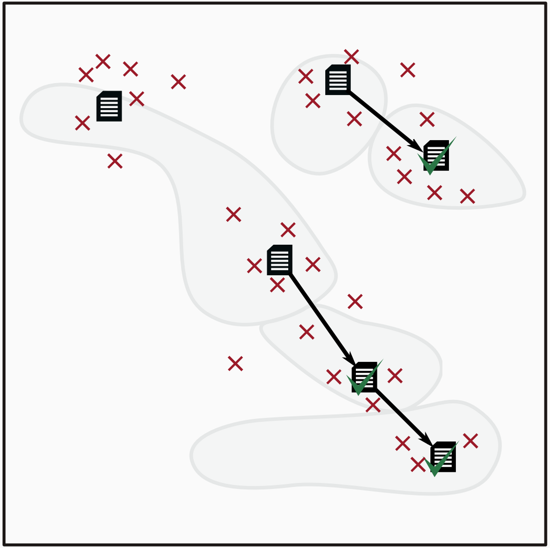

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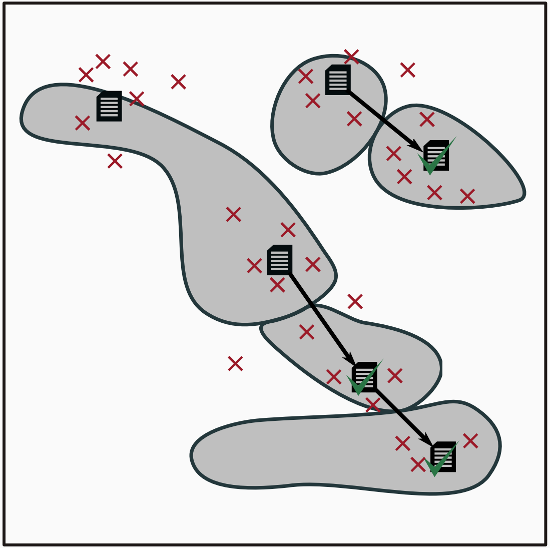
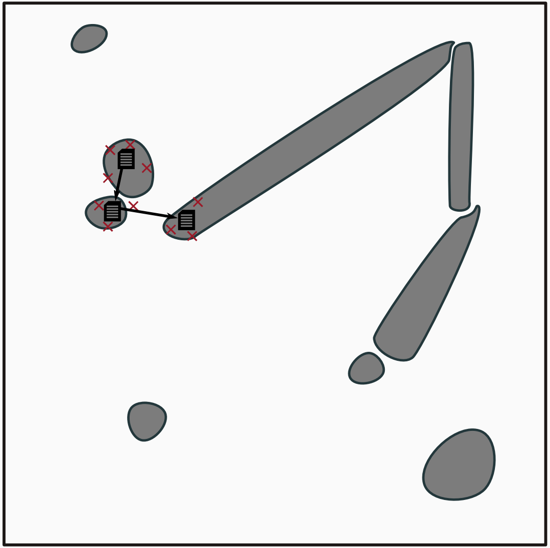


