# Anatomy of an Unsafe Smart Contract Programming Language

Evan Sultanik

@ESultanik

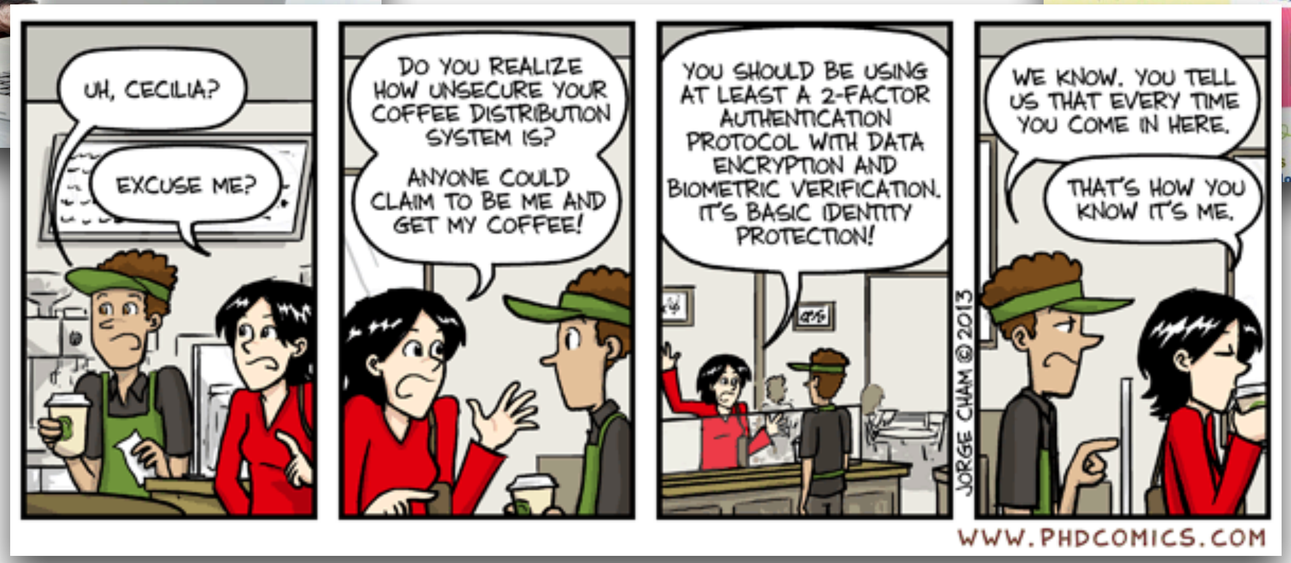
`whoami`

`whoami`

`whoami`


pets.com
because pets can't drive
shopping cart
my account
gift center
home
dogs
cats
fish
birds
ferrets
reptiles
small pets
find
today's features
Portrait of a Poodle
To capture Fido at his best, go with a pro.
A Very Kitty Christmas
Your cat can get into the holiday spirit, too.
Hanukkah at My House
Dogs love latkes almost as much as we do.
Animal Instincts:
I confess—I have a thing for leashes.
Bunny Speak
Who knew? Rabbits are quite expressive!
Celebrate our Anniversary
With 10% off Everything!
community
resources
Pet of the Day
Try this for dogs
Nutro MAX Mini Chunk
reg. price: $26.49
sale price: $19.99
Or this for cats
Pets.com Cat Gift Basket
reg. price: $29.99
sale price: $18.99
associates program
make money on your website
pets.commitment
Make your own Pets.commitment.
AVMF American Veterinary Medical Foundation
pets law
Landlord Liability
pets vet
Dr. Bobbie on Family:
sign up for
FROM INTERNET ARCHIVE WAYBACK MACHINE

# `whoami`


UH, CECILIA?
EXCUSE ME?
DO YOU REALIZE HOW UNSECURE YOUR COFFEE DISTRIBUTION SYSTEM IS?
ANYONE COULD CLAIM TO BE ME AND GET MY COFFEE!
YOU SHOULD BE USING AT LEAST A 2-FACTOR AUTHENTICATION PROTOCOL WITH DATA ENCRYPTION AND BIOMETRIC VERIFICATION. IT'S BASIC IDENTITY PROTECTION!
WE KNOW. YOU TELL US THAT EVERY TIME YOU COME IN HERE.
THAT'S HOW YOU KNOW IT'S ME.
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pets.com
because pets can't drive
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associates program
make money on your website
pets.commitment
Make your own Pets.commitment.
AVMF American Veterinary Medical Foundation
pets vet
sign up for
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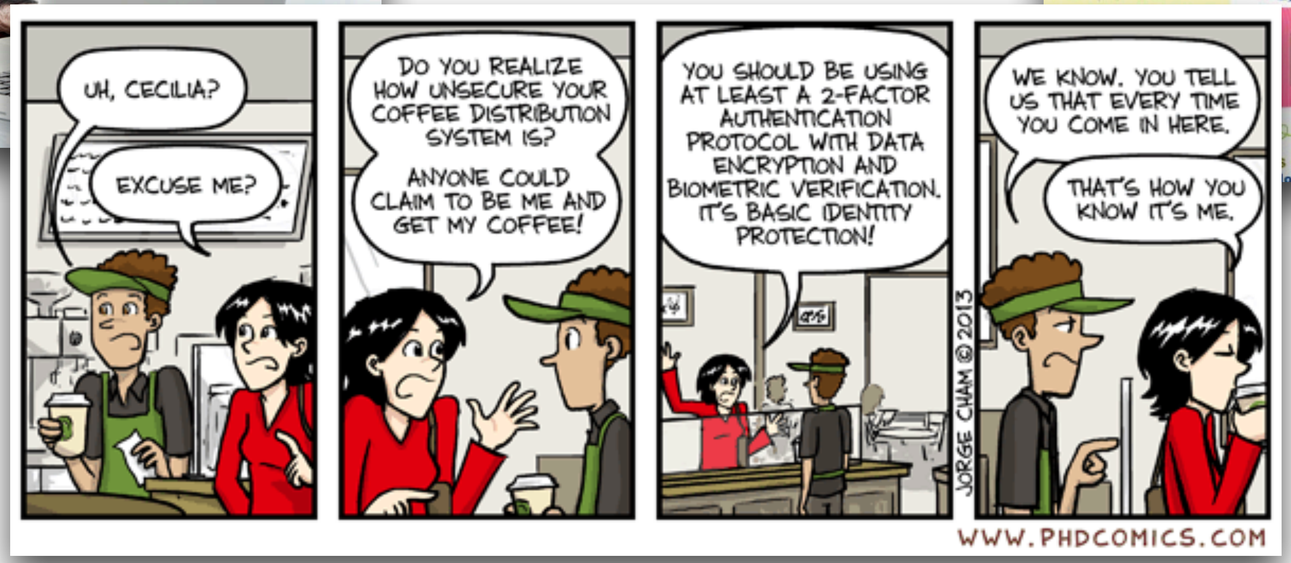
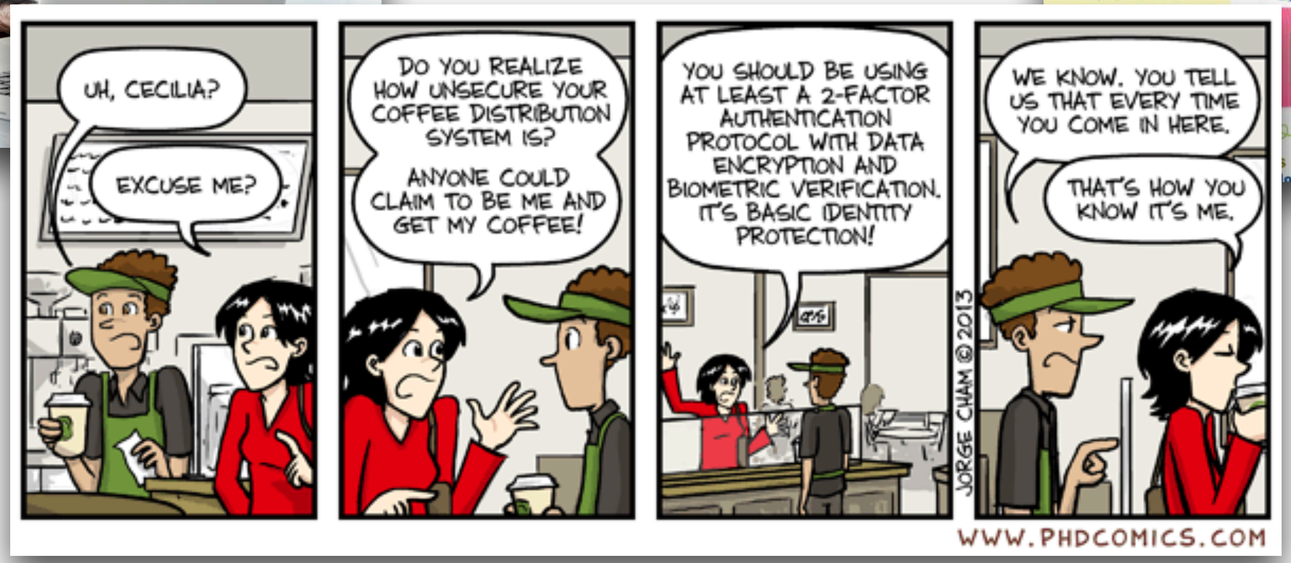



