A Tool for Teaching Reverse Engineering

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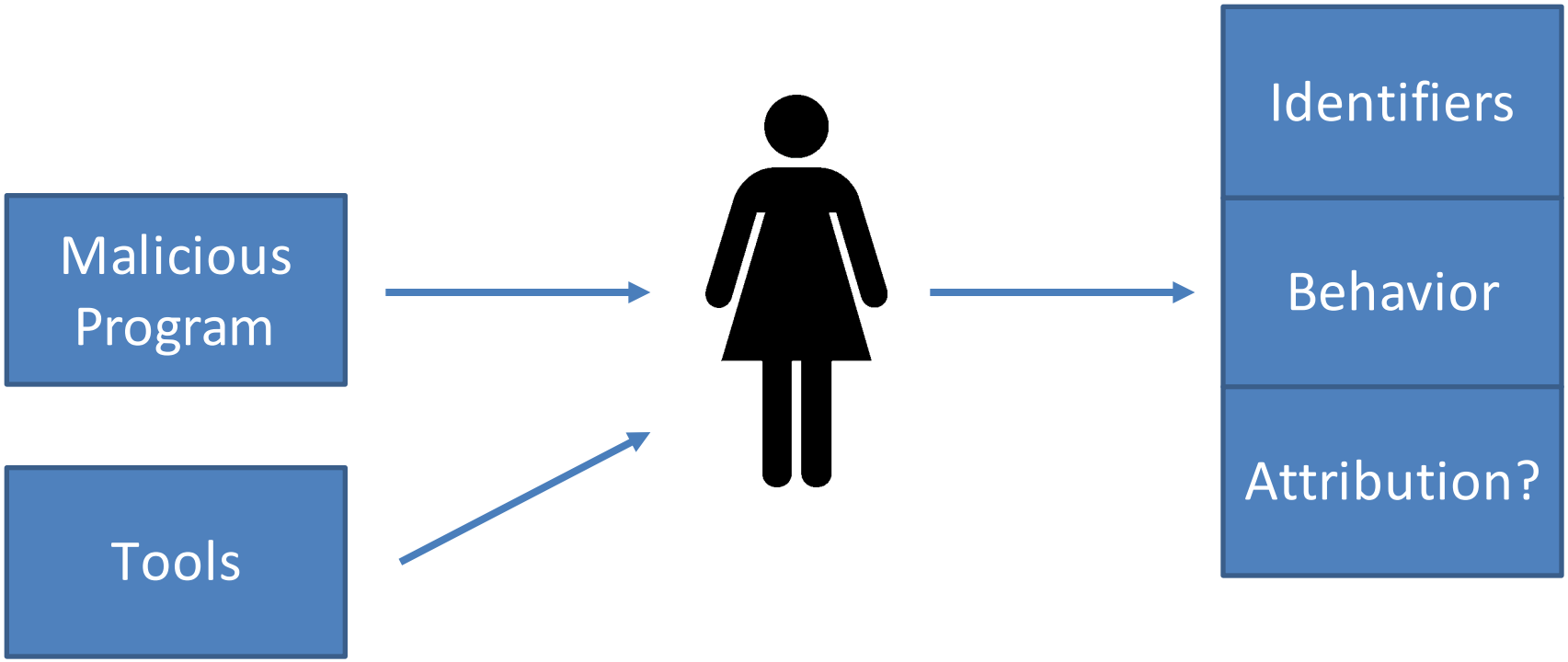
Why Teach Reverse Engineering?

- Maintaining old code
  - Not related to security or obfuscation

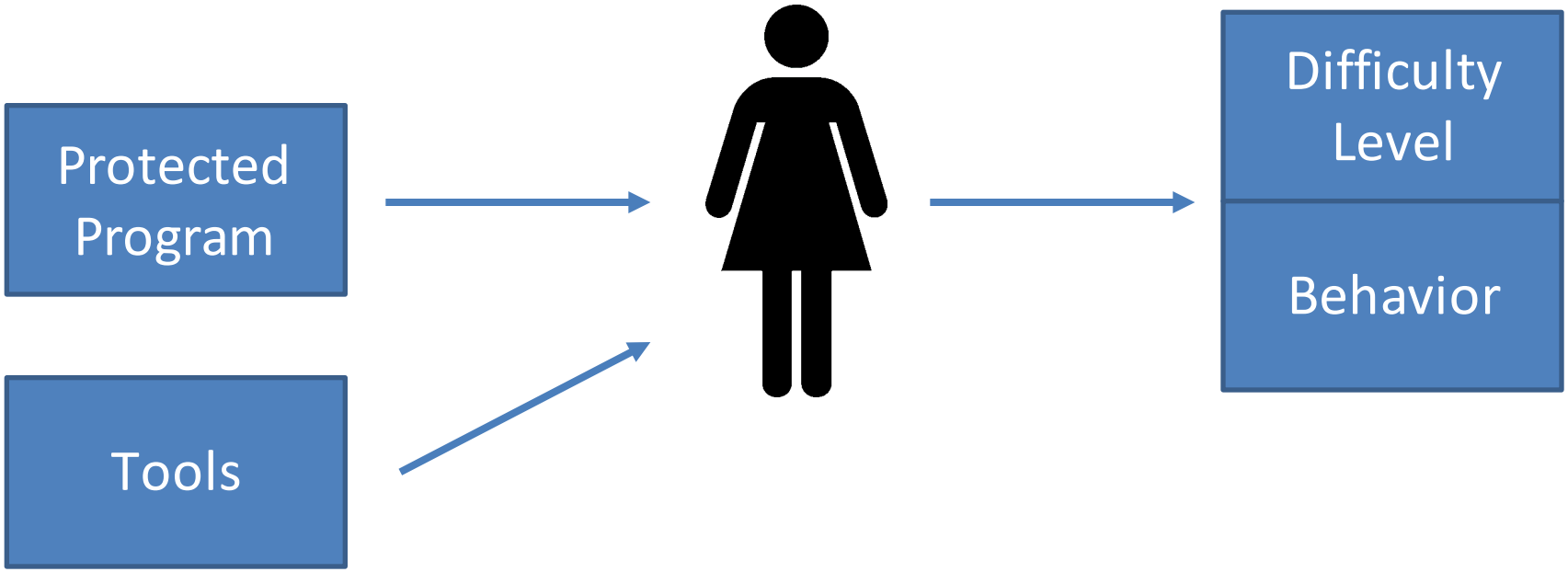
Why Teach Reverse Engineering?