Limitations



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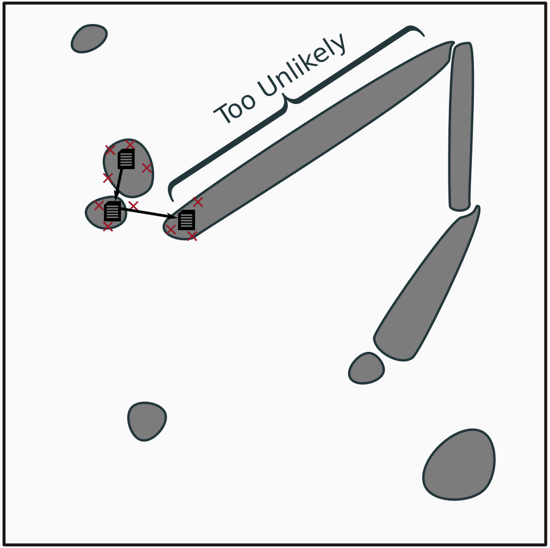
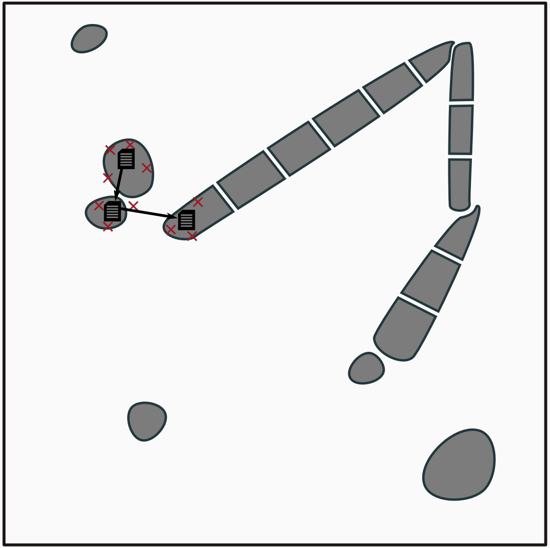
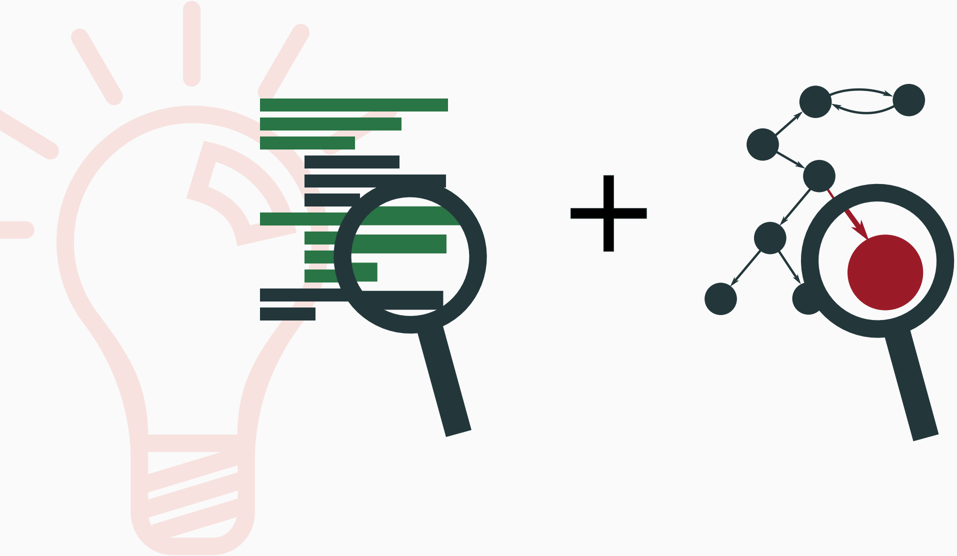


Better Feedback





Annotations

```
while(true) {
    // ...

    switch (input[i]) {
        case 'w': y--; break;
        case 's': y++; break;
        case 'a': x--; break;
        case 'd': x++; break;
    }
    // ...
}
```

```
+-+---+---+
|X|     |#|
| | --+ | |
| |   | | |
| +-- | | |
|     |   |
+-----+---+
```

