Solidity Contracts :

- Function Overloading

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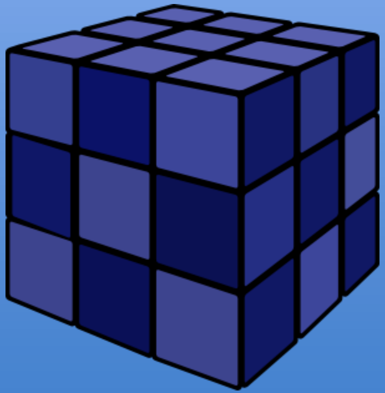
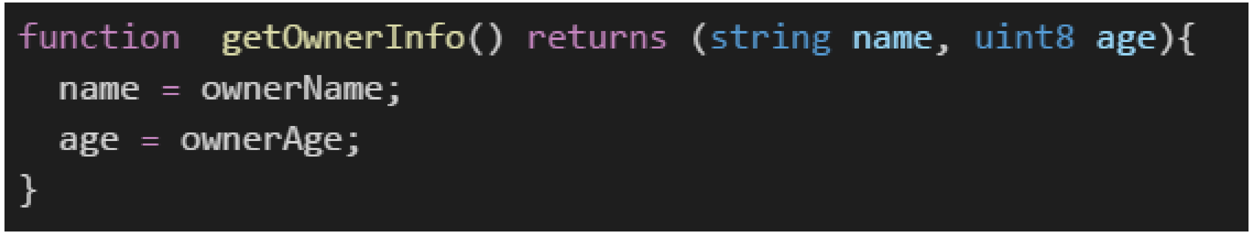
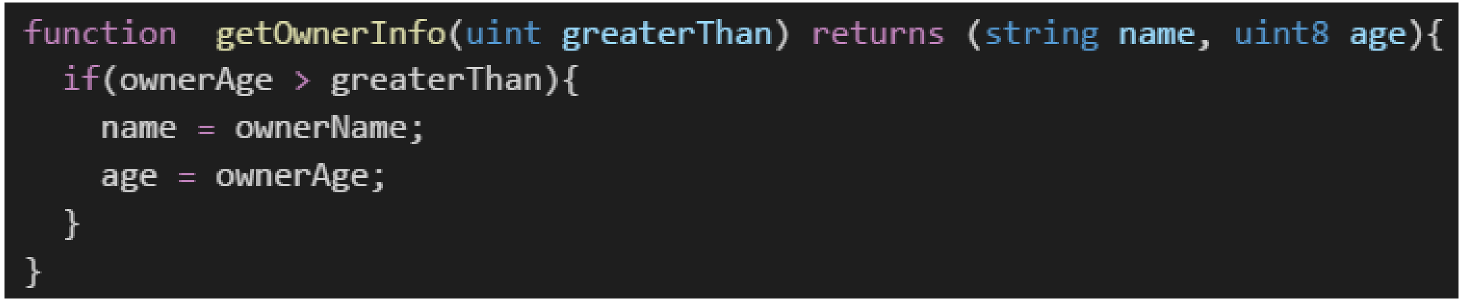


Function Overloading

- Functions with same name but different input parameters



```
function  getOwnerInfo() returns (string name, uint8 age){
  name = ownerName;
  age = ownerAge;
}
```



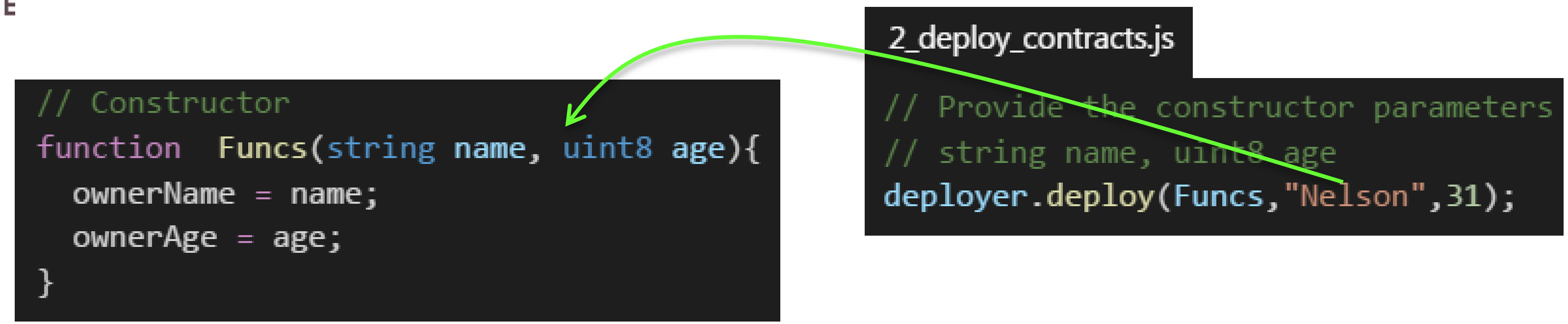
```
function  getOwnerInfo(uint greaterThan) returns (string name, uint8 age){
  if(ownerAge > greaterThan){
    name = ownerName;
    age = ownerAge;
  }
}
```