- Dissecting malicious code



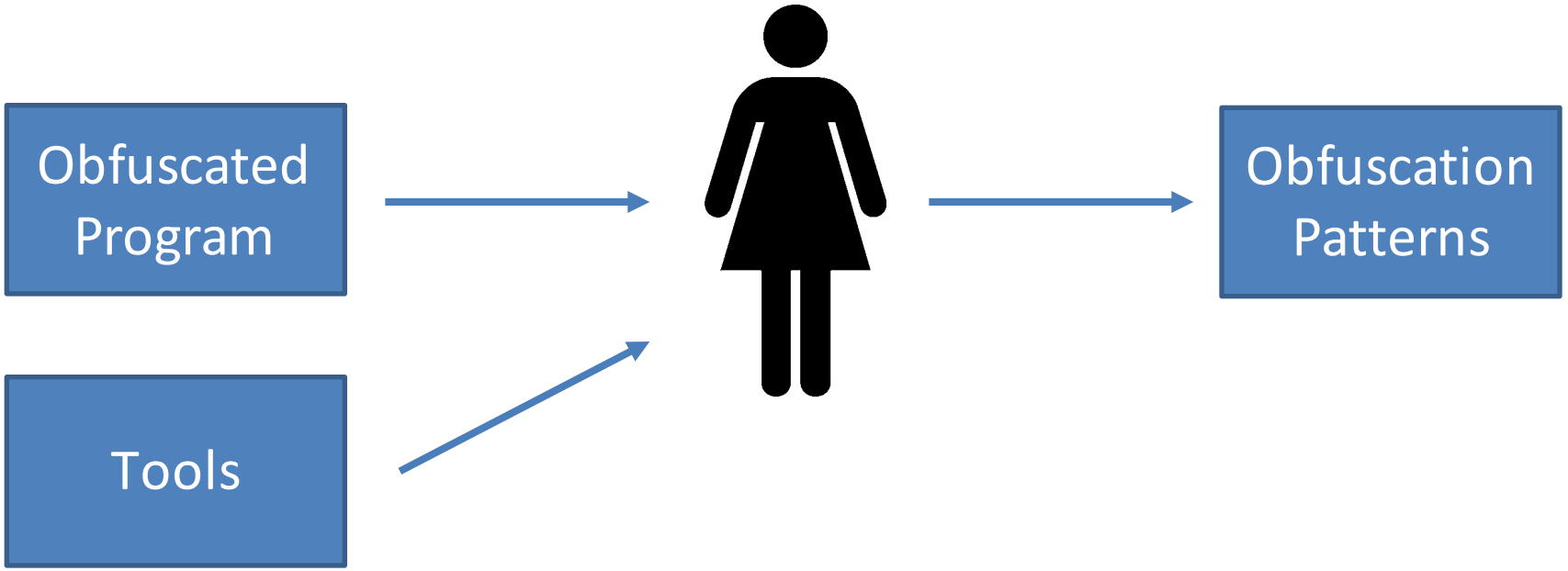
Why Teach Reverse Engineering?

- Analyzing reverse engineering vulnerabilities



Why Teach Reverse Engineering?

- Understanding obfuscation methods



Why Teach Reverse Engineering?

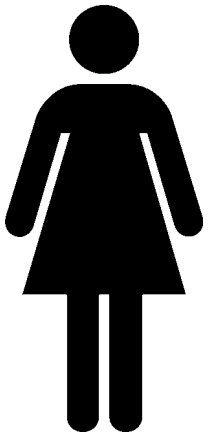
- Analyze and counter malware threats
- Protect software assets from man-at-the-end (MATE) attacks
- Contribute to the field
- Malicious uses?

The Problem

- Generating and administering unique reverse engineering exercises is difficult

For each student:

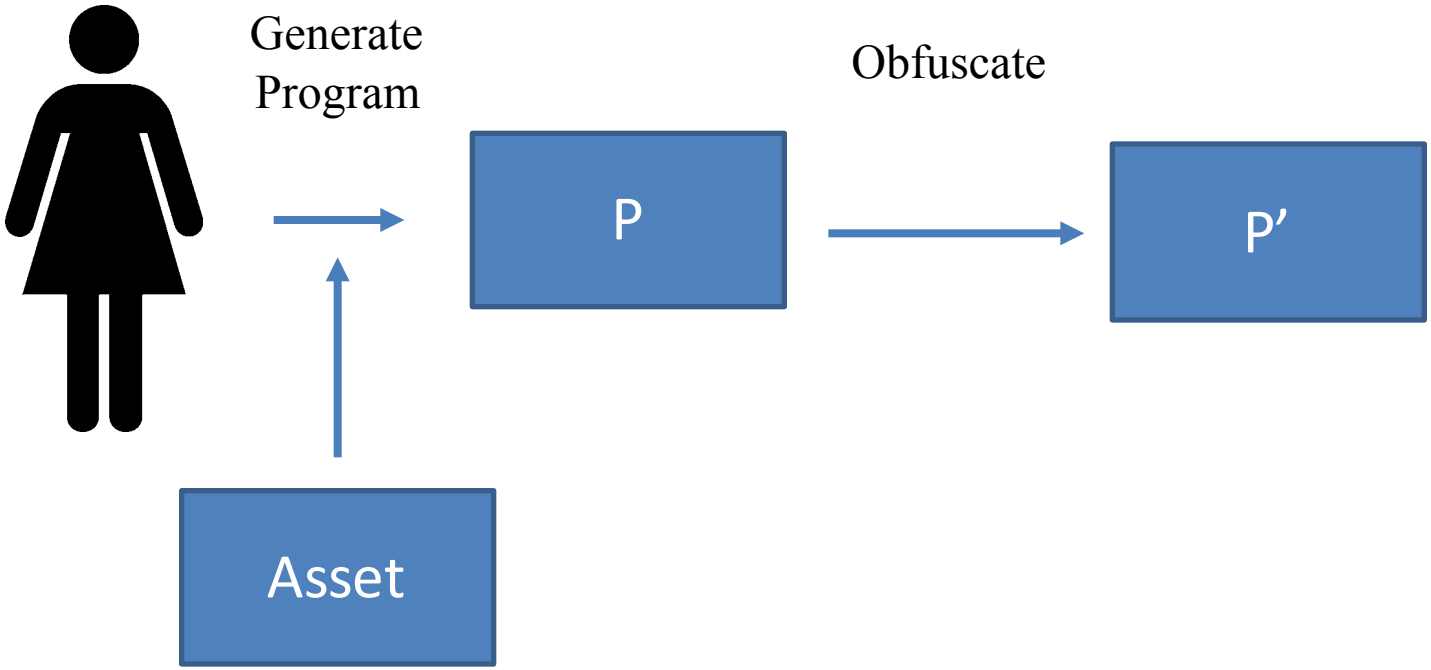
1. Generate problem
2. Obfuscate problem
3. Send problems
4. Grade problems