TRAIL OF BITS

# `whoami`


TRAIL OF BITS

Drexel UNIVERSITY

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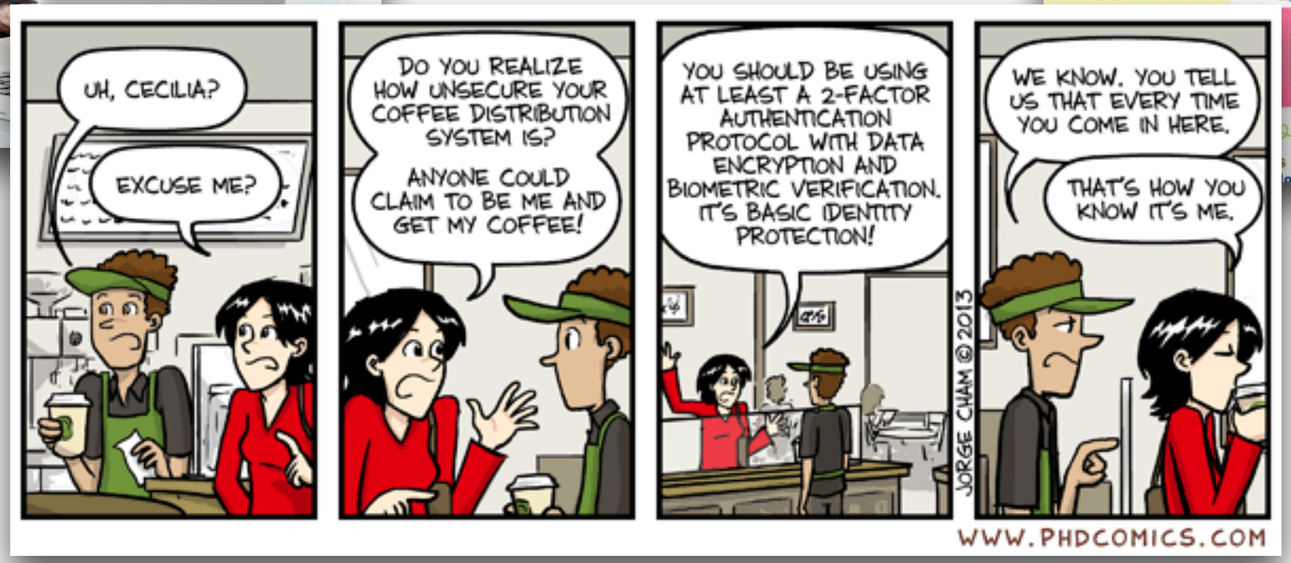
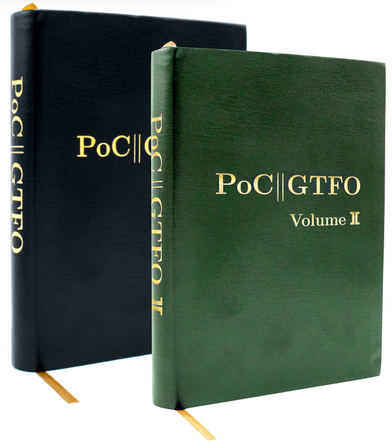
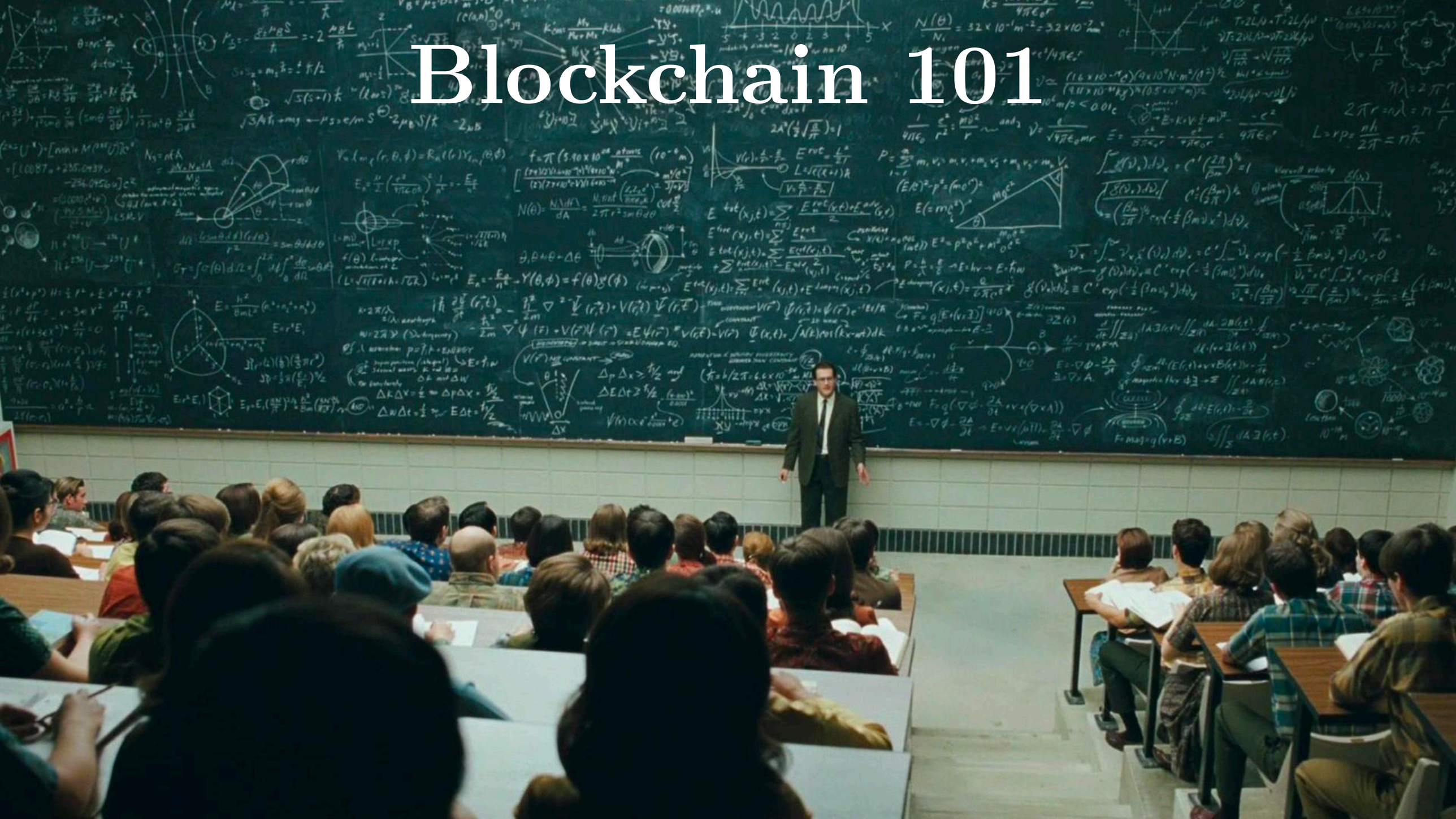



TRAIL OF BITS

Drexel UNIVERSITY



# Blockchain 101



# What Does “Crypto” Mean?

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Crypto Means Cryptography

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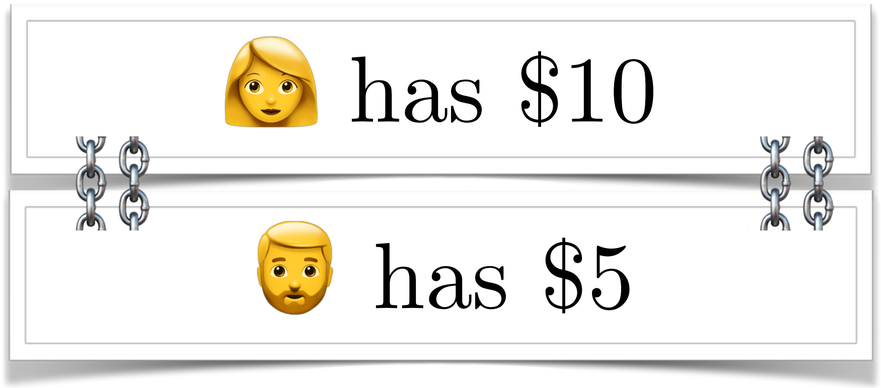
## Crypto Means Cryptography

or Cryptozoology,
that’s also cool.

# Blockchain

All it is: An immutable public ledger



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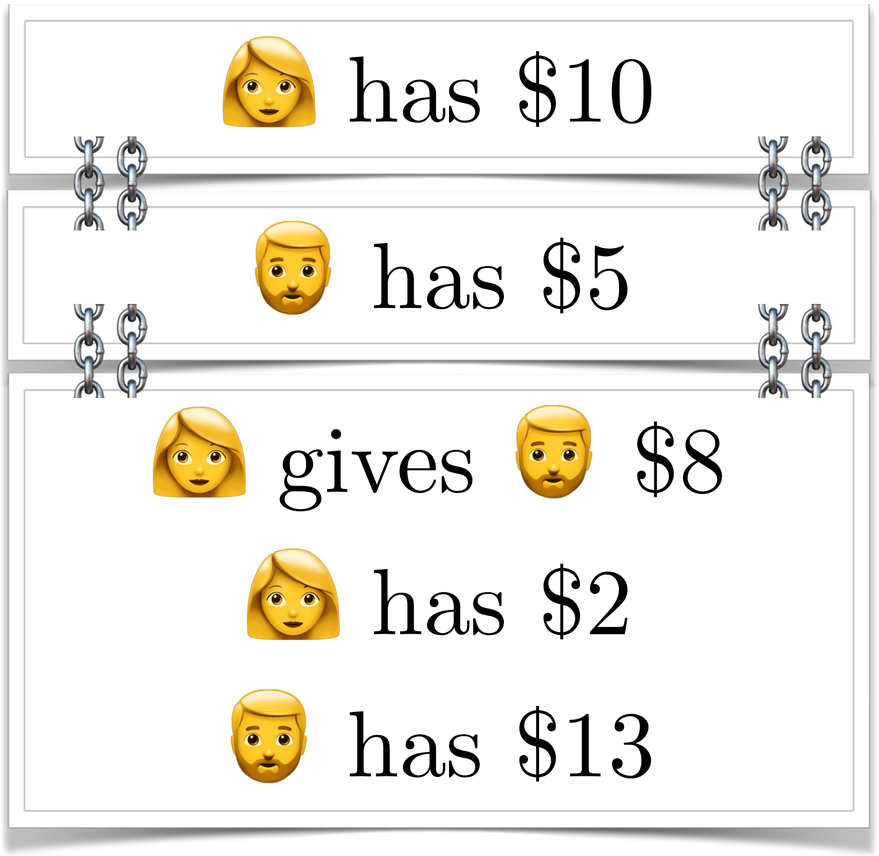

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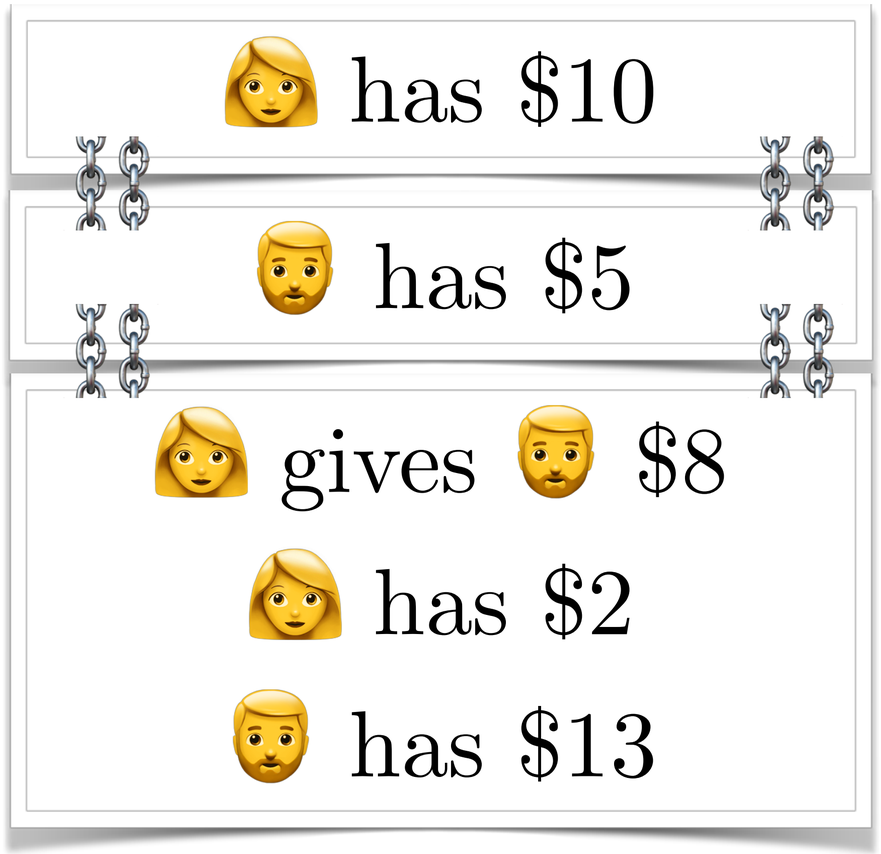


offers to give $10

# Blockchain

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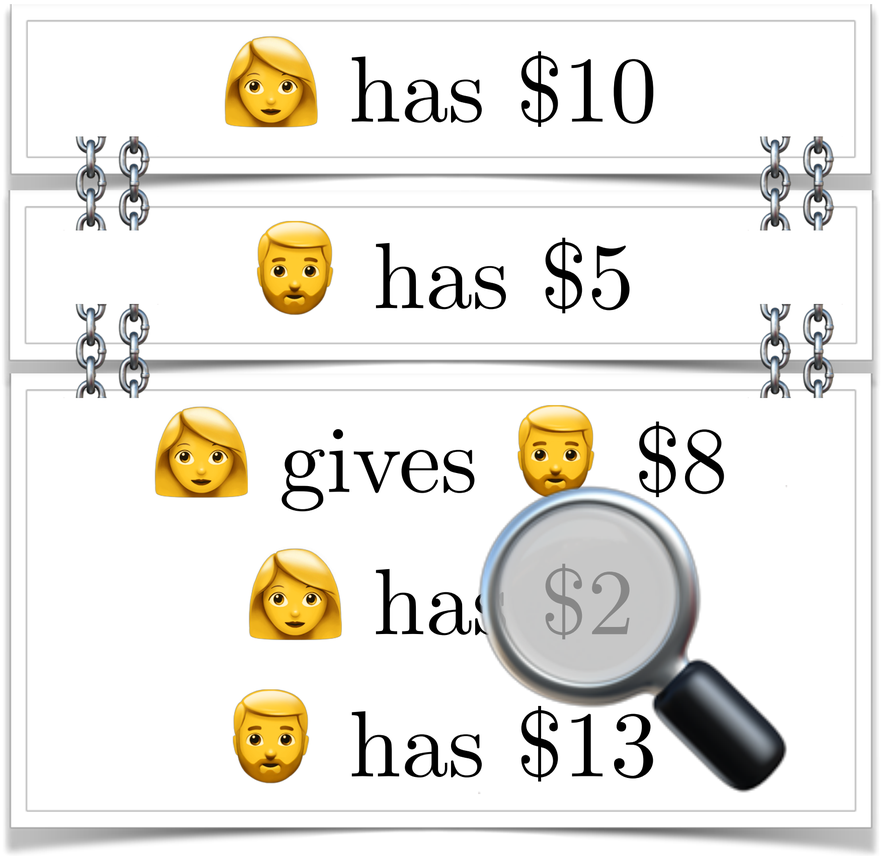