Constructor

- Constructor function name = Name of the contract
- Only <u>ONE</u> constructor allowed

TRUFFLE

➢ To pass parameters to the constructor



```
// Constructor
function  Funcs(string name, uint8 age){
  ownerName = name;
  ownerAge = age;
}
```

2_deploy_contracts.js

```
// Provide the constructor parameters
// string name, uint8 age
deployer.deploy(Funcs,"Nelson",31);
```

Functions Summary

- Functions:
  - May return multiple values
  - Supports return variables
  - Arg names may be skipped
  - Overloading supported
  - Variable scope is function not the block
- Only one constructor allowed
- Tuple is an ordered list of values
  - Declared using keyword **var**
  - Object type need not be specified

Solidity Contracts :

- Complex Datatypes

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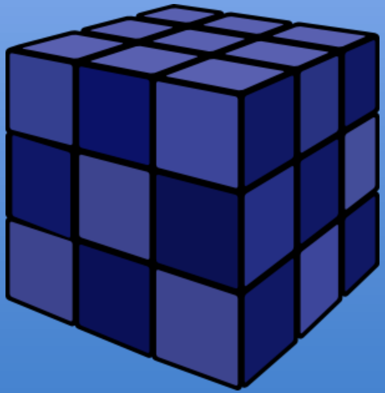
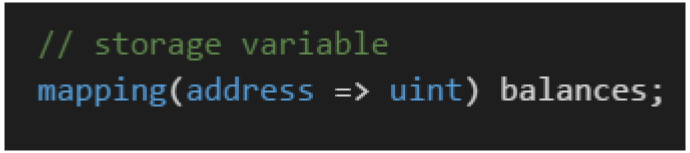


Mapping Type

- *Hashtable* like structure

- Allowed only as storage or state variable



```
// storage variable
mapping(address => uint) balances;
```

- Key can be any type except mapping

  - Value type can be Mapping

Mappings Vs Hashtable

Mapping	Hashtable
Value exists for all keys (0x0, 0 ..)	Missing key indicated by undefined/null
keccak256(Key data) hash is stored	Key data is stored
By default NOT iterable	Get all keys and iterate through values
No concept of length	Length can be determined

Enums

- Creates custom types with finite set of values

```
enum  TransferType  {Domestic, Foreign}          // No semicolon
```

- Not part of the ABI definition

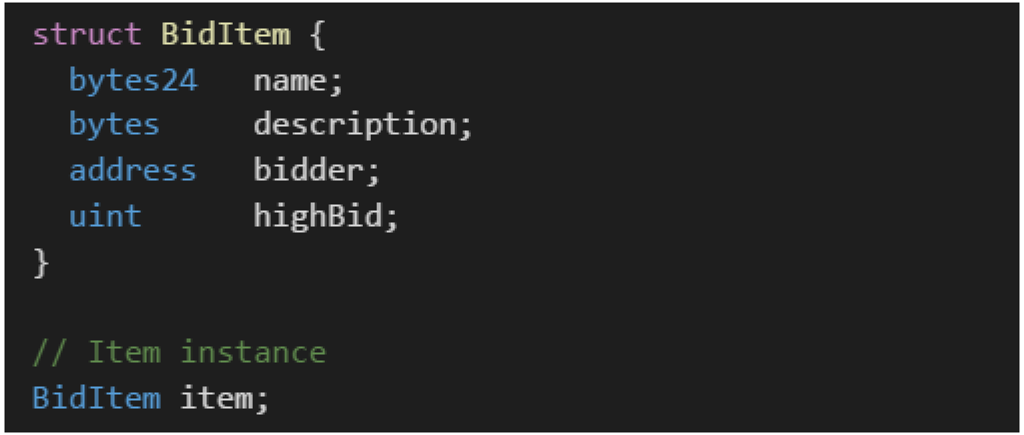
- Explicit conversion to/from all integer types

```
uint8    x = TransferType.Domestic;          // Compiler error

uint8    x = uint8(TransferType.Domestic);   // Will work
```