Alice

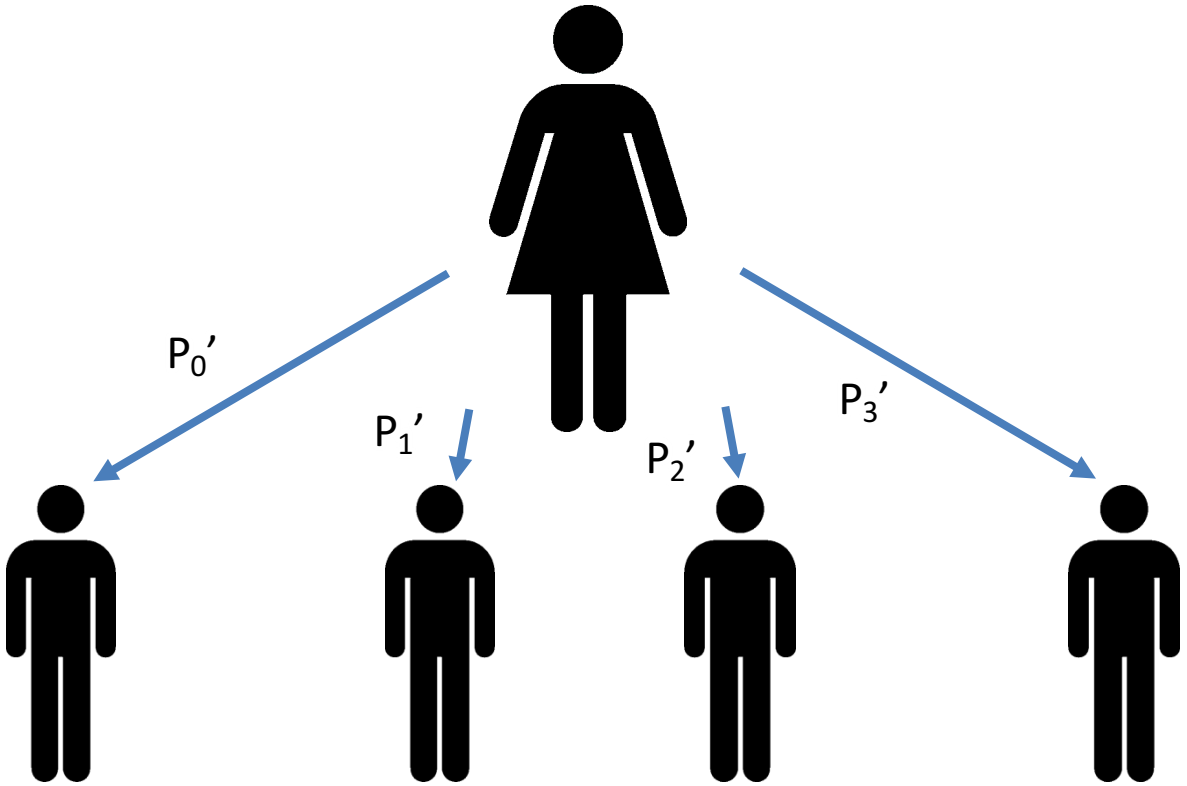
Generation

- Alice generates a problem for each student



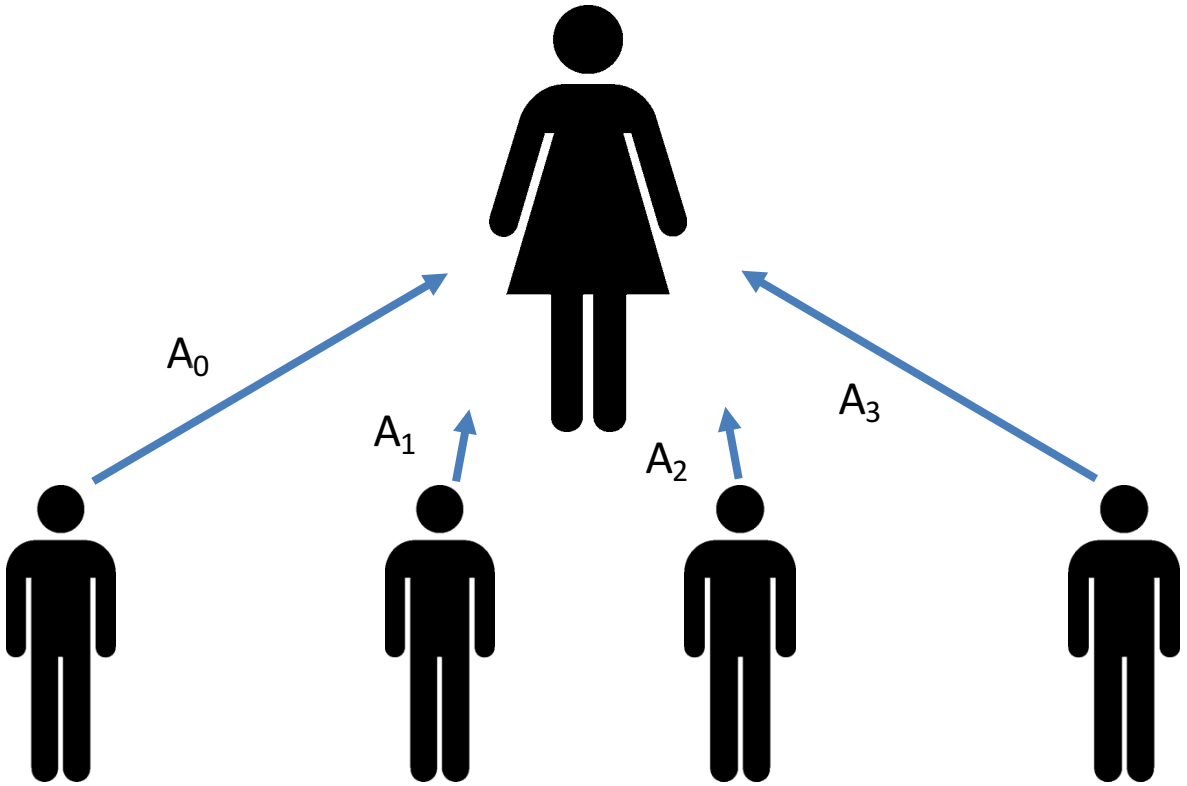
Distribution

- Alice sends the problems to the students



Grading

- Students submit answers to Alice



The Problem

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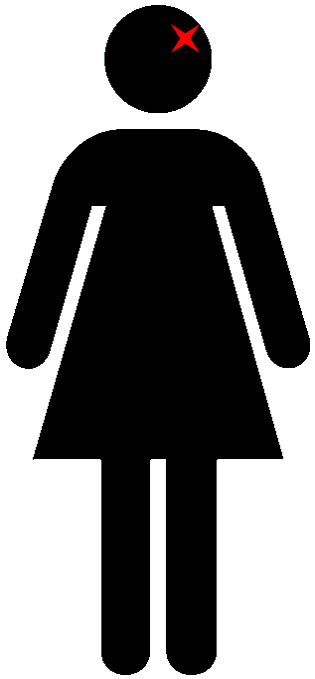
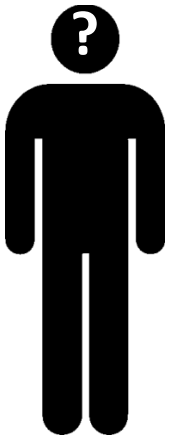


Student Environment Setup

- Students have problems getting started

1. Download OS
2. Configure VM
3. Install tools and dependencies
4. Get P' onto VM
5. Solve P' → P
6. Turn in P



Our Solution

- Automate exercise generation, with randomization
- Automate exercise administration
- Automate environment setup
- Automation, *automation*, **automation**