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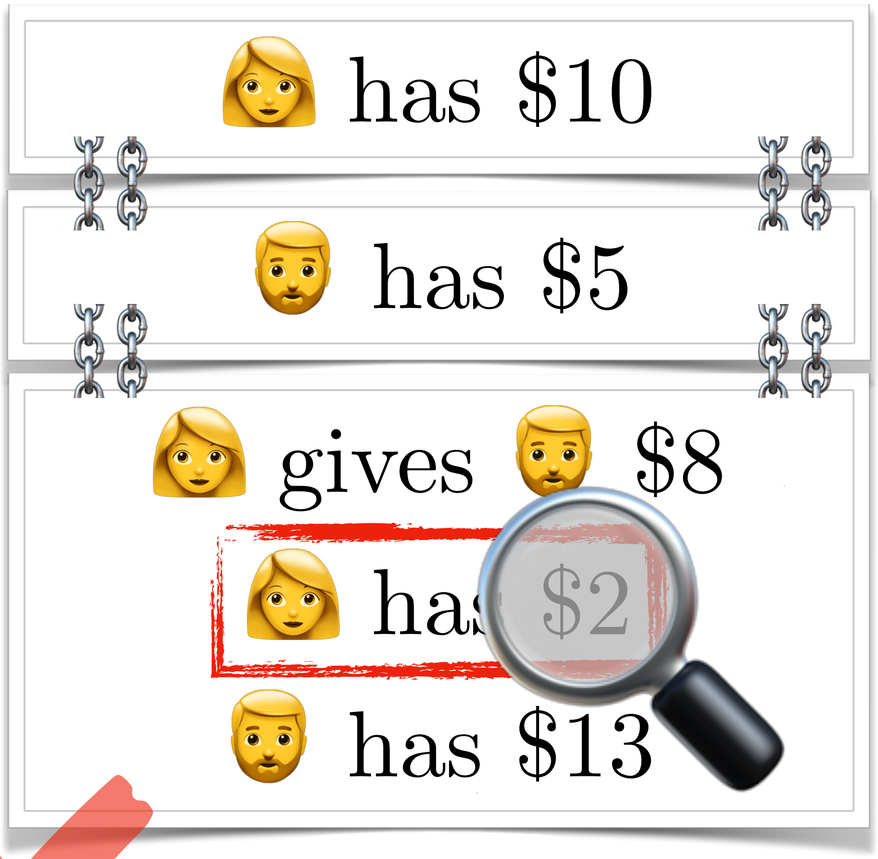
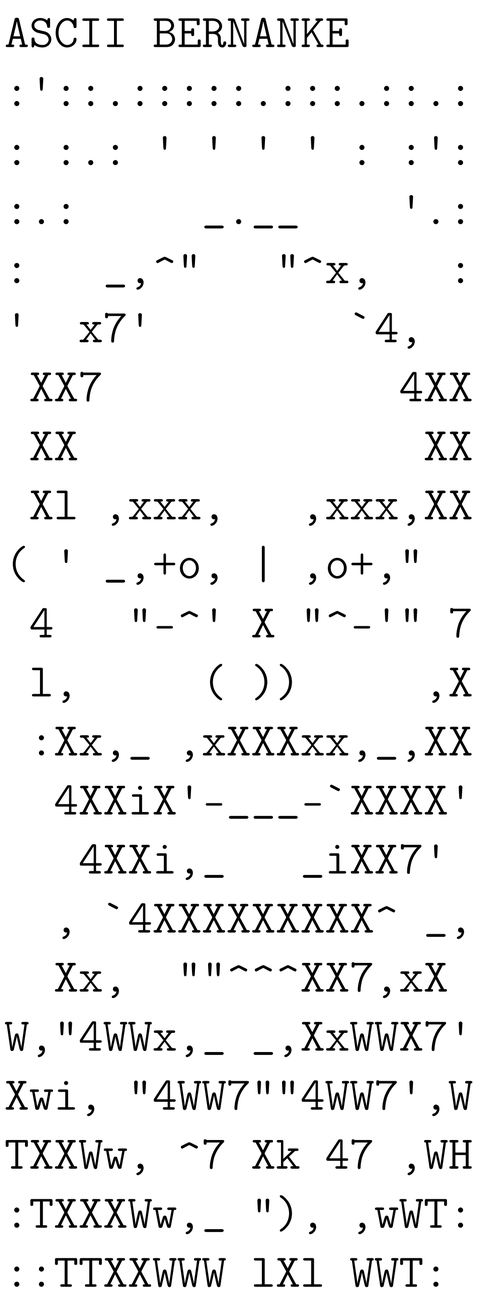



offers to give $10

You can put
anything
on a blockchain!

You can put anything on a blockchain!



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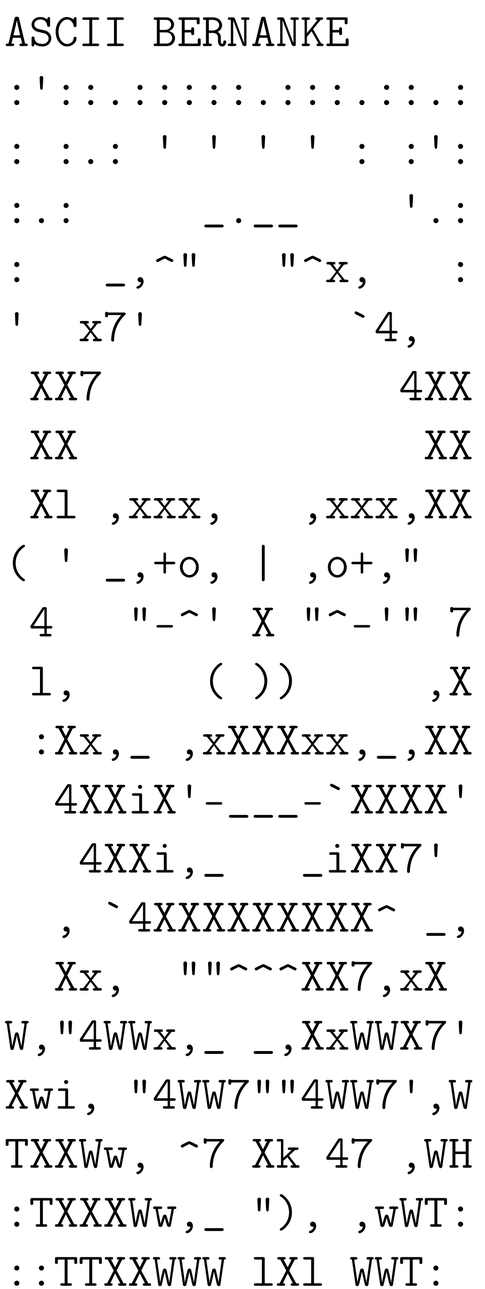


Even code...

# Smart Contracts

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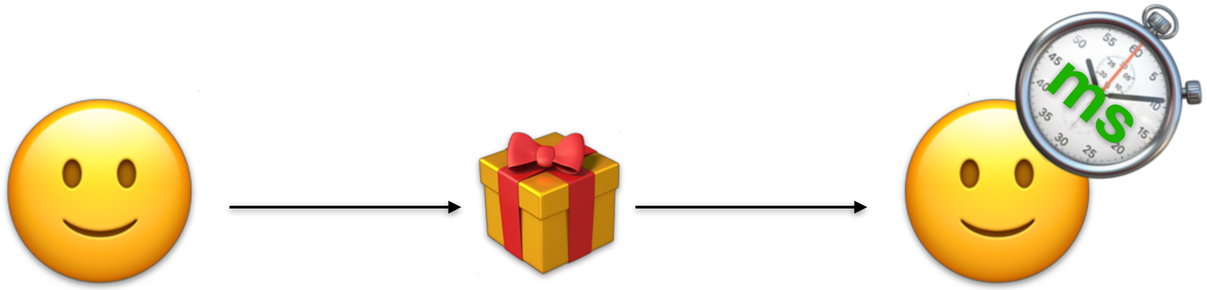

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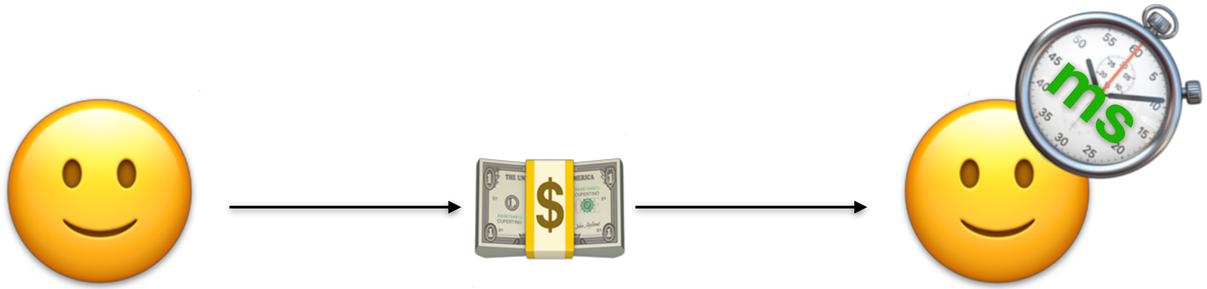

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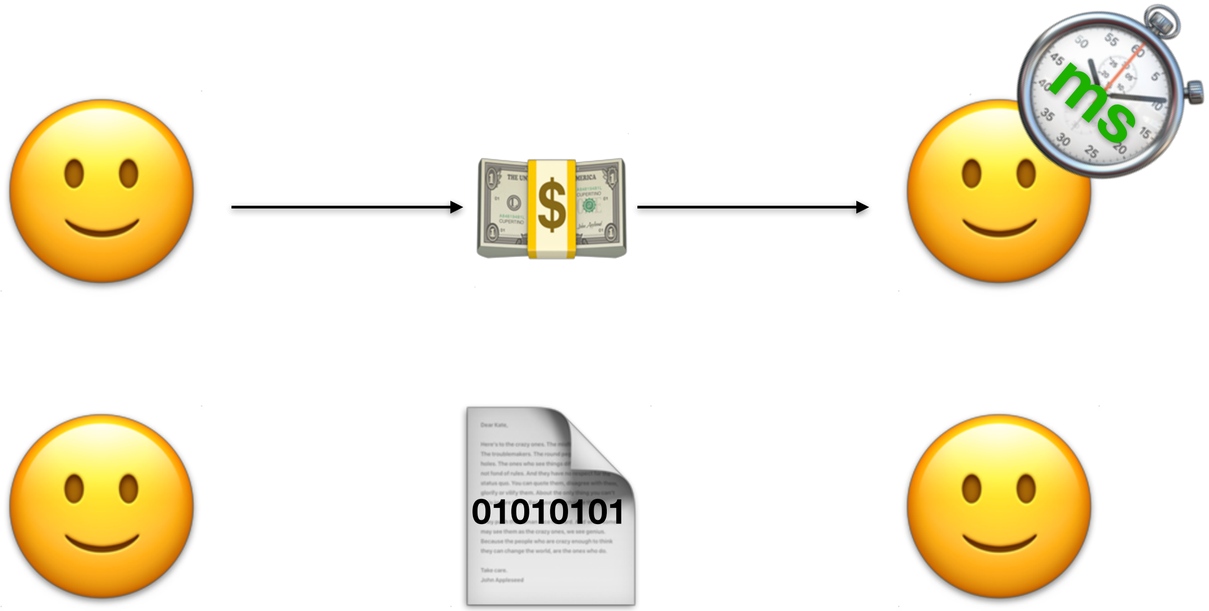