Struct

- Declared using the keyword struct

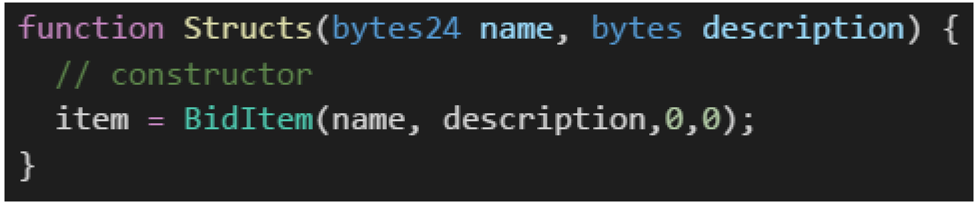


```
struct BidItem {
  bytes24   name;
  bytes     description;
  address   bidder;
  uint      highBid;
}

// Item instance
BidItem item;
```

- Cannot have member of its own type
- Can be contained in arrays and mappings

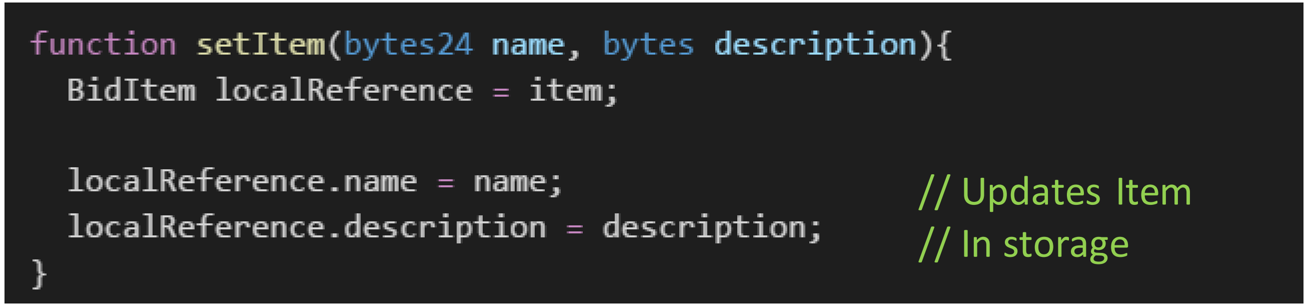
References



```
function Structs(bytes24 name, bytes description) {
  // constructor
  item = BidItem(name, description,0,0);
}
```

// Copies to storage

- Local reference to the structure instance in storage



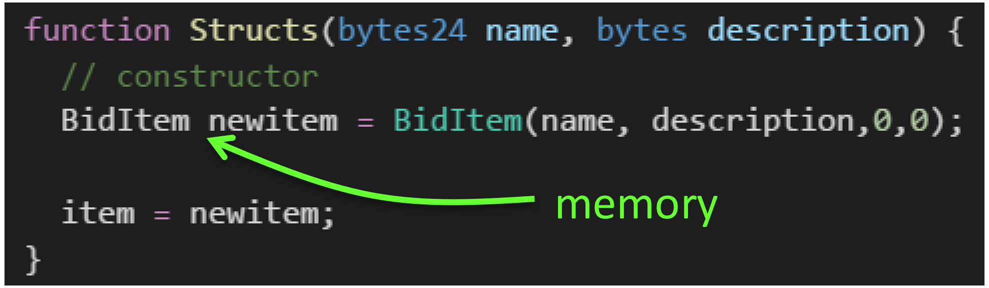
```
function setItem(bytes24 name, bytes description){
  BidItem localReference = item;

  localReference.name = name;
  localReference.description = description;
}
```

// Updates Item
// In storage

Memory variables

- Default for struct type local variable is *Storage* type



```
function Structs(bytes24 name, bytes description) {
  // constructor
  BidItem newitem = BidItem(name, description,0,0);

  item = newitem;
}
```