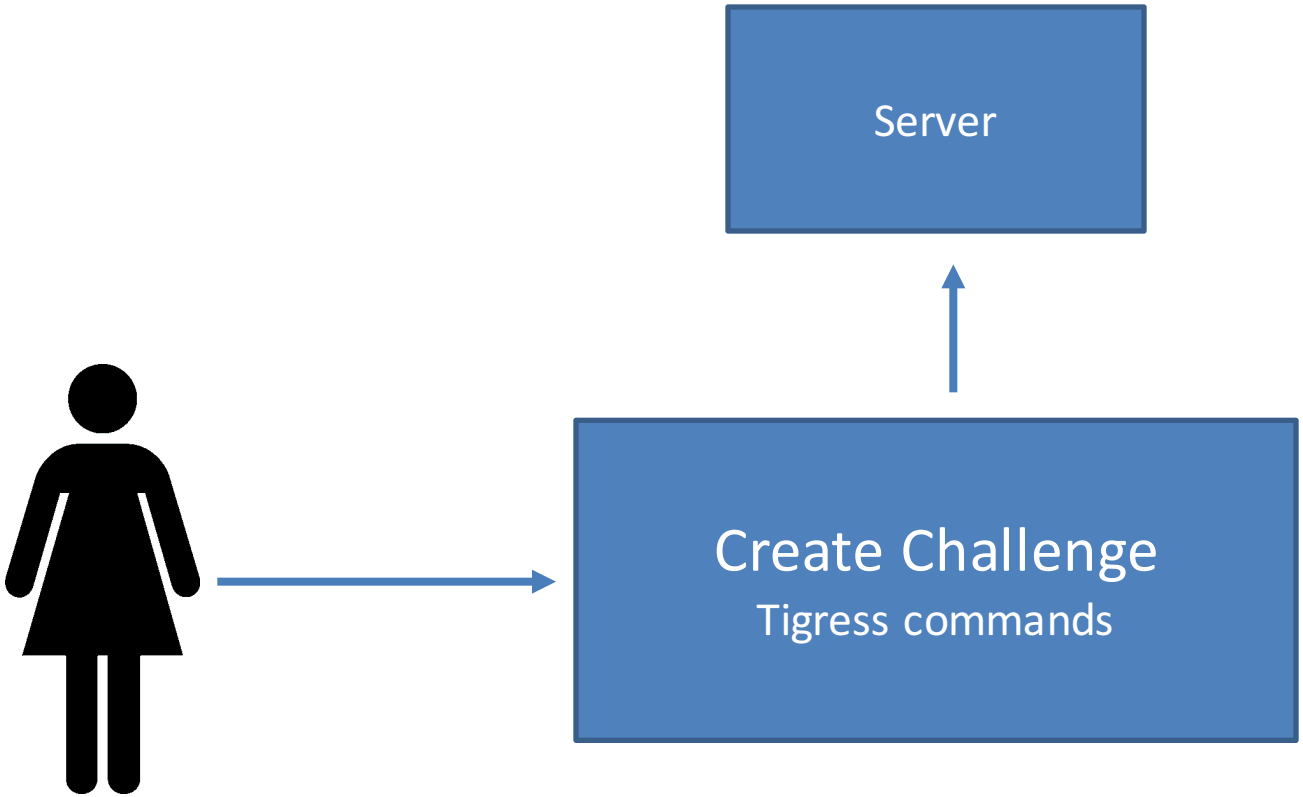
Desired Functionality

1. Administrative functions
2. Challenge generation
   - Automated, random code generation
   - Automated, random code obfuscation
3. Grading system
   - Manual
   - Automated
4. Environment distribution
   - Static
   - Dynamic
5. Data collection

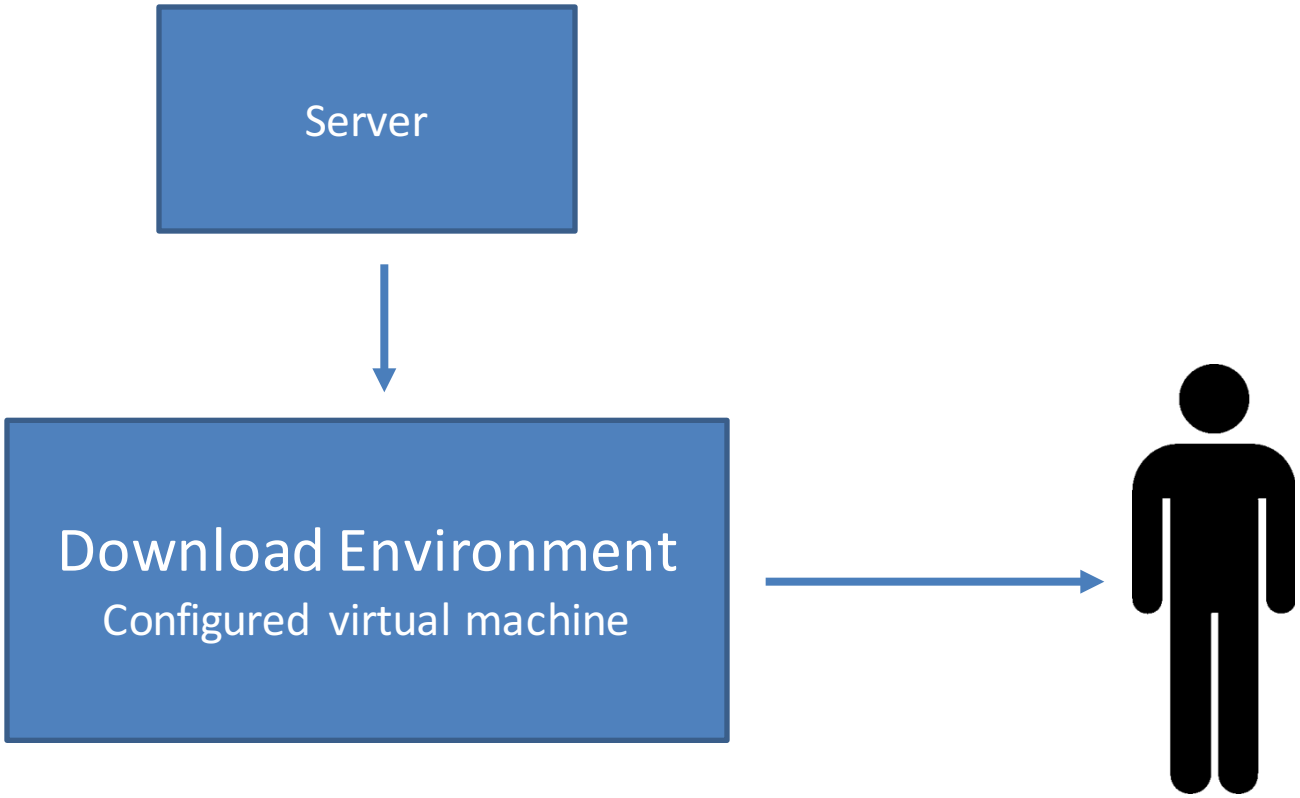
Implementation Strategy

- Web application
  - Easy for students to use
  - Few dependencies; no client setup
  - Accessible on the internet
- Student terminals
  - Preconfigured environment
  - Virtual or physical/device