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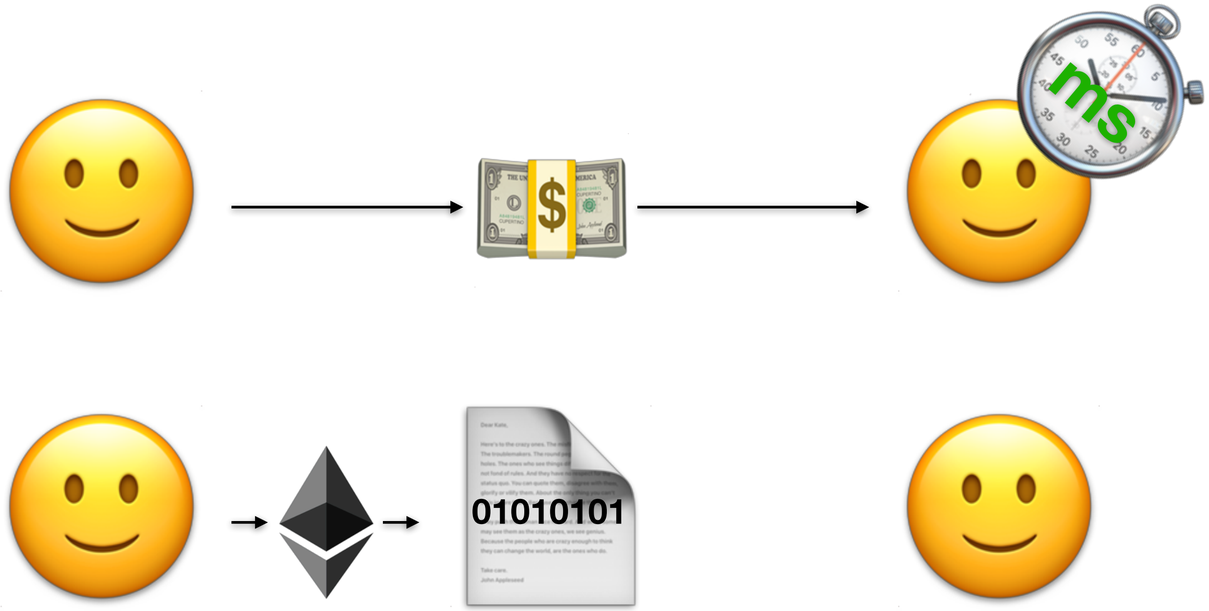

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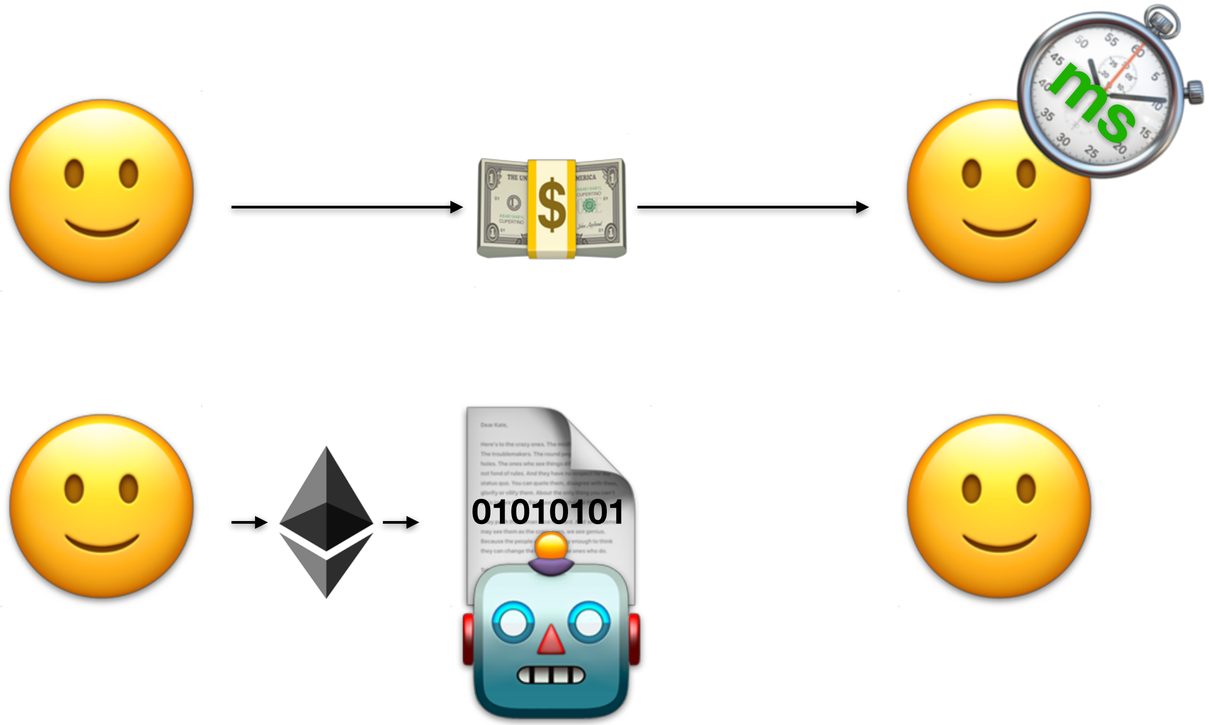

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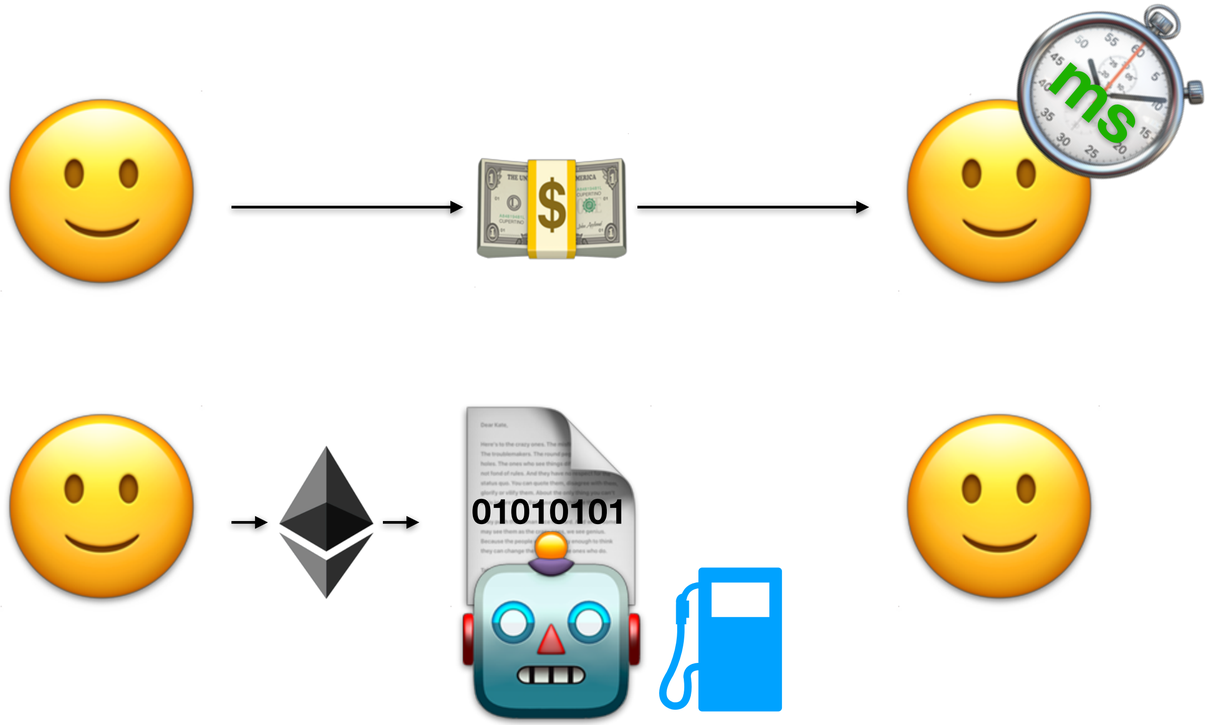

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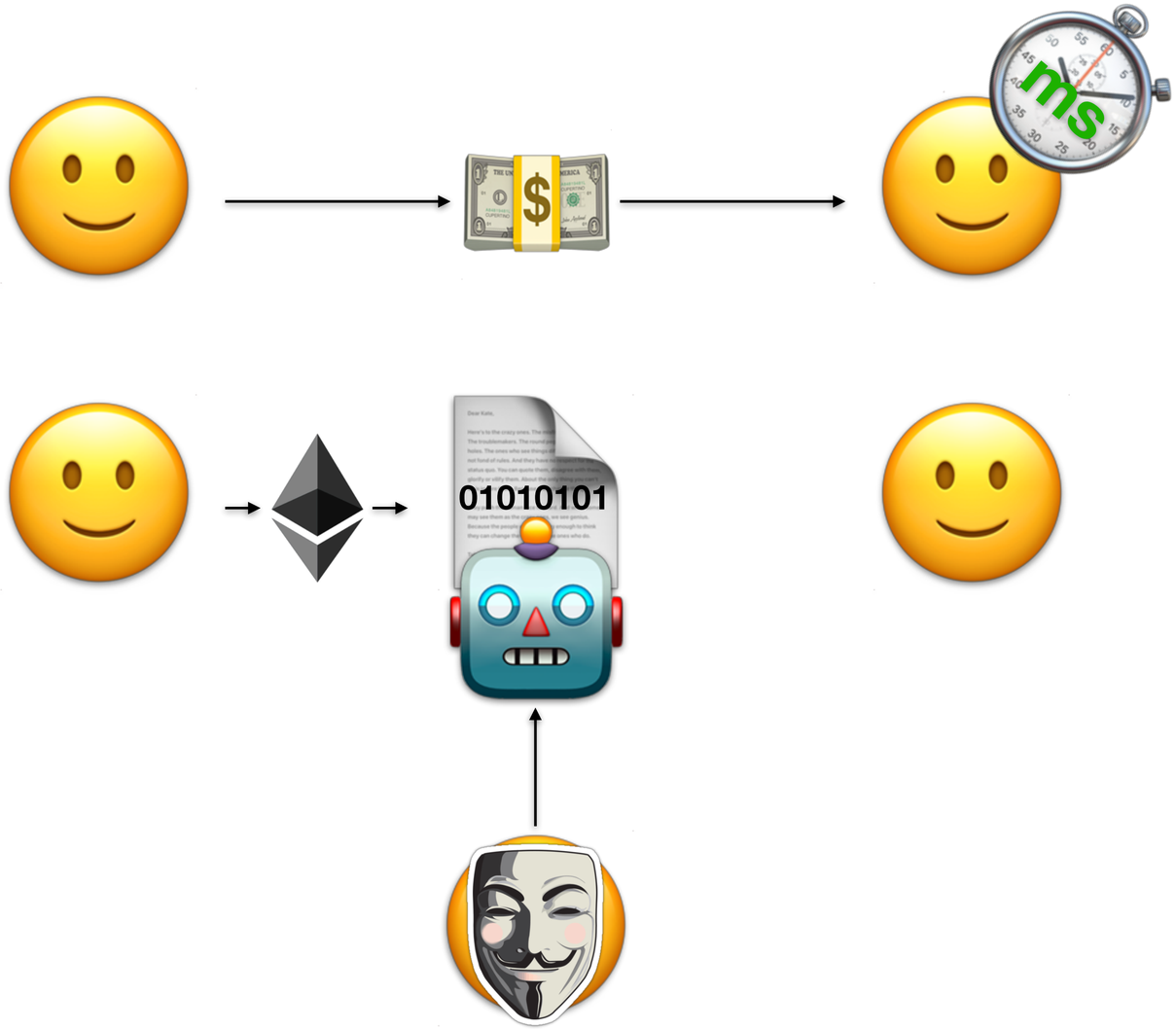