// Compilation error

Mapping, Enum, Struct

- Mapping is like a Hashtable | Associative array
    - Does NOT Provide length function/attribute & a way to iterate
    - Returns 0, empty string for non existent keys
- Enum are not part of the public interface
    - Explicitly converted to/from integers
- Struct are not part of the public interface
    - Cannot contain member of its own type

Solidity Contracts :

- Object orientation

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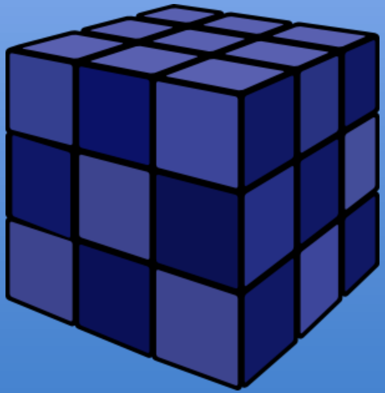
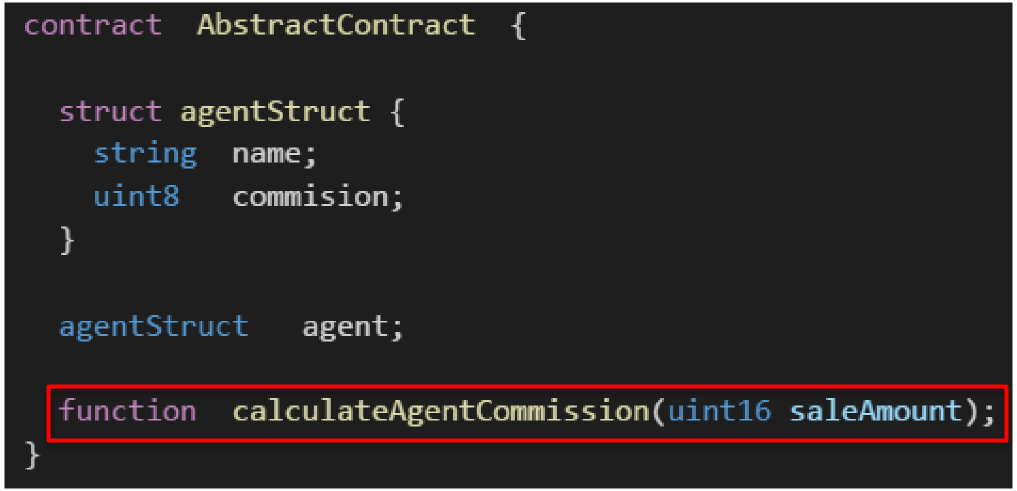


Inheritance >> Abstract Contract

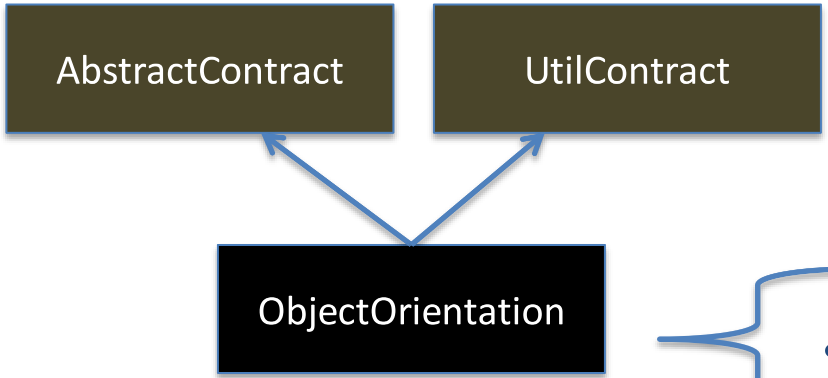
- NO keyword for abstract contracts
  - Functions declared but no body provided



```
contract  AbstractContract  {

  struct agentStruct {
    string  name;
    uint8   commision;
  }

  agentStruct   agent;

  function  calculateAgentCommission(uint16 saleAmount);
}
```