System Usage



System Usage



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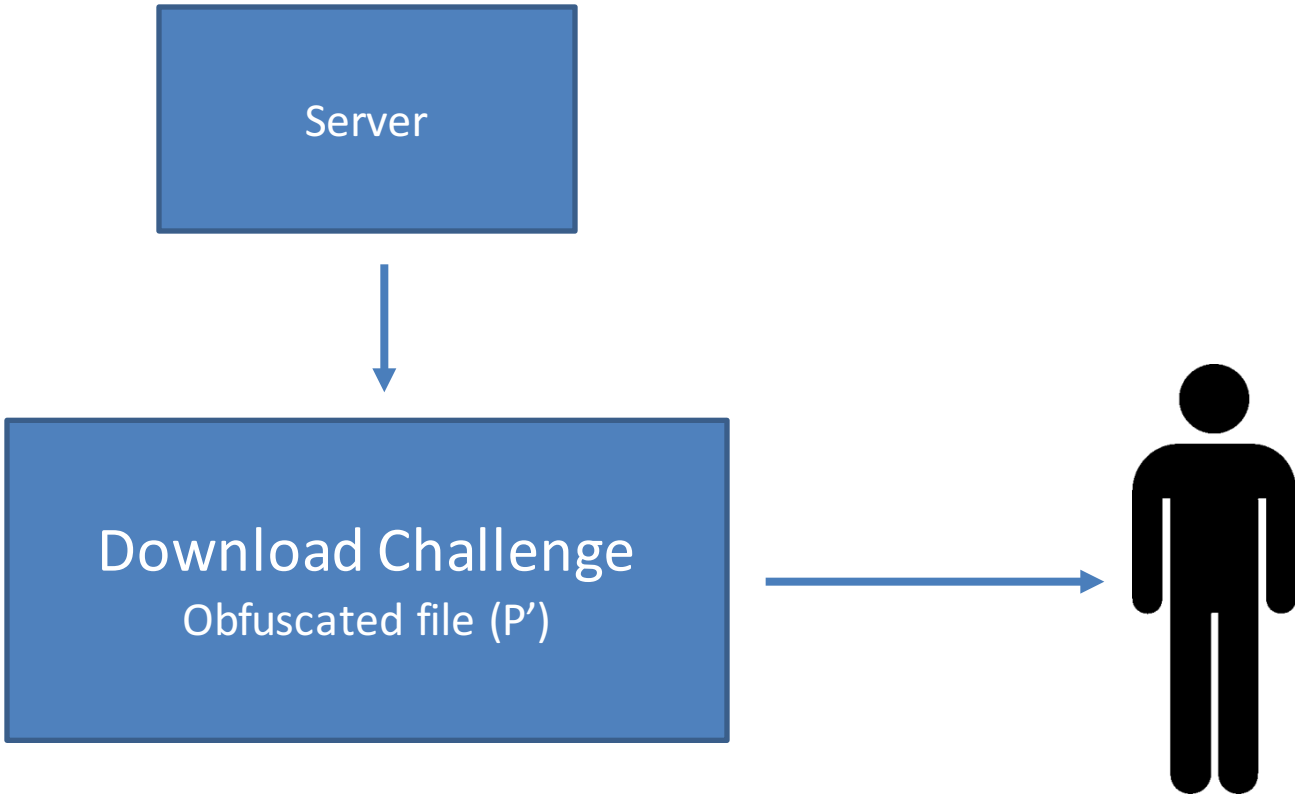