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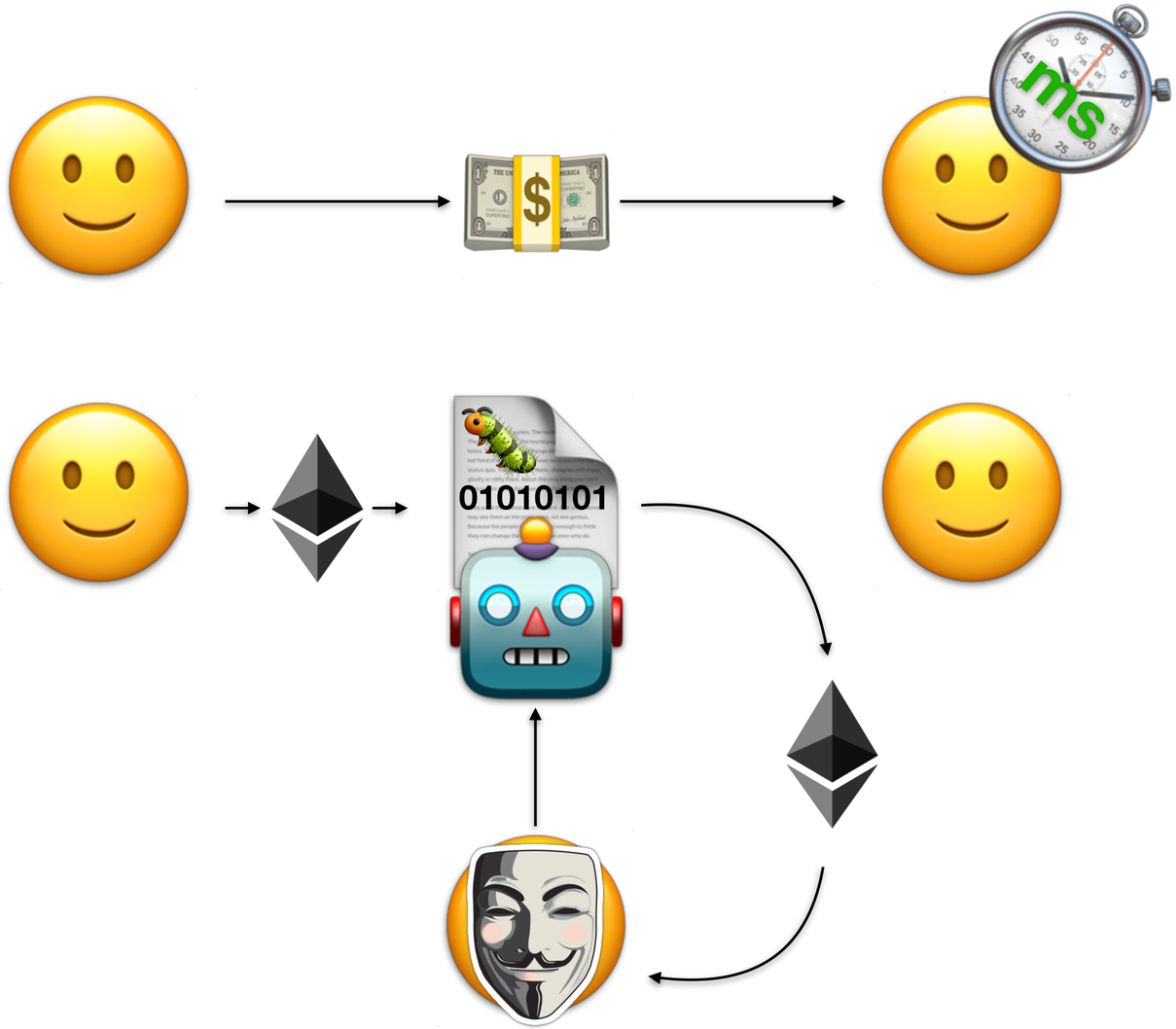

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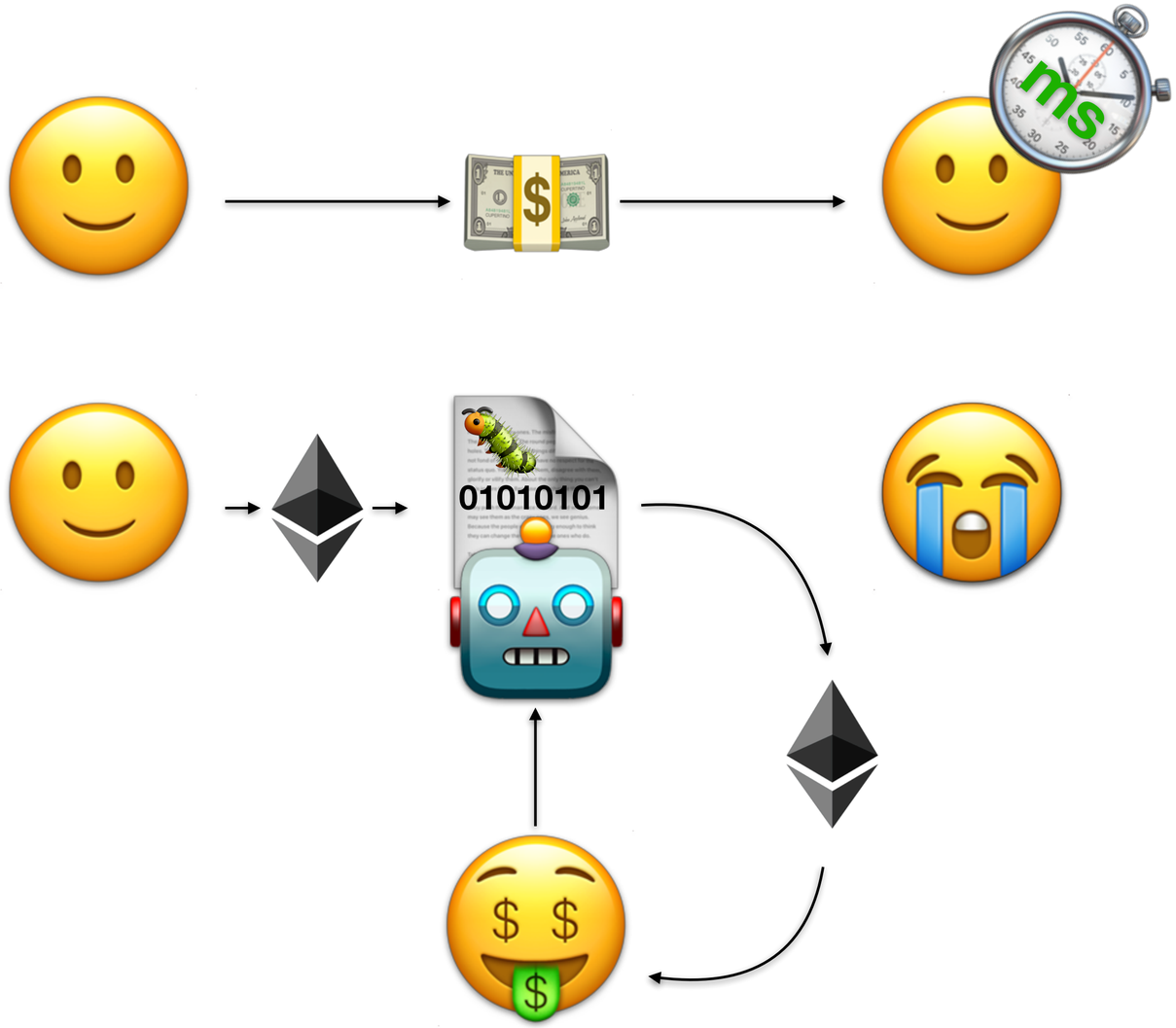

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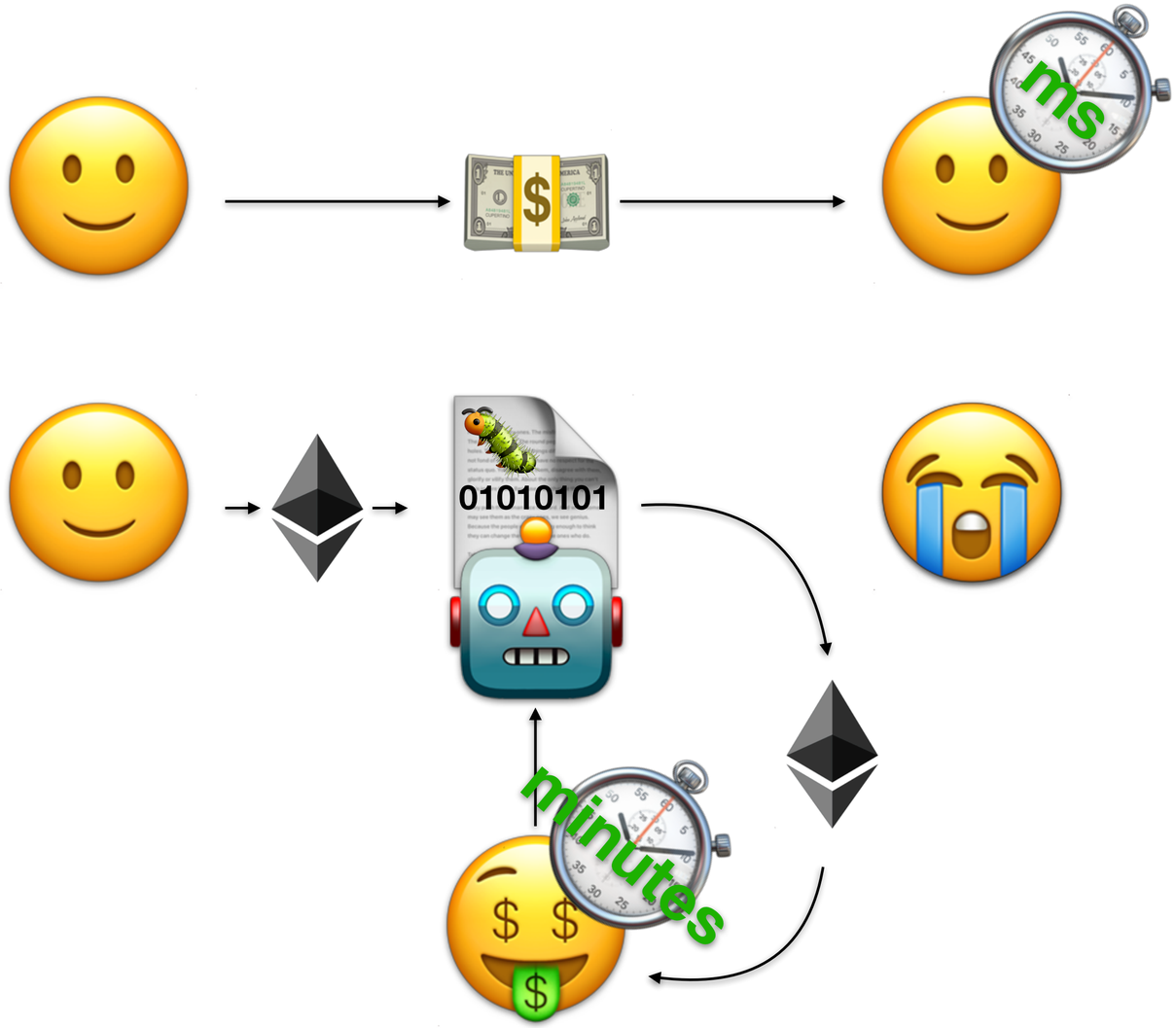
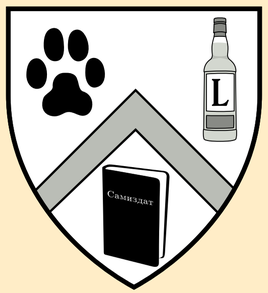


# *Certificate of Completion*

# Blockchain 101

*Signed* ナカモト サトシ




*Dated* _____

# *Certificate of Completion*

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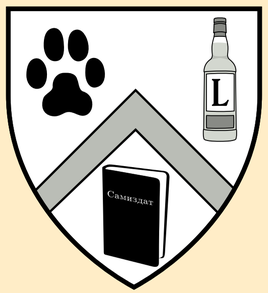


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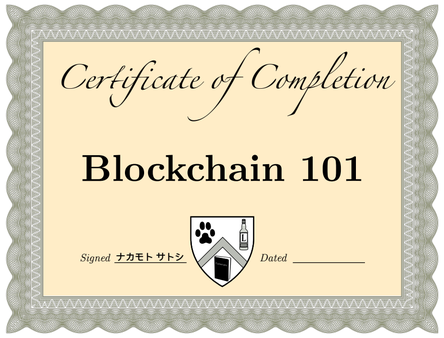
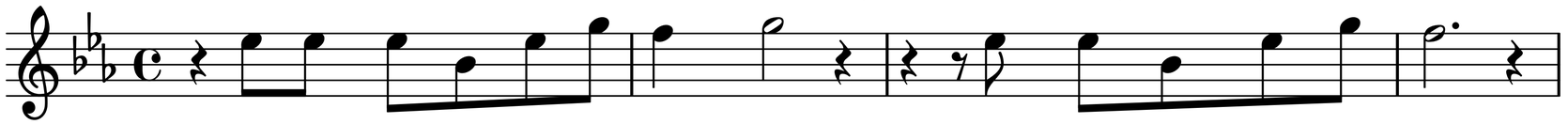



# Do You Want to Build a Blockchain?

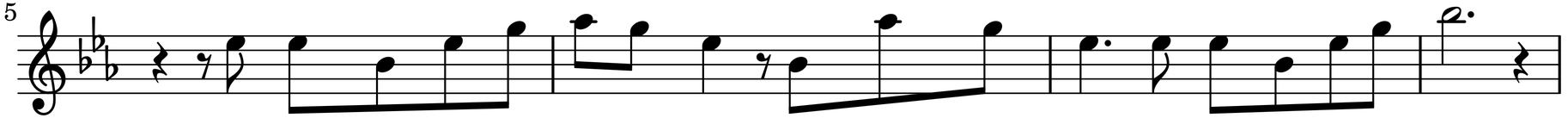
Music by Christophe Beck

Lyrics and Arrangement by Evan A. Sultanik



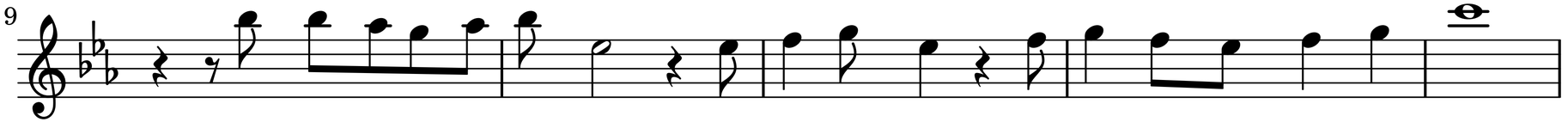
Do you want to build a block chain? We'll have an I. C. O.