Annotations

```
while(true) {
    // ...
    IJON_SET(hash(x,y));
    switch (input[i]) {
        case 'w': y--; break;
        case 's': y++; break;
        case 'a': x--; break;
        case 'd': x++; break;
    }
    // ...
}
```

```
+-+---+---+
|X|     |#|
| | --+ | |
| |   | | |
| +-- | | |
|     |   |
+-----+---+
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```
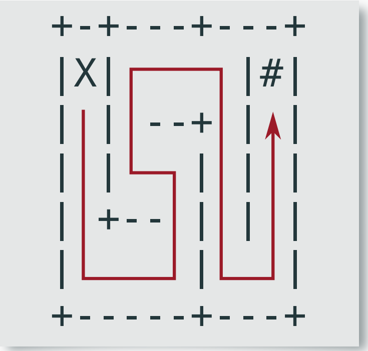
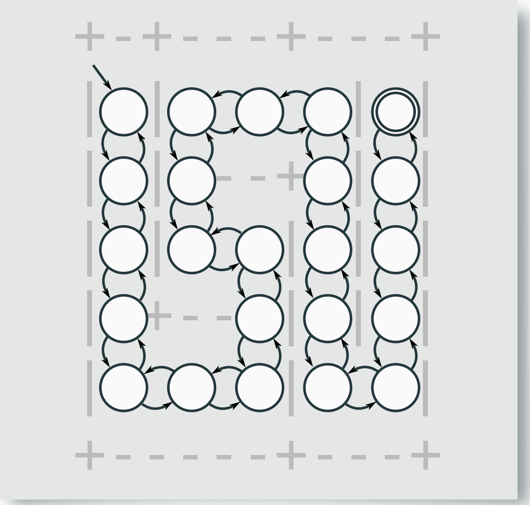



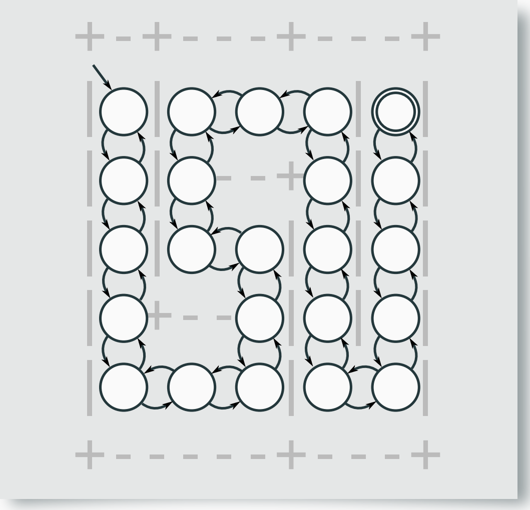
```
+-+---+---+
|X|     |#|
| | --+ | |
| |   | | |
| +-- | | |
|     |   |
+-----+---+
```

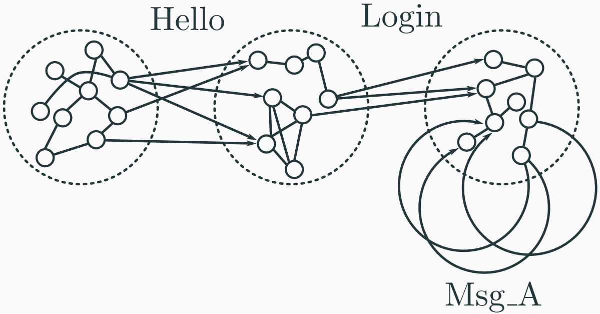
Real World?

Implicit State Machine



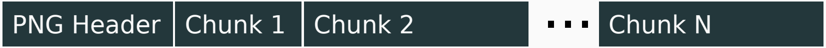
Implicit State Machine





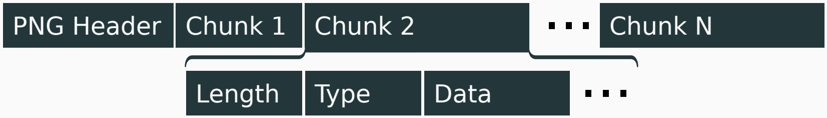
libpng

libpng



PNG Header | Chunk 1 | Chunk 2 | ... | Chunk N

libpng



PNG Header

Chunk 1

Chunk 2

...

Chunk N

Length

Type

Data

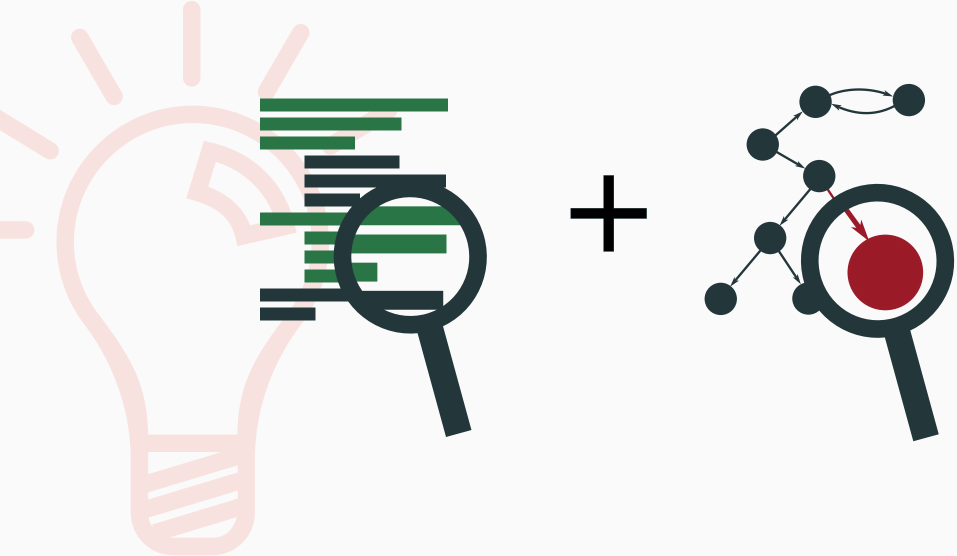
...

libpng