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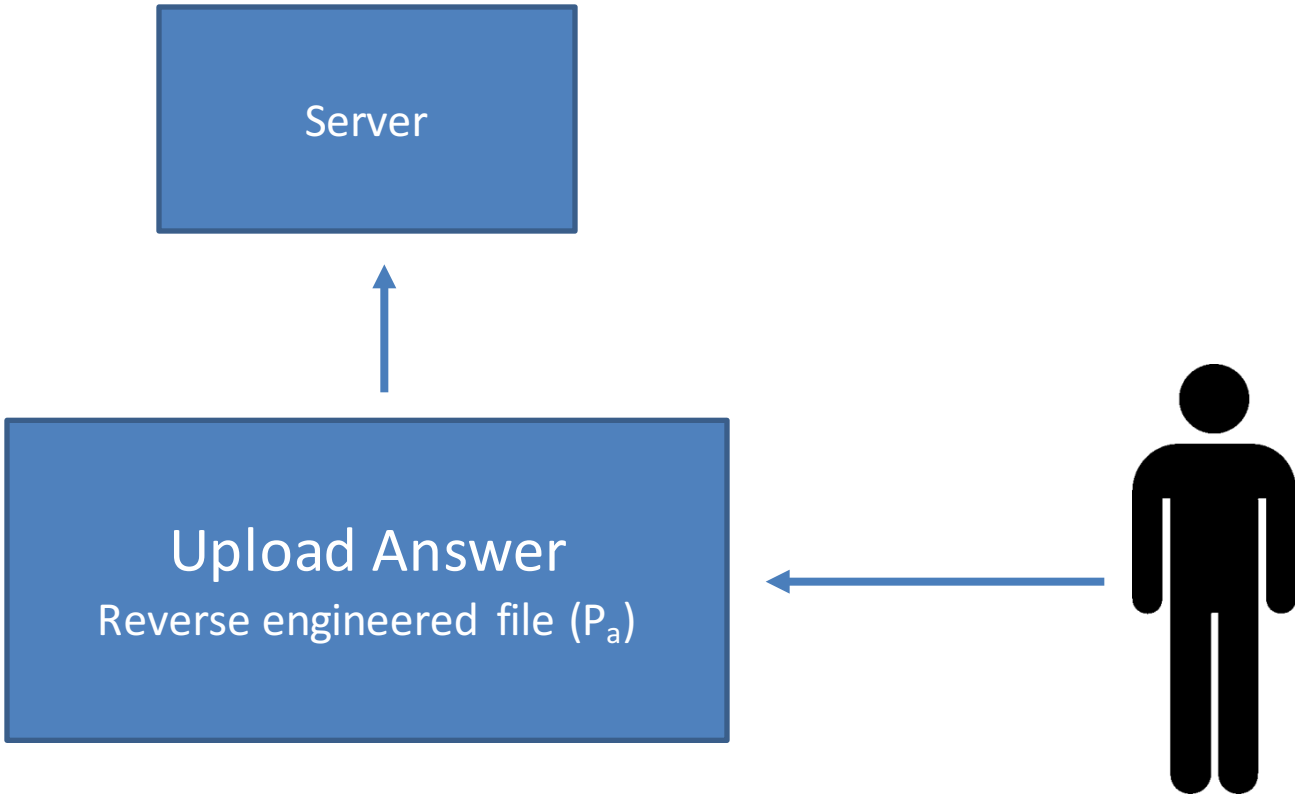
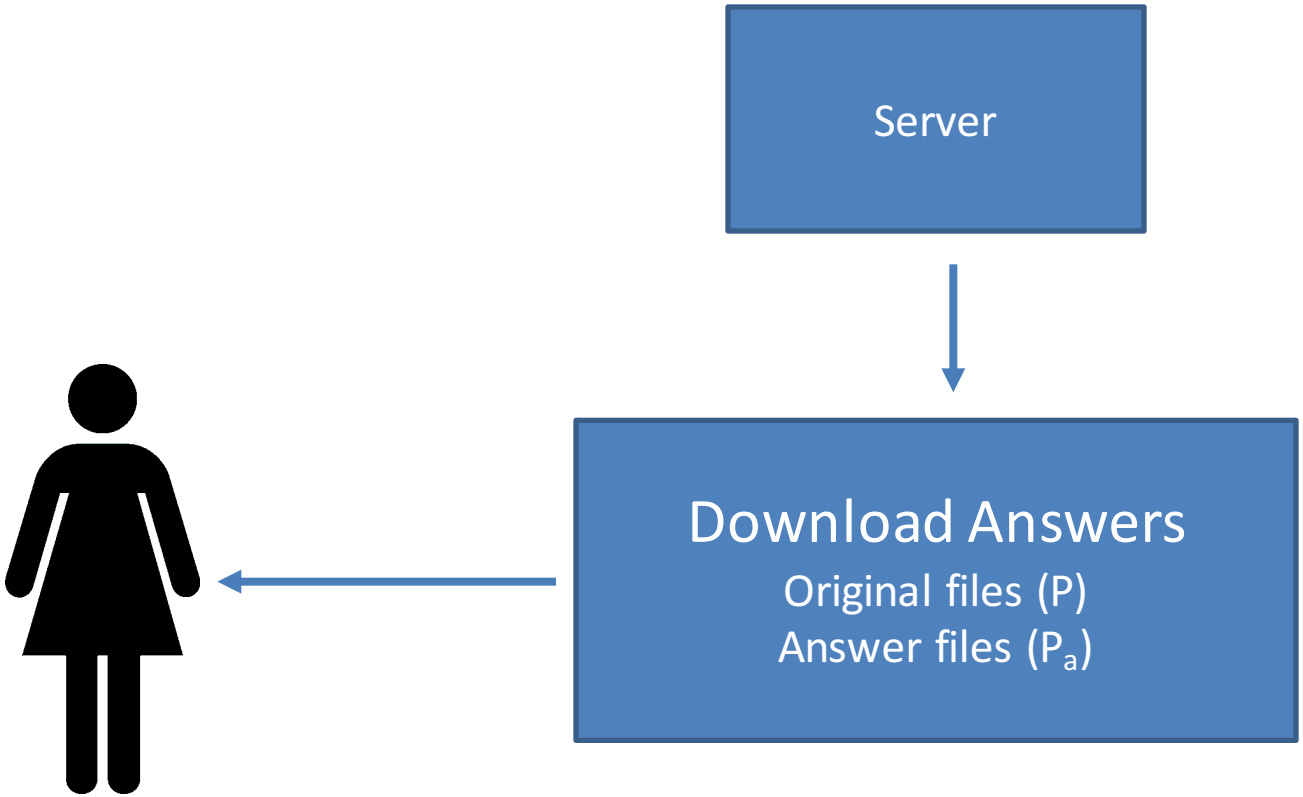
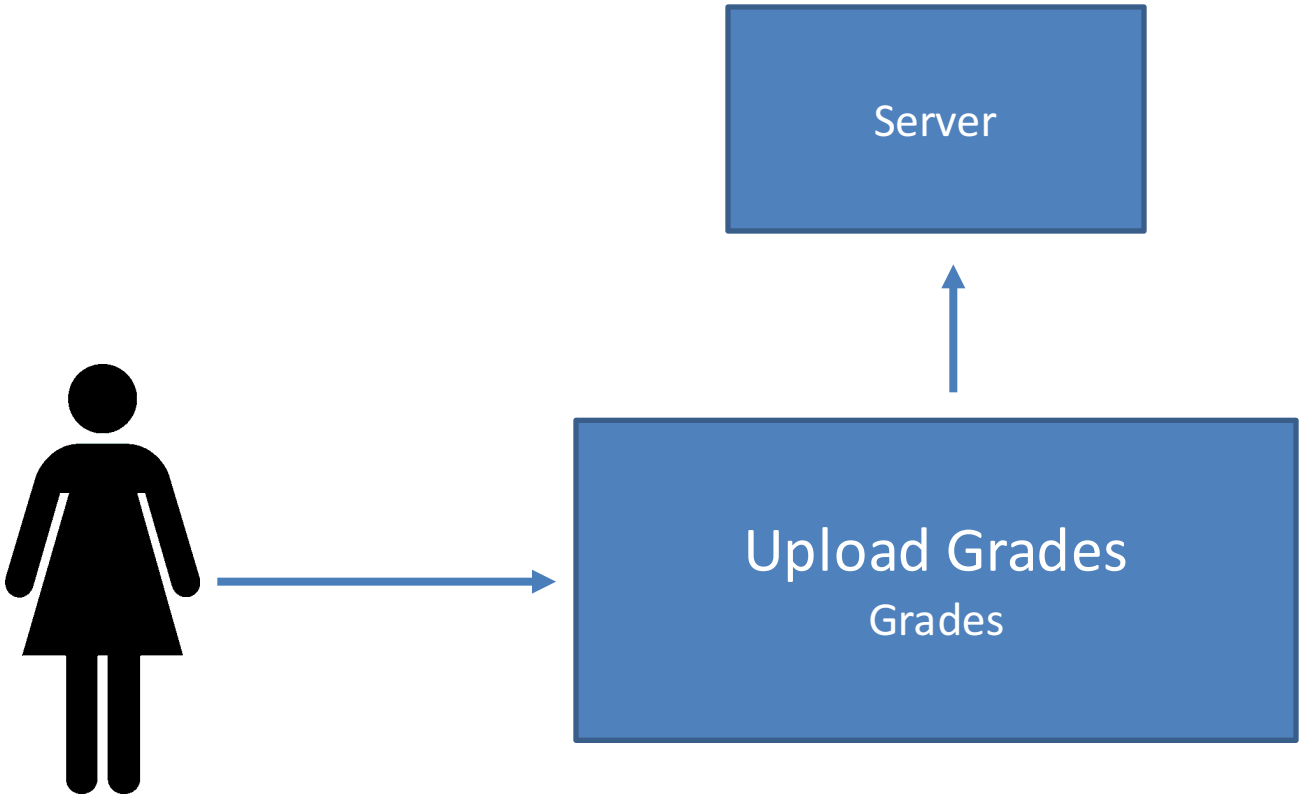