Do you want to build a block chain? Smart contracts steal the show.



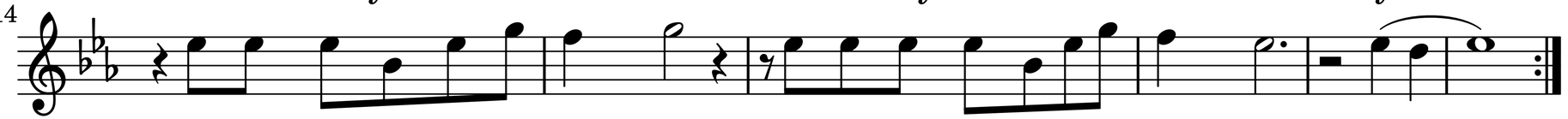
I think we'll get rich sup-er quick! The pump- dump trick! No one will ev-er know.

Be care - ful with re - entran-cy; don't want to be an-oth - er D. A. O.!



We need to do it fast or the Pon-zi scheme of Te-ther will bring us down.

Does an - y one un der stand So - li - di - ty? Semantics are real - ly weird!



Do you want to build a block chain? It doesn't have to be a block chain. HODL.

Do you want to build a block chain? It doesn't have to be a block chain. Crypto!

# Solidity

Programming Language Checklist
by Colin McMillen, Jason Reed, and Elly Jones.

You appear to be advocating a new:
[ ] functional [ ] imperative [X] object-oriented [X] procedural [X] stack-based
[ ] "multi-paradigm" [ ] lazy [ ] eager [X] statically-typed [ ] dynamically-typed
[ ] pure [ ] impure [ ] non-hygienic [ ] visual [ ] beginner-friendly
[X] non-programmer-friendly [ ] completely incomprehensible
programming language. Your language will not work. Here is why it will not work.

**Your language will not work.**

You appear to believe that:
[ ] Syntax is what makes programming difficult
[ ] Garbage collection is free [ ] Computers have infinite memory
[X] Nobody really needs:
    [ ] concurrency [ ] a REPL [X] debugger support [ ] IDE support [ ] I/O
    [ ] to interact with code not written in your language
[ ] The entire world speaks 7-bit ASCII
[ ] Scaling up to large software projects will be easy
[ ] Convincing programmers to adopt a new language will be easy
[ ] Convincing programmers to adopt a language-specific IDE will be easy
[ ] Programmers love writing lots of boilerplate
[ ] Specifying behaviors as "undefined" means that programmers won't rely on them
[X] "Spooky action at a distance" makes programming more fun

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Unfortunately, your language (has/lacks):
[ ] comprehensible syntax [ ] semicolons [ ] significant whitespace [ ] macros
[ ] implicit type conversion [ ] explicit casting [X] type inference
[ ] goto [ ] exceptions [X] closures [ ] tail recursion [ ] coroutines
[ ] reflection [X] subtyping [ ] multiple inheritance [X] operator overloading
[ ] algebraic datatypes [X] recursive types [ ] polymorphic types
[ ] covariant array typing [X] monads [ ] dependent types
[ ] infix operators [ ] nested comments [ ] multi-line strings [X] regexes
[ ] call-by-value [ ] call-by-name [ ] call-by-reference [ ] call-cc

The following philosophical objections apply:

The following philosophical objections apply:
[ ] Programmers should not need to understand category theory to write "Hello, World!"
[ ] Programmers should not develop RSI from writing "Hello, World!"
[ ] The most significant program written in your language is its own compiler
[ ] The most significant program written in your language isn't even its own compiler
[X] No language spec
[X] "The implementation is the spec"
   [ ] The implementation is closed-source  [ ] covered by patents  [ ] not owned by you
[X] Your type system is unsound  [X] Your language cannot be unambiguously parsed
   [X] a proof of same is attached
   [ ] invoking this proof crashes the compiler
[ ] The name of your language makes it impossible to find on Google
[ ] Interpreted languages will never be as fast as C
[ ] Compiled languages will never be "extensible"
[ ] Writing a compiler that understands English is AI-complete
[ ] Your language relies on an optimization which has never been shown possible
[ ] There are less than 100 programmers on Earth smart enough to use your language
[ ] _____ takes exponential time
[ ] _____ is known to be undecidable

Your implementation has the following flaws:
[ ] CPUs do not work that way

Your implementation has the following flaws:

[ ] CPUs do not work that way
[ ] RAM does not work that way
[ ] VMs do not work that way
[X] Compilers do not work that way
[ ] Compilers cannot work that way
[ ] Shift-reduce conflicts in parsing seem to be resolved using rand()
[ ] You require the compiler to be present at runtime
[ ] You require the language runtime to be present at compile-time
[X] Your compiler errors are completely inscrutable
[X] Dangerous behavior is only a warning
[ ] The compiler crashes if you look at it funny
[ ] The VM crashes if you look at it funny
[X] You don't seem to understand basic optimization techniques
[X] You don't seem to understand basic systems programming
[ ] You don't seem to understand pointers
[ ] You don't seem to understand functions

Additionally, your marketing has the following problems:

[ ] Unsupported claims of increased productivity
[ ] Unsupported claims of greater "ease of use"
[ ] Obviously rigged benchmarks
    [ ] Graphics, simulation, or crypto benchmarks where your code just calls handwritten assembly through your FFI

Additionally, your marketing has the following problems:

[ ] Unsupported claims of increased productivity
[ ] Unsupported claims of greater "ease of use"
[ ] Obviously rigged benchmarks
  [ ] Graphics, simulation, or crypto benchmarks where your code just calls handwritten assembly through your FFI
  [ ] String-processing benchmarks where you just call PCRE
  [ ] Matrix-math benchmarks where you just call BLAS
[ ] Noone really believes that your language is faster than:
  [ ] assembly [ ] C [ ] FORTRAN [ ] Java [ ] Ruby [ ] Prolog
[ ] Rejection of orthodox programming-language theory without justification
[ ] Rejection of orthodox systems programming without justification
[ ] Rejection of orthodox algorithmic theory without justification
[ ] Rejection of basic computer science without justification

Taking the wider ecosystem into account, I would like to note that:

[ ] Your complex sample code would be one line in: _____
[ ] We already have an unsafe imperative language
[ ] We already have a safe imperative OO language
[ ] We already have a safe statically-typed eager functional language
[ ] You have reinvented Lisp but worse
[X] You have reinvented Javascript but worse
[ ] You have reinvented Java but worse
[ ] You have reinvented C++ but worse
[ ] You have reinvented PHP but worse

[ ] assembly [ ] C [ ] FORTRAN [ ] Java [ ] Ruby [ ] Prolog
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[ ] You have reinvented Java but worse
[ ] You have reinvented C++ but worse
[ ] You have reinvented PHP but worse
[ ] You have reinvented PHP better, but that's still no justification
[ ] You have reinvented Brainfuck but non-ironically

In conclusion, this is what I think of you:
[X] You have some interesting ideas, but this won't fly.
[X] This is a bad language, and you should feel bad for inventing it.
[X] Programming in this language is an adequate punishment for inventing it.

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```
if(1 | 0 < 1) {
    /* case 1 */
} else {
    /* case 2 */
}
```

```
if(1 | 0 < 1) {
```

C, C++, Javascript, Java, ...

```
} else {
    /* case 2 */
}
```

```
if(1 | 0 < 1) {
```

C, C++, Javascript, Java, ...

```
} else {
```


**WOW!**

```
}
```

**LEEEROYYY JENKINS!**

```
for (var i = 0; i < foo.length; ++i) {
    foo[i] = i;
}
```

```
for (var i = 0; i < foo.length; ++i) {
    foo[i] = i;
}
```

What does `foo[1337]` look like after this?

```
for (var i = 0; i < foo.length; ++i) {
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```

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# How to Write a Solidity Parser

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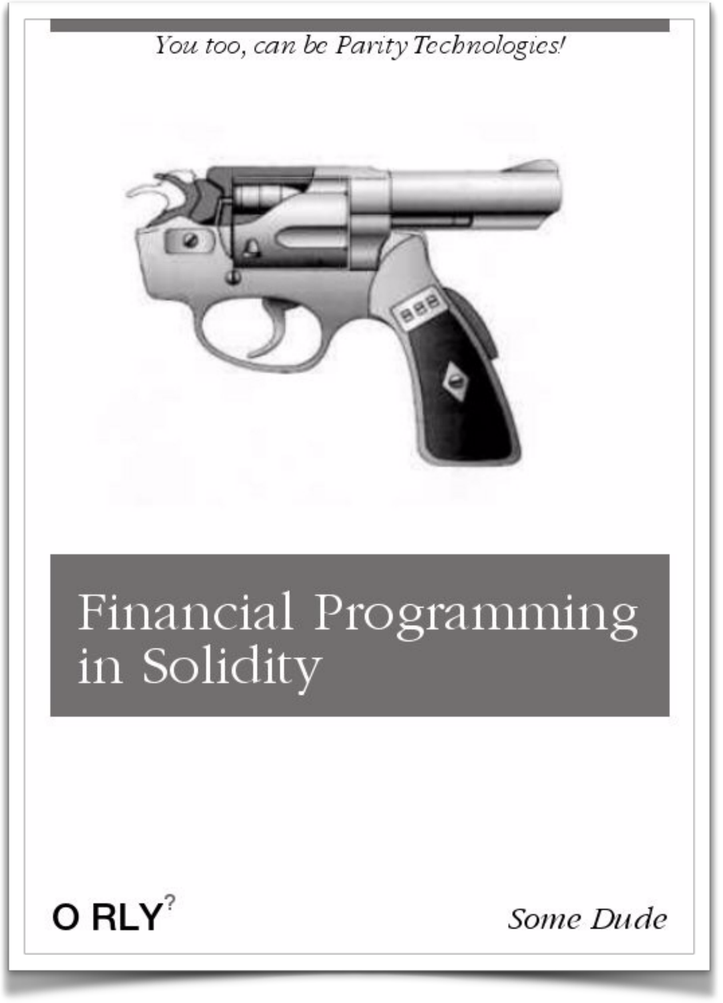
(1) ☕

(2) Look up the official grammar



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(9) 💉⚰️

# One Does Not Simply Implement the Shunting Yard Algorithm

# One Does Not Simply

# Implement the Shunting Yard Algorithm

```
contract C{
    struct myStruct{
        function(uint) my_func;
    }

    function test(){
        myStruct m;

        m.my_func = call_log;
        m.my_func(0);

        m.my_func = call_log2;
        m.my_func(0);
    }

    function call_log(uint a){
        Log(a);
    }

    function call_log2(uint a){
        Log2(a);
    }

    event Log(uint);
    event Log2(uint);
}
```