- Derived class that does not implement functions, itself abstract

Inheritance >> Multiple Inheritance

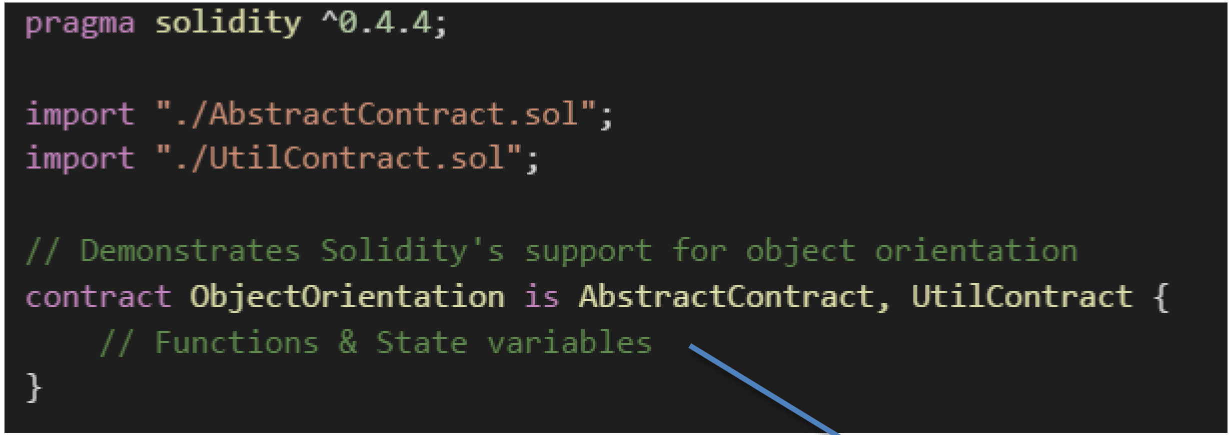


- Only a single contract created
- By copying
- Name collision lead to errors

- The base & derived class can be in the same file or in multiple files

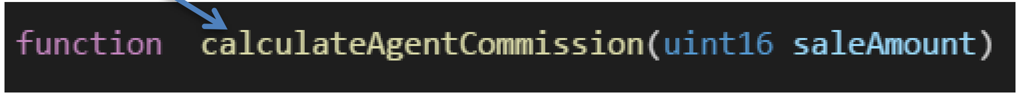
Inheritance >> Multiple Inheritance

- Inheritance relation created using the keyword **is**



```
pragma solidity ^0.4.4;

import "./AbstractContract.sol";
import "./UtilContract.sol";

// Demonstrates Solidity's support for object orientation
contract ObjectOrientation is AbstractContract, UtilContract {
    // Functions & State variables
}
```

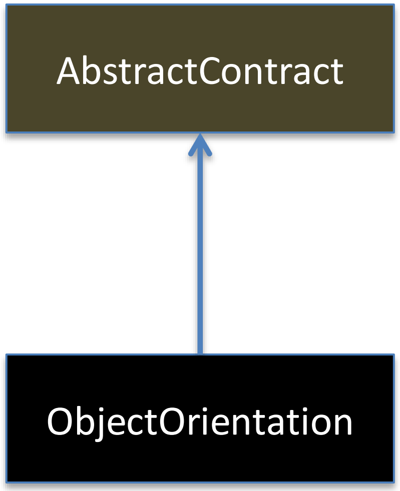
  - To be deployable: Implement

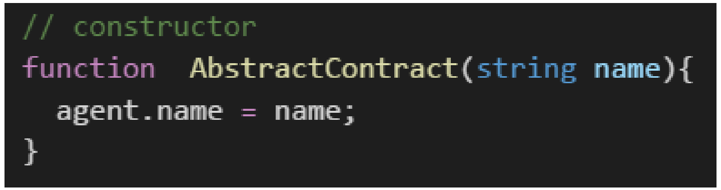


```
function  calculateAgentCommission(uint16 saleAmount)
```

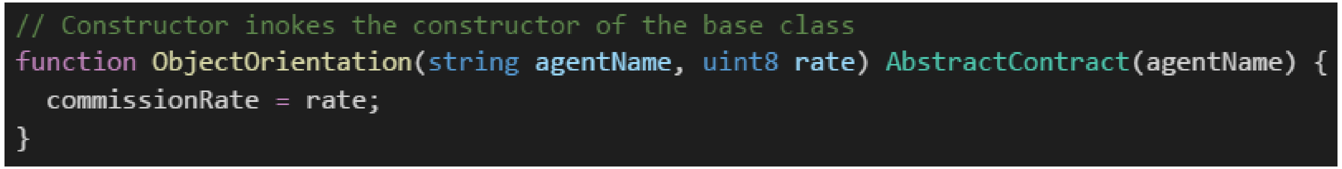
Inheritance >> Base Constructor

- Derived contract constructor need to provide the arguments for all the base contracts