System Usage



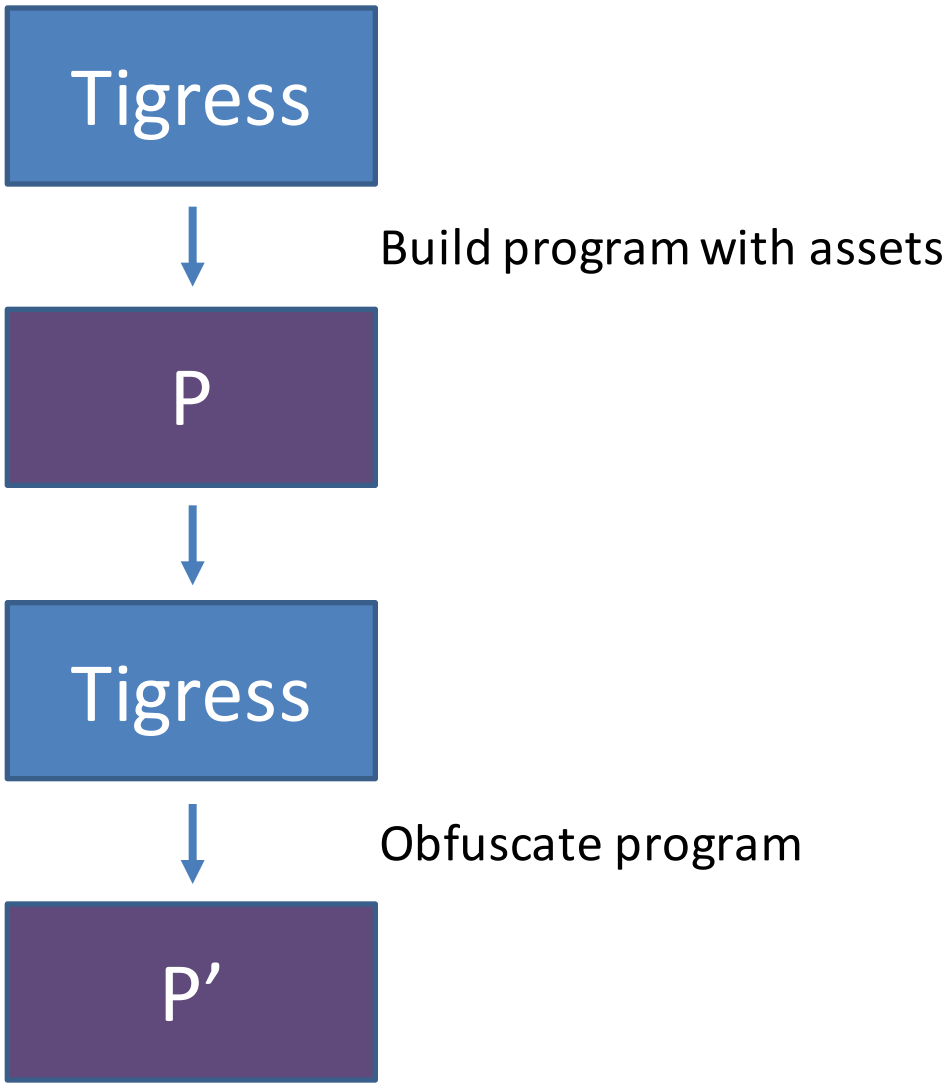
System Usage



Obfuscation

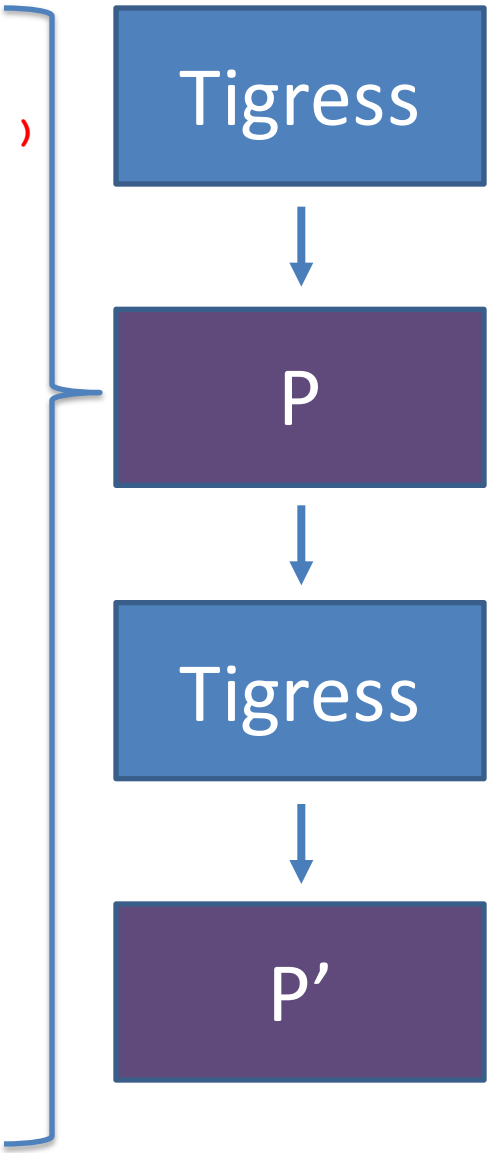
- Tigress
  - Operates on C language
  - Source-to-source obfuscator
  - Numerous transforms
  - Randomization built in
  - Includes code generation components
- Gcc compiler

Tigress Obfuscation Examples



Tigress Obfuscation Examples

```
#include ≤stdio.h>
#include ≤stdlib.h>
void SECRET(unsigned long input[1] , unsigned long output[1] )
{ ... }
int main(int argc, char** argv) {
{
  unsigned long input[1] ;
  unsigned long output[1] ;
  int i5 ;
  unsigned long value6 ;
  int i7 ;
  }
  i5 = 0;
  while (i5 < 1) {
    value6 = strtoul(argv[i5 + 1], 0, 10);
    input[i5] = value6;
    i5 ++;
  }
  SECRET(input, output);
  i7 = 0;
  while (i7 < 1) {
    printf("%lu\n", output[i7]);
    i7 ++;
  }
}
```