# a struct that contains a pointer to a function

```
contract C{
    struct myStruct{
        function(uint) my_func;
    }

    function test(){
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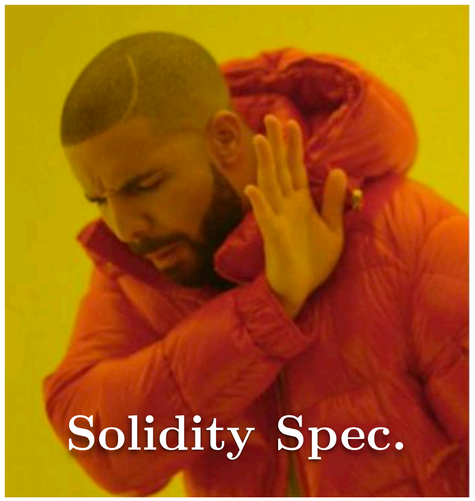
# a struct that contains a pointer to a function

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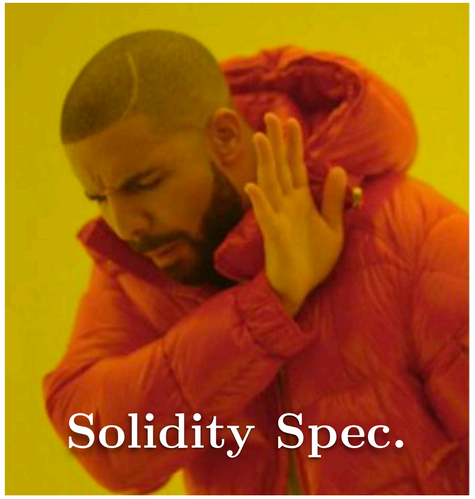


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```

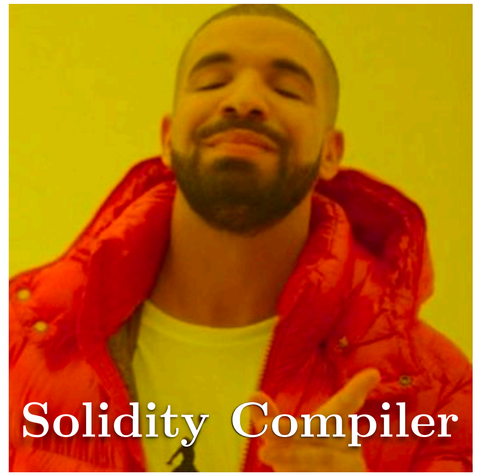

# Solidity Parsing Using SmaCC: Challenges and Irregularities

Henrique Rocha Stephane Ducasse
Marcus Denker
INRIA Lille - Nord Europe
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marcus.denker}@inria.fr

Jason Lecerf
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## Abstract

Solidity is a language used to implement smart contracts on a blockchain platform. Since its initial conception in 2014, Solidity has evolved into one of the major languages for the Ethereum platform as well as other blockchain technologies. Due to its popularity, there are many tools specifically designed to handle smart contracts written in Solidity. However, there is a lack of tools for Pharo to handle Solidity contracts. Therefore, we implemented a parser using SmaCC to serve as a base for further developing Solidity support in Pharo. In this paper we describe the parser creation, the irregularities we found in the Solidity grammar specification, and common practices on how to adapt the grammar to an LR type parser. Our experiences with parsing the Solidity language using SmaCC may help other developers trying to convert similar grammars.

***Keywords*** Solidity, Parser, SmaCC, Blockchain, Ethereum.

## 1. Introduction

The Blockchain technology attracted a lot attention recently [LCO+16]. Blockchain is a distributed database, managed by a peer-to-peer network that stores a list of blocks or records. Ethereum [Eth14], and BitCoin [Nak09] are examples of blockchain technologies. Blockchains can be used for many applications such as cryptocurrency, digital wallets, adhoc networks, and remote transactions [LCO+16, HL16, LMH16, Dzi15, Eth14, Nak09]. One notable application of blockchain is the execution of smart contracts [LCO+16].



Smart contracts are what embedded procedures are for databases: programs executed in the blockchain to manage and transfer digital assets. When used in platforms like Ethereum, the contract language is Turing-complete [BDLF+16]. Therefore, smart contracts can be used in many different scenarios [LCO+16]. For example, there are smart contracts employed to simple storage [Eth17], and outsourced computation [LTKS15].

Solidity [Eth17] is a programming language loosely based on JavaScript, and it is used to specify smart contracts on blockchain platforms. Solidity was originally designed to be the primary smart contract language for the Ethereum platform. Even though other contract languages have been created for Ethereum [DAKM15], Solidity is still one of the major ones. Moreover, Solidity can also be used in other blockchain platforms such as Monax[1] and Hyperledger[2].

Probably because of its popularity, there are many tools to help integrate smart contracts written in Solidity with other languages and technologies [Eth17]. For example, we have Solidity compilers coded in C/C++ and NodeJs, third-party parsers and grammar specifications (JavaScript and ANTLR), plugins for IDEs and editors (IntelliJ, Visual Studio, Vim, Atom, and etc.). Such tool integration support developers of smart contracts. However, as far as we know, there is a lack of tools for Pharo Smalltalk to handle Solidity smart contracts. Moreover, most academic work towards smart contracts focuses on security [LCO+16, BDLF+16, DAK+15] and not in tool support.

In this paper, we plan to partially tackle this lack of tools problem by building a Solidity parser that runs on Pharo Smalltalk. We claim that with a parser and its generated AST (Abstract Syntax Tree), we will be able to develop strong tool support for Solidity contracts. For instance, it would be much easier to create code inspection tools on top of a functional parser than to rely on the purely textual content of the contract. To accomplish these goals, we used SmaCC

[1] https://monax.io/, verified 2017-06-19.
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**Solidity Parsing Using SmaCC:**
**Challenges and Irregularities**

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Jason Lecerf
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Another interesting challenge we found to parse Solidity was that the language uses the same symbol (comma) as a separator for expression lists but also as an operator for the expression itself. ... This causes a serious problem because when the parser finds a comma in the input it does not know if it is an operator for the current expression (matching the Expression rule) or a separator to the current expression and the beginning of a new one (matching ExpressionList). This is a potential problem for any parser due to the ambiguity of matching either rule when encountering a comma.

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**Università degli Studi di Padova**

DIPARTIMENTO DI MATEMATICA "TULLIO LEVI-CIVITA"

CORSO DI LAUREA MAGISTRALE IN INFORMATICA


# How Solid is Solidity?

## An In-dept Study of Solidity's Type Safety

Master thesis

*Supervisor*
Prof. Silvia Crafa

*Author*
Matteo Di Pirro

SEPTEMBER 2018

**Università degli Studi di Padova**

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...we found out that Solidity's type system is far from being safe with respect to any type of error:


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in many occasions, contract interfaces are not consulted at compile-time, and this makes the execution raise an exception and the user waste money.

SEPTEMBER 2018

The difference between an amateur and a professional is: you write your own compiler.

**Ryan Stortz**
@withzombies

There are contracts on the blockchain that calculate 1 with exponentiation. This actually costs people money...

```
    JUMPI(#0x200, %13),
  ]>,
  <SSA:BasicBlock ofs:0x24c insns:[
    %14 = SLOAD(#0x3),
    %15 = EXP(#0x100, #0x0),
    %16 = DIV(%14, %15),
    %17 = EXP(#0x2, #0xA0),
    %18 = SUB(%17, #0x1),
```

10:39 PM - 6 Mar 2018

# 16 Block Trace

by Martin Holst Swende

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18,538 invocations of `EXP`

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Well over half were calculating 160 raised to the power of 1

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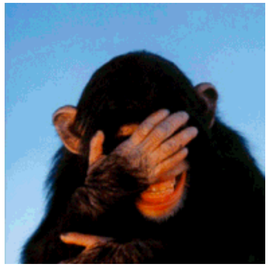
Martin's GitHub profile pic:



# Exponentiation: How does it work?

4 libsolidity/codegen/ExpressionCompiler.cpp — View

```
@@ -2069,7 +2069,9 @@ bool ExpressionCompiler::cleanupNeededForOp(Type::Category _type, Token::Value _
 {                                                    {
       if (Token::isCompareOp(_op) || Token::isShiftOp(_op))
             return true;
-      else if (_type == Type::Category::Integer && (_op == Token::Div || _op == Token::Mod))
+      else if (_type == Type::Category::Integer && (_op == Token::Div || _op == Token::Mod || _op == Token::Exp))
+            // We need cleanup for EXP because 0**0 == 1, but 0**0x100 == 0
+            // It would suffice to clean the exponent, though.
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       else
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       else                                                       else
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       else                                                       else
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```

Using the ** operator with an exponent of type shorter than 256 bits can result in unexpected values.

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       else                                                       else
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# Things Are Improving

**Nick Oprisan** @NicuOprisan · Nov 30

#Solidity needs to be more stable if we want to grow the dev community. As a dev I feel I can't keep-up with the releases. Add this to the growing rate of changes in the #JS community and you've got yourself a confused dev.

> **Chris** @ethchris
> Have you updated to #Solidity 0.5.0 already? We are about to release 0.5.1 in the next days! Yes, I know, it's crazy, it has not even been three weeks!
> Show this thread

4 4 10

**Chris**
@ethchris

Replying to @NicuOprisan

The breaking release before 0.5.0 was over two years ago. I think Solidity needs to get more flexible. We are planning breaking releases roughly every 6 months now. And I think it's fine, one reason being that you cannot change deployed code anyway.

4:12 AM - 30 Nov 2018

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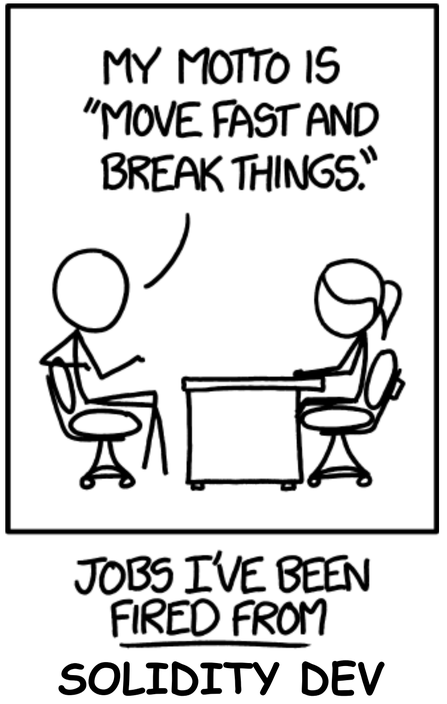


Adapted from https://xkcd.com/1428/

# Upgradable Contracts

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# Backward Compatibility?

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**mo-seph** commented 27 days ago • edited

Compliation fails for `solidity` using recommended install method. I'm on macos 10.13.6, and I've just installed brew to compile solc.

I've run

```
brew update
brew upgrade
brew tap ethereum/ethereum
```

I've tried installing the latest version, also tried 0.4.24. Here's a log with the latest version

**mo-seph** commented 27 days ago • edited

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```
brew update
brew upgrade
brew tap ethereum/ethereum
```

I've tried installing the latest version, also tried 0.4.24. Here's a log with the latest version

**axic** commented 26 days ago — Member

Since it works with 0.5.0, which has been released now, closing this issue.

👍 1 👎 1

**axic** closed this 26 days ago

# They're Proposing a New Intermediate Representation, YUL

```
Block = '{' Statement* '}'
Statement =
    Block |
    FunctionDefinition |
    VariableDeclaration |
    Assignment |
    Expression |
    Switch |
    ForLoop |
    BreakContinue
FunctionDefinition =
    'function' Identifier '(' TypedIdentifierList? ')'
    ( '->' TypedIdentifierList )? Block
VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
Switch =
    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

```
ForLoop =
    'for' Block Expression Block Block
BreakContinue =
    'break' | 'continue'
FunctionCall =
    Identifier '(' ( Expression ( ',' Expression )* )? ')'
Identifier = [a-zA-Z_$] [a-zA-Z_0-9]*
IdentifierList = Identifier ( ',' Identifier)*
TypeName = Identifier | BuiltinTypeName
BuiltinTypeName = 'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
TypedIdentifierList = Identifier ':' TypeName ( ',' Identifier ':' TypeName )*
Literal =
    (NumberLiteral | StringLiteral | HexLiteral | TrueLiteral | FalseLiteral) ':'
TypeName
NumberLiteral = HexNumber | DecimalNumber
HexLiteral = 'hex' ('"' ([0-9a-fA-F]{2})* '"' | '\'' ([0-9a-fA-F]{2})* '\'')
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

# They're Proposing a New Intermediate Representation, YUL