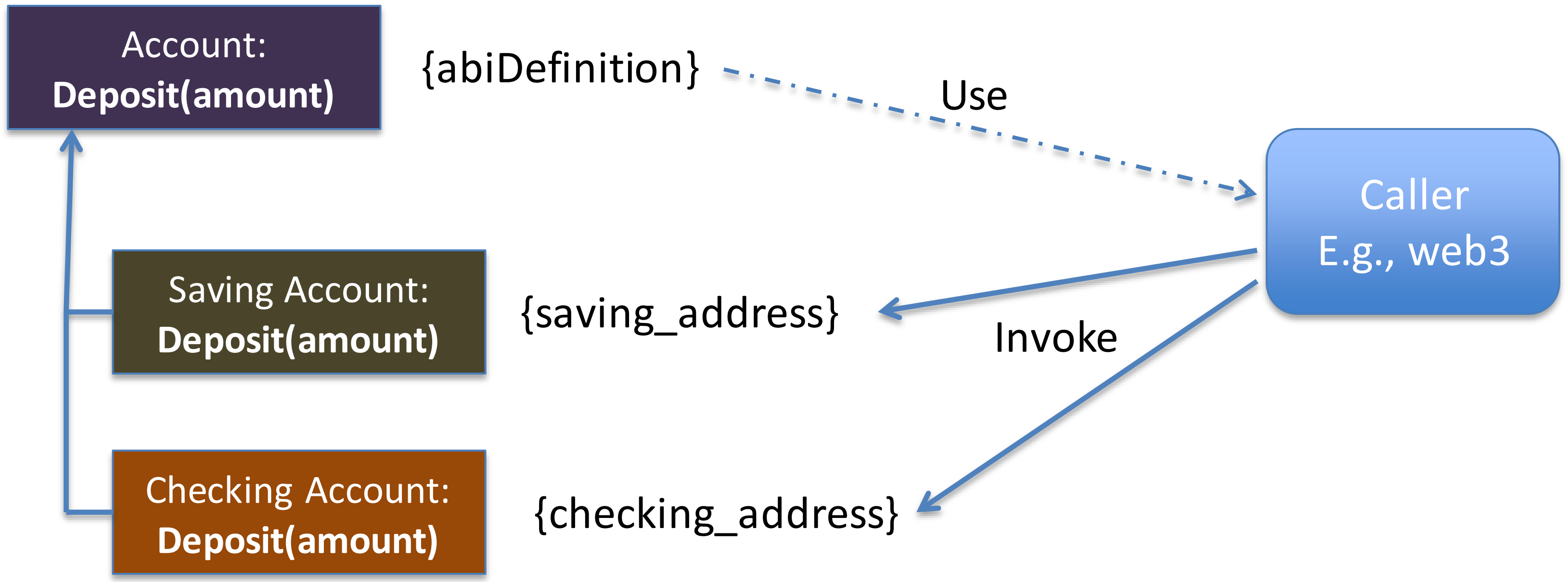


```
// constructor
function  AbstractContract(string name){
  agent.name = name;
}
```



```
// Constructor inokes the constructor of the base class
function ObjectOrientation(string agentName, uint8 rate) AbstractContract(agentName) {
  commissionRate = rate;
}
```

Polymorphism



Object Orientation

- Solidity supports function overloading
  - No constructor overloading
- Supports multiple inheritance by way of copying
  - Inheritance relation created using the **is** keyword
  - No keyword for abstract contracts
- Supports polymorphism

Solidity Contracts :

- Function visibility

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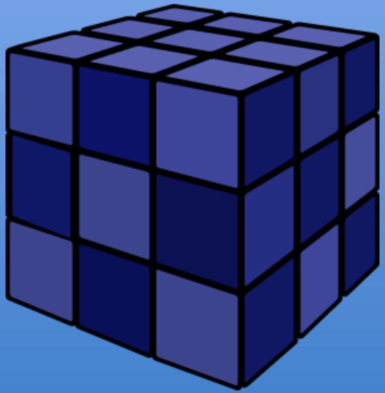