Tigress Obfuscation Examples

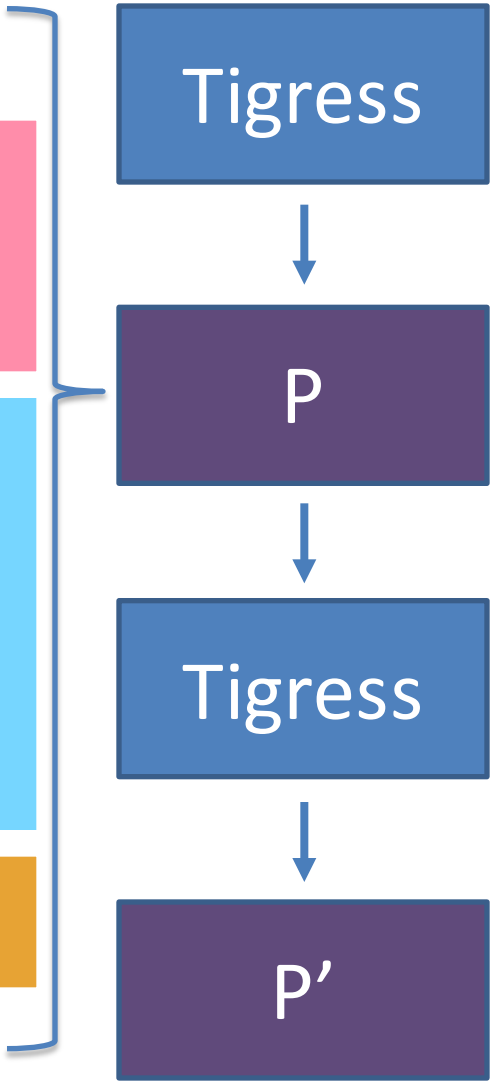
```
void SECRET(unsigned long i[1] , unsigned long o[1] ) {
  unsigned long s[4] ;

  s[0UL] = i[0UL] + 762537946UL;
  s[1UL] = i[0UL] | ((16601096UL << (s[0UL] % 16UL | 1UL)) |
           (16601096UL >> (64 - (s[0UL] % 16UL | 1UL))));
  s[2UL] = (i[0UL] ^ 643136481UL) ^ (s[0UL] + 292656718UL);
  s[3UL] = (i[0UL] << (((s[1UL] >> 4UL) & 15UL) | 1UL)) |
           (i[0UL] >> (64 - (((s[1UL] >> 4UL) & 15UL) | 1UL)));

  unsigned long l = 0UL;
  while (l < 3UL) {
    s[1UL] |= (s[2UL] & 15UL) << 3UL;
    s[l + 1UL] = s[l]; l += 2UL;
  }
  if ((s[0UL] | s[1UL]) > (s[2UL] | s[3UL])) {
    s[3UL] |= (s[1UL] & 31UL) << 3UL;
  } else {
    s[2UL] = s[0UL]; s[3UL] |= (s[2UL] & 15UL) << 3UL;
  }
  s[0UL] = s[2UL];

  o[0UL] = (s[0UL] << (s[1UL] % 8UL | 1UL)) <<
           ((((s[2UL] << (s[3UL] % 8UL | 1UL))
           >> 1UL) & 7UL) | 1UL);

}
```

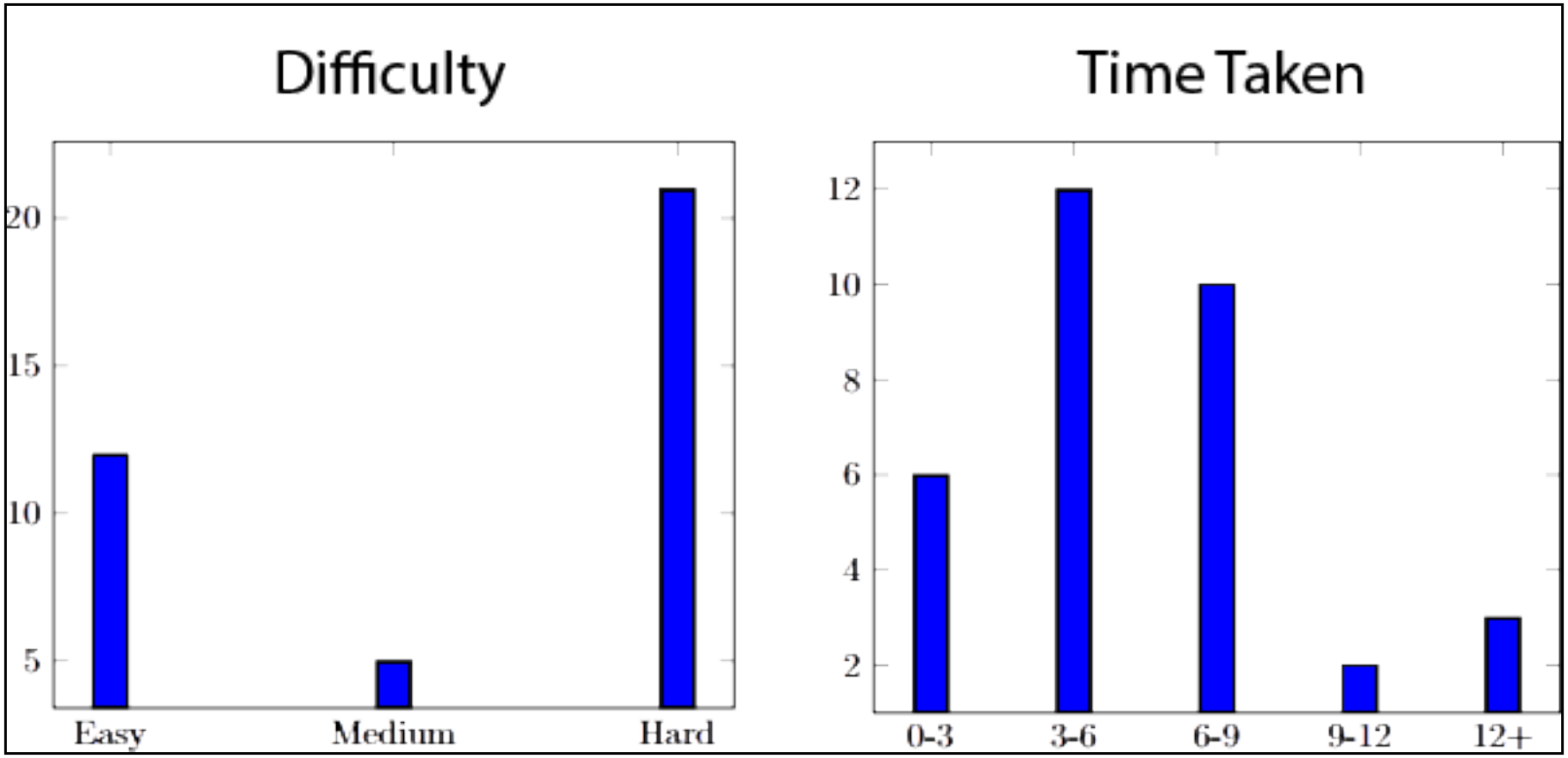


Deployment

- System used for a ~35 student course
- Configured for two binary challenges
- Students answered several additional questions:
  - What was the level of difficulty?
  - How long did it take to solve the problem?

Results

- Students were able to use the system and solve the easier problem



Future Work

- Dynamic environments
  - Docker
  - Provisioner
- Automated grading
  - Simple token grading
  - Input/output cases
  - Natural language processing
  - Code entropy
- Data collection
  - Syslog ng
  - Splunk
  - Custom built solutions
- Visualization

Conclusion

- Reverse engineering is a valuable skill
- Teaching that skill typically involves a lot of overhead
- Integrating Tigress with a webapp allowed us to easily generate and administer randomized exercises

Questions?