```
Block = '{' Statement* '}'
Statement =
    Block |
    FunctionDefinition |
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    Expression |
    Switch |
    ForLoop |
    BreakContinue
FunctionDefinition =
    'function' Identifier '(' TypedIdentifierList? ')'
    ( '->' TypedIdentifierList )? Block
VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
Switch =
    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

```
ForLoop =
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FunctionCall =
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HexLiteral = 'hex' ('"' ([0-9a-fA-F]{2})* '"' | '\'' ([0-9a-fA-F]{2})* '\'')
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# They're Proposing a New Intermediate Representation, YUL

```
Block = '{' Statement* '}'
Statement =
    Block |
    FunctionDefinition |
    VariableDeclaration |
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    ForLoop |
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VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
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    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

**The "If" production rule is never used!**

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ForLoop =
    'for' Block Expression Block Block
BreakContinue =
    'break' | 'continue'
FunctionCall =
    Identifier '(' ( Expression ( ',' Expression )* )? ')'
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    'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
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TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# They're Proposing a New Intermediate Representation, YUL

```
Block = '{' Statement* '}'
Statement =
    Block |
    FunctionDefinition |
    VariableDeclaration |
    Assignment |
    Expression |
    Switch |
    ForLoop |
    BreakContinue
VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
Switch =
    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

**The "If" production rule is never used!**

**The default switch case isn't followed by a ':'**

```
ForLoop =
    'for' Block Expression Block Block
BreakContinue =
    'break' | 'continue'
FunctionCall =
    Identifier '(' ( Expression ( ',' Expression )* )? ')'
Identifier = [a-zA-Z_$] [a-zA-Z_0-9]*
IdentifierList = Identifier ( ',' Identifier)*
    ier | BuiltinTypeName
    'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
    t = Identifier ':' TypeName ( ',' Identifier ':' TypeName )*
Literal =
    (NumberLiteral | StringLiteral | HexLiteral | TrueLiteral | FalseLiteral) ':'
    hex' ( ([0-9a-fA-F]{2})*  |  ([0-9a-fA-F]{2})*  ')
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# They're Proposing a New Intermediate Representation, YUL

**"switch foo" is a legal production in this grammar**

**The "If" production rule is never used!**

**The default switch case isn't followed by a ':'**

```
Block = '{' Statement* '}'
    FunctionDefinition |
    VariableDeclaration |
    Assignment |
    Expression |
    Switch |
    ForLoop |
    BreakContinue
VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
Switch =
    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

```
    'for' Block Expression Block Block
BreakContinue =
    'break' | 'continue'
FunctionCall =
    Identifier '(' ( Expression ( ',' Expression )* )? ')'
Identifier = [a-zA-Z_$] [a-zA-Z_0-9]*
IdentifierList = Identifier ( ',' Identifier)*
    ier | BuiltinTypeName
    'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
    t = Identifier ':' TypeName ( ',' Identifier ':' TypeName )*
Literal =
    (NumberLiteral | StringLiteral | HexLiteral | TrueLiteral | FalseLiteral) ':'
    ([0-9a-fA-F]{2})*  |  \'  ([0-9a-fA-F]{2})*  \' )
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# They're Proposing a New Intermediate Representation, YUL

**"switch foo" is a legal production in this grammar**

**StringLiteral can't be represented without casting**

**The "If" production rule is never used!**

**The default switch case isn't followed by a ':'**

```
Block = '{' Statement* '}'
    FunctionDefinition |
    VariableDeclaration |
    Assignment |
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    Switch |
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VariableDeclaration =
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```
    'for' Block Expression Block Block
BreakContinue =
Identifier = [a-zA-Z_$] [a-zA-Z_0-9]*
IdentifierList = Identifier ( ',' Identifier)*
ier | BuiltinTypeName
'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
t = Identifier ':' TypeName ( ',' Identifier ':' TypeName )*
Literal =
    (NumberLiteral | StringLiteral | HexLiteral | TrueLiteral | FalseLiteral) ':'
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# They're Proposing a New ermediate Representation, Y

EVM::SSA

SlithIR

**"su is a legal production in this grammar**

**StringLiteral can't be represented without casting**

**The "If" production rule is never used!**

**The default switch case isn't followed by a ':'**

```
Block = '
    ion |
    ration |
    |
    on |
    |
    Loop |
    BreakContinue

VariableDeclaration =
    'let' TypedIdentifierList ( ':=' Expression )?
Assignment =
    IdentifierList ':=' Expression
Expression =
    FunctionCall | Identifier | Literal
If =
    'if' Expression Block
Switch =
    'switch' Expression Case* ( 'default' Block )?
Case =
    'case' Literal Block
```

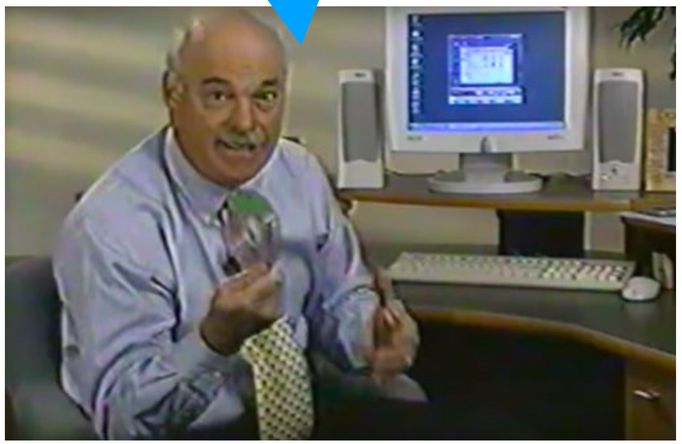
```
    'for' Block Expression Block Block
BreakContinue =

Identifier = [a-zA-Z_$] [a-zA-Z_0-9]*
IdentifierList = Identifier ( ',' Identifier)*
    ier | BuiltinTypeName
    'bool' | [us] ( '8' | '32' | '64' | '128' | '256' )
    t = Identifier ':' TypeName ( ',' Identifier ':' TypeName )*
Literal =
    (NumberLiteral | StringLiteral | HexLiteral | TrueLiteral | FalseLiteral) ':'
HexLiteral = 'hex' ('"' ([0-9a-fA-F]{2})* '"' | '\'' ([0-9a-fA-F]{2})* '\'')
StringLiteral = '"' ([^"\r\n\\] | '\\' .)* '"'
TrueLiteral = 'true'
FalseLiteral = 'false'
HexNumber = '0x' [0-9a-fA-F]+
DecimalNumber = [0-9]+
```

All of this has happened before ... and will happen again.

# What can be done?

# What can be done?

`https://github.com/trailofbits/...`




TRAIL OF BITS

# What can be done?

`https://github.com/trailofbits/...`

**Manticore** Symbolic Execution


TRAIL OF BITS

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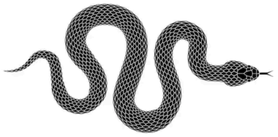
**Manticore** Symbolic Execution



**Slither** Static Analysis


TRAIL OF BITS

# What can be done?

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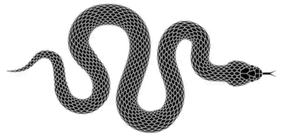
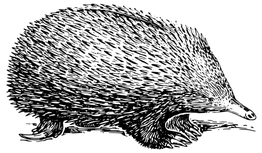
**Manticore** Symbolic Execution



**Slither** Static Analysis



**Echidna** Property Based Fuzzer


TRAIL OF BITS

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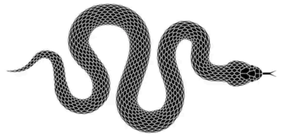
**Manticore** Symbolic Execution



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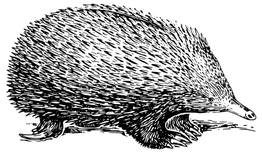

**Echidna** Property Based Fuzzer

**Rattle** EVM to SSA Lifter


TRAIL OF BITS

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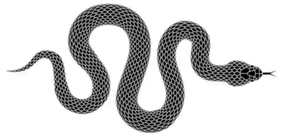
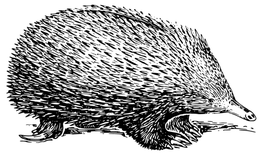


**Slither** Static Analysis



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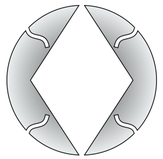

**Etheno** Test Framework Integration

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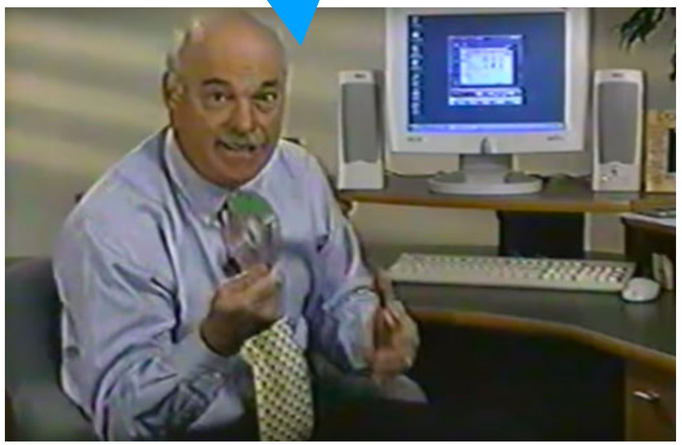

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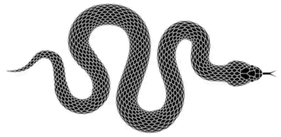

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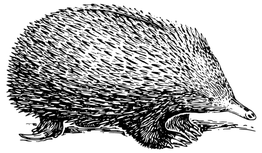

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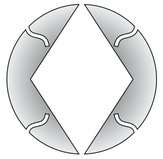
**Rattle** EVM to SSA Lifter



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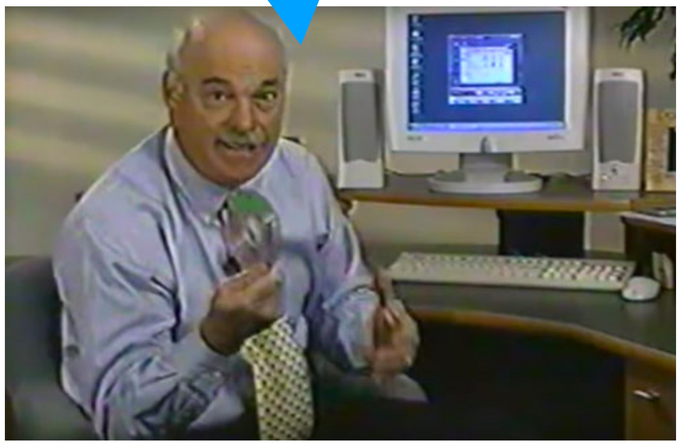

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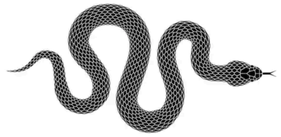

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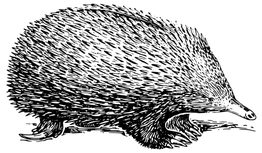

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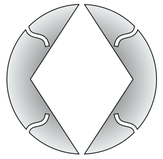

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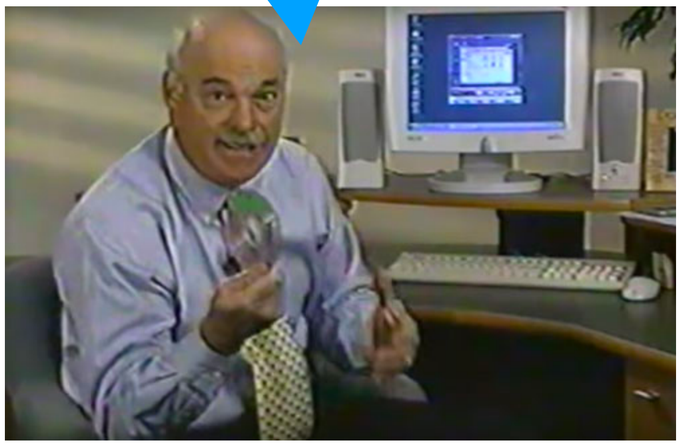
VM Reference



**blockchain-security-contacts**
it's surprisingly hard to disclose bugs

**not-so-smart-contracts**
common vulnerability database

**awesome-ethereum-security**
security best practices

# Thanks!

@ESultanik

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@ESultanik

# Acknowledgements


| | |
|---|---|
| Ryan Stortz | `@withzombies` |
| Jay Little | `@computerality` |
| Josselin Feist | `@montyly` |
| Stefan Edwards | `@lojikil` |
| JP | `@japesinator` |

*Et pl. al.*