```
while(true) {
    hdr = read_chunk_hdr();
    switch (hdr.type) {
        case png_oFFs: handle_oFFs(); break;
        case png_IDAT: handle_IDAT(); break;
        // ...
    }




}
```

libpng

```
uint32_t log = 0;
while(true) {
    hdr = read_chunk_hdr();
    switch (hdr.type) {
        case png_oFFs: handle_oFFs(); break;
        case png_IDAT: handle_IDAT(); break;
        // ...
    }
    if( no_parse_error() ){
        log = log << 8 | hash(hdr.type)&0xff;
        IJON_SET(log)
    }
}
```



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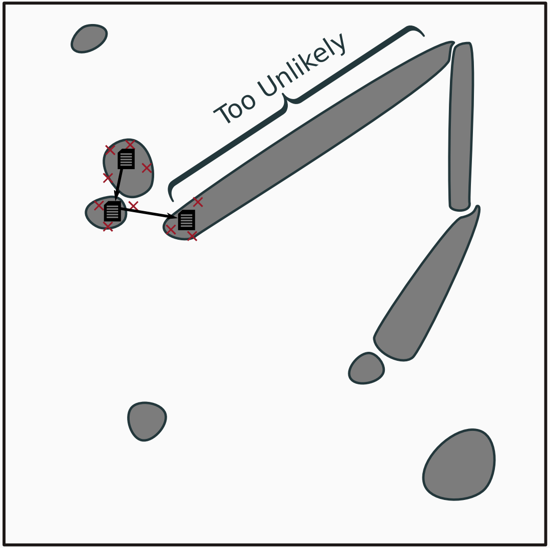

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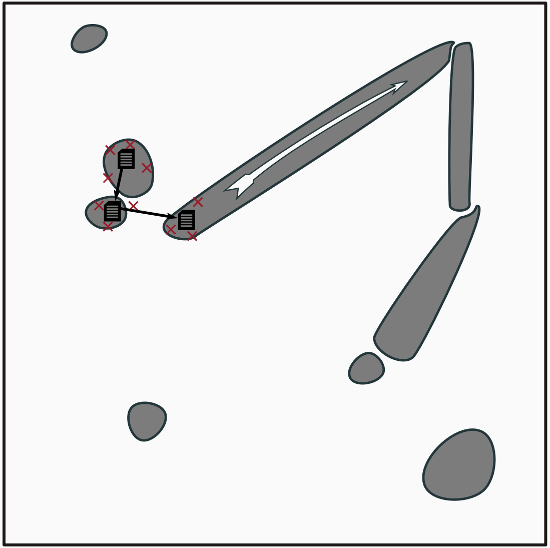
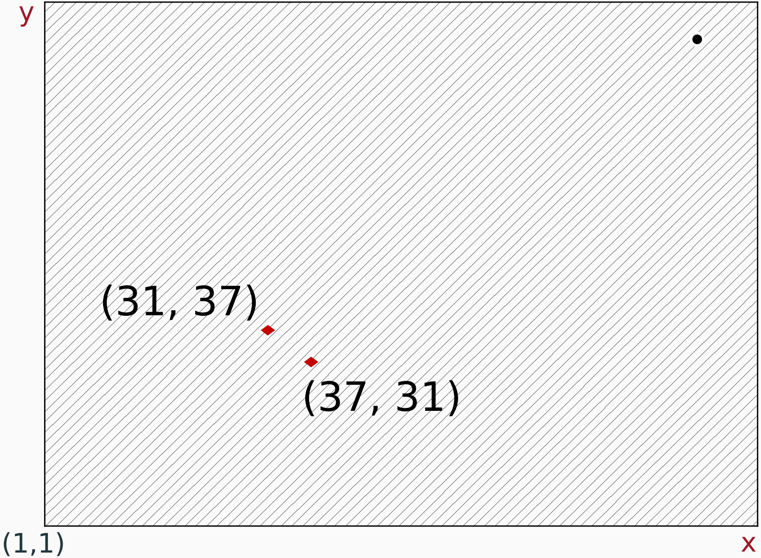


High Level Mutation Fuzzing

```
if(x > 1 && y > 1)

  if( x * y == 1147 )
    bug(1);
```



High Level Mutation Fuzzing

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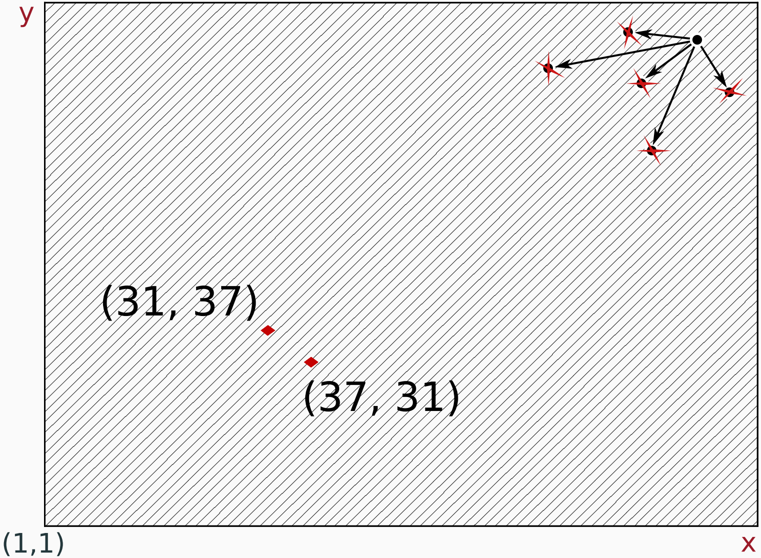

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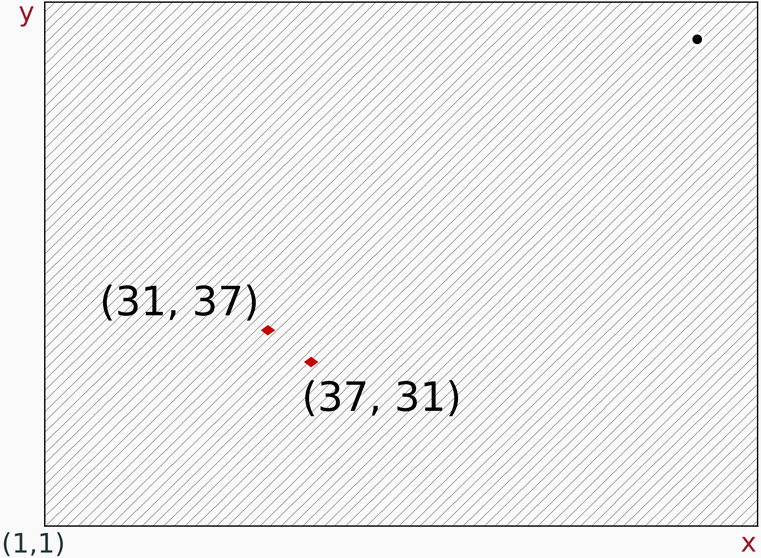
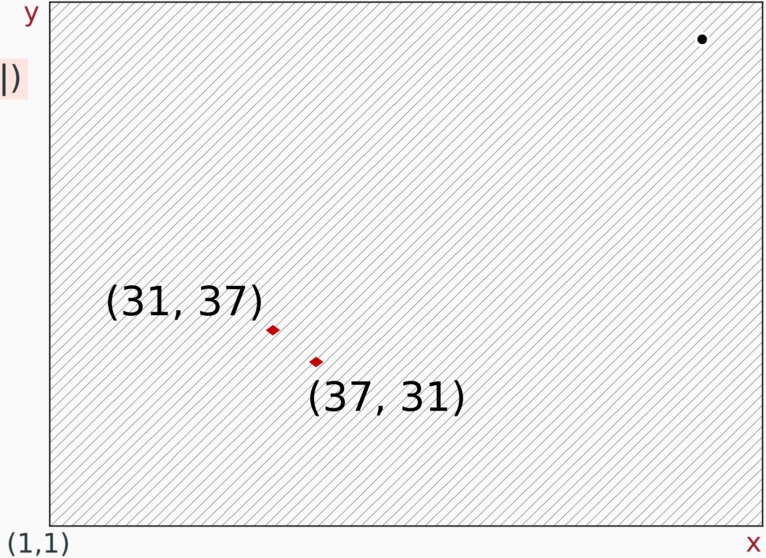


High Level Mutation Fuzzing

```
if(x > 1 && y > 1)
minimize(|x*y - 1147|)
  if( x * y == 1147 )
    bug(1);
```



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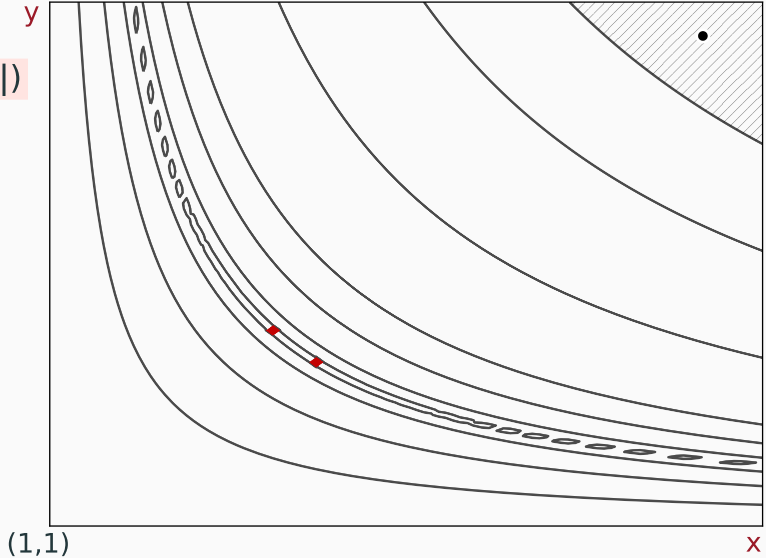

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  if( x * y == 1147 )
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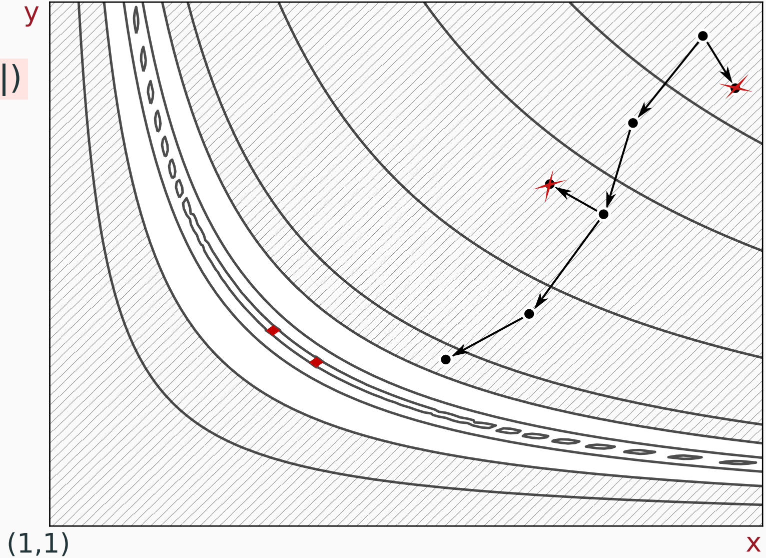
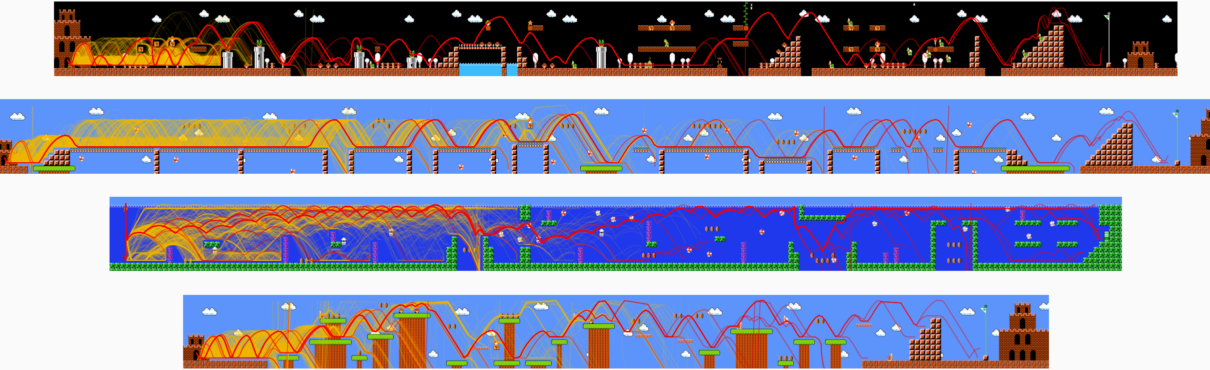


Super Mario Bros.

```
IJON_MAX(player_x);
```

+

Super Mario Bros.



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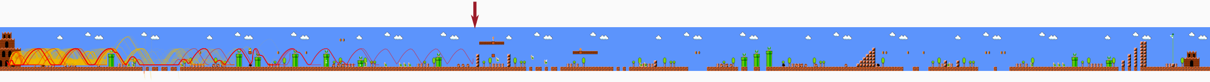


Real World?

dmg2img

```
data = (char *)malloc(xml.len + 1);
if (!data)
   exit_with_error();
//....
data[xml.len] = '\0';
```

dmg2img

Overflow?

```
data = (char *)malloc(xml.len + 1);
if (!data)
   exit_with_error();
//....
data[xml.len] = '\0';
```

dmg2img

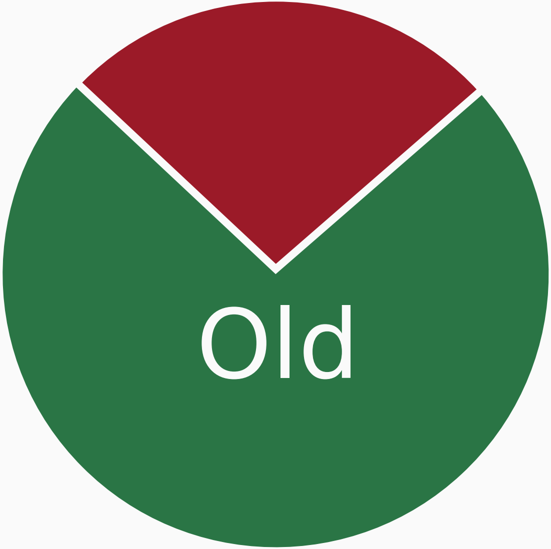
```
IJON_MAX(xml.len);
data = (char *)malloc(xml.len + 1);
if (!data)
   exit_with_error();
//....
data[xml.len] = '\0';
```

Eval

CGC

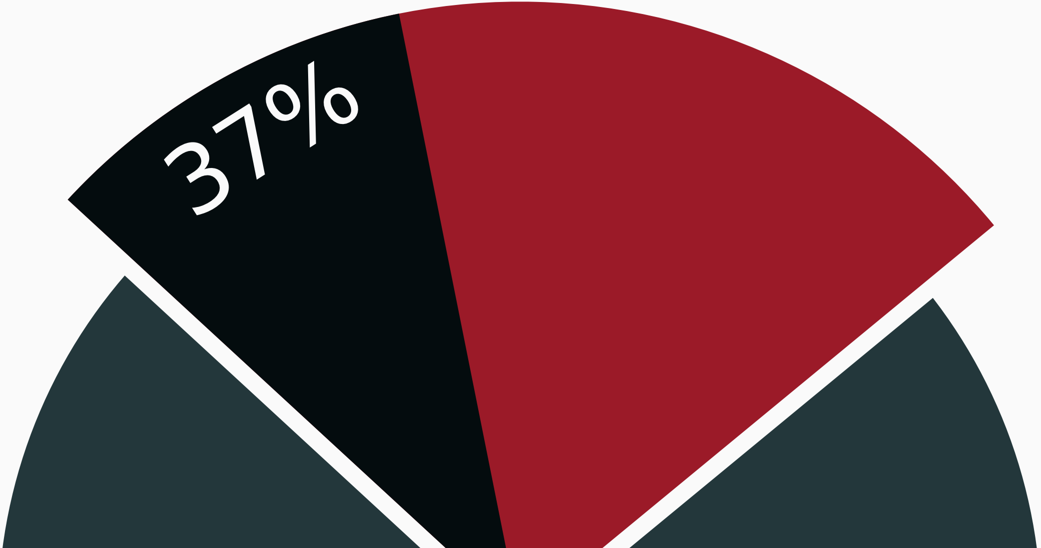
(226 Challenges)

Eval



Eval

Eval



Eval

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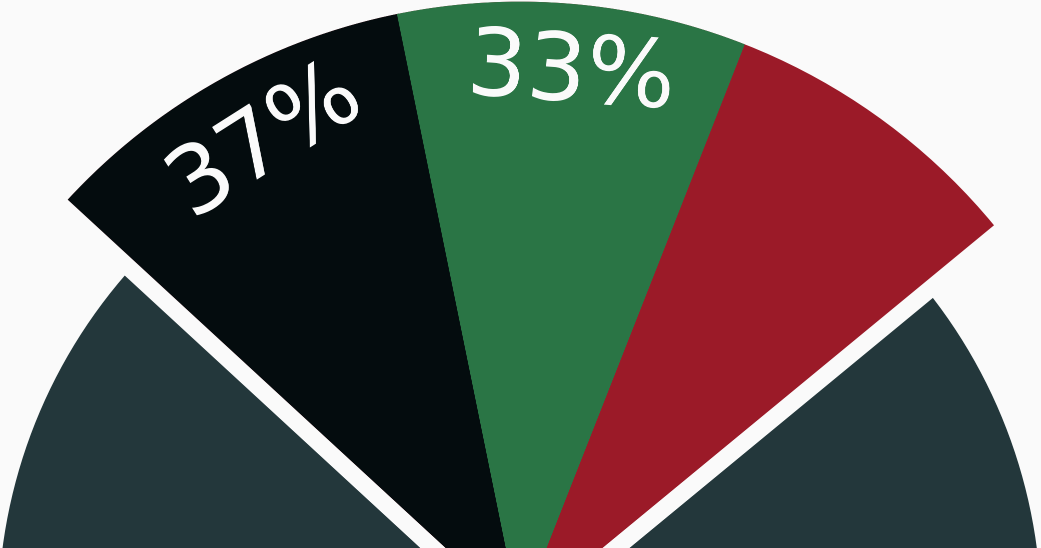
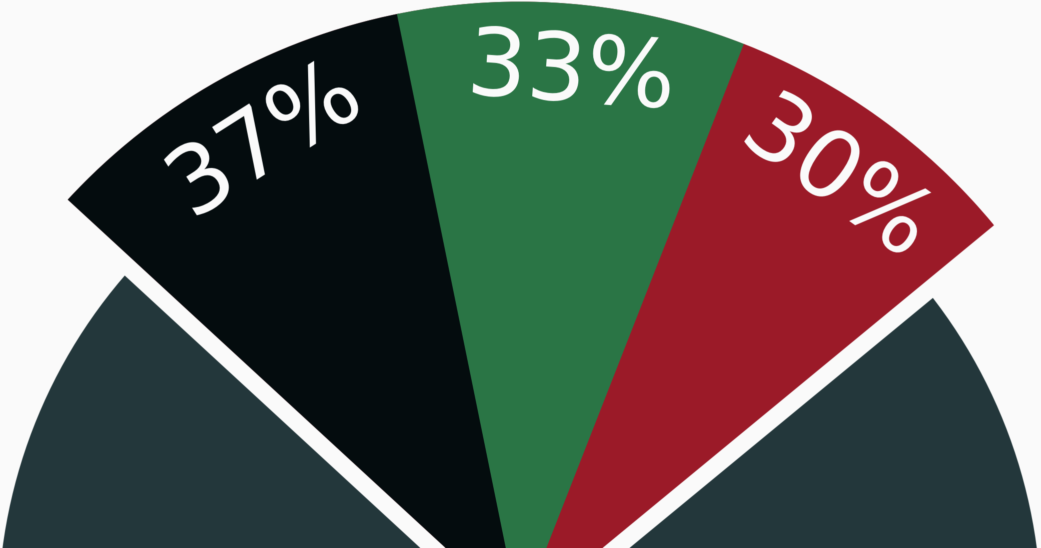


Eval



Future