Visibility Overview

public

private

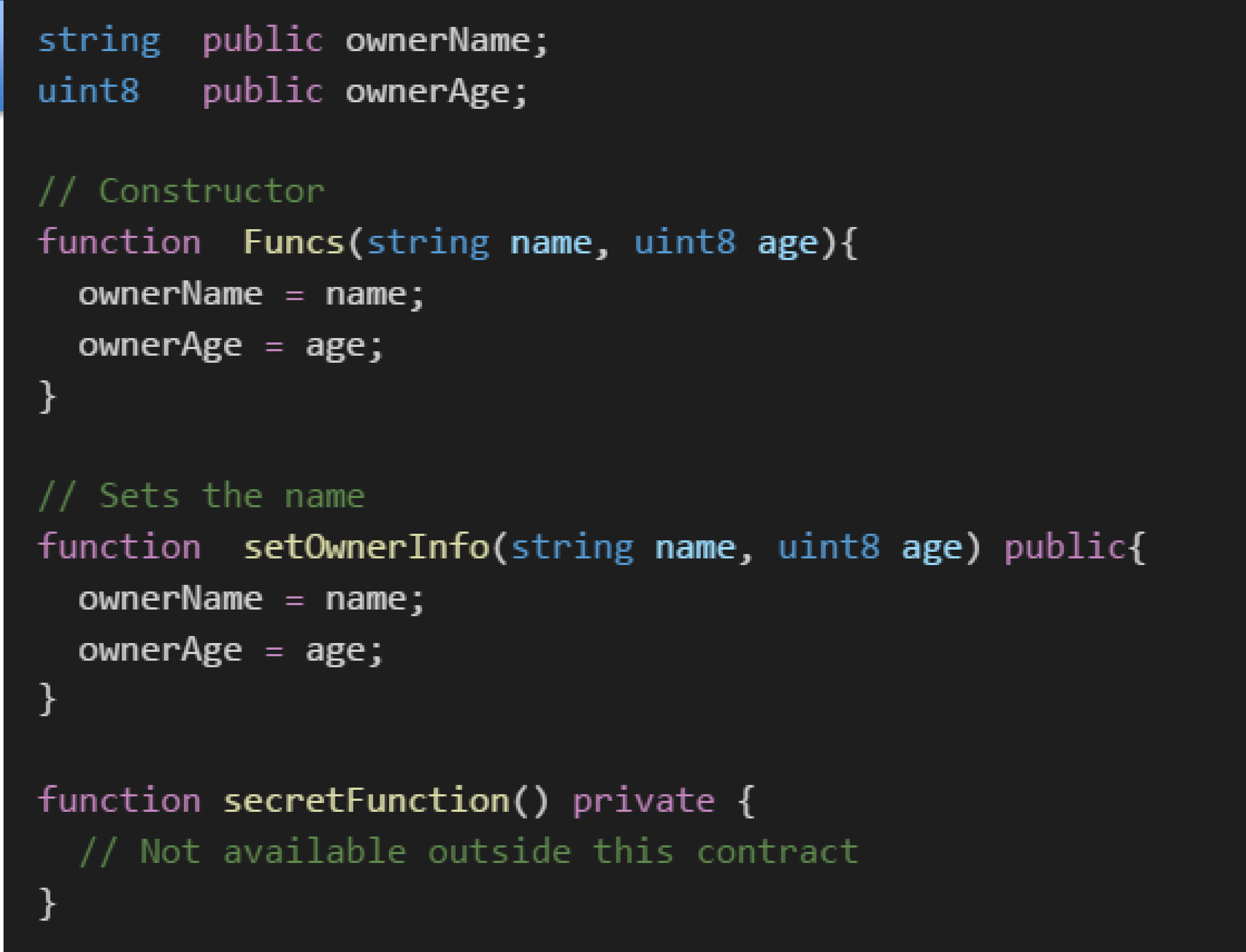
internal

external

Does not apply to storage variables

- Functions can be called from other contracts in a transaction a.k.a. message calls

Public & Private



```
string  public ownerName;
uint8   public ownerAge;

// Constructor
function  Funcs(string name, uint8 age){
  ownerName = name;
  ownerAge = age;
}

// Sets the name
function  setOwnerInfo(string name, uint8 age) public{
  ownerName = name;
  ownerAge = age;
}

function secretFunction() private {
  // Not available outside this contract
}
```

public

Default for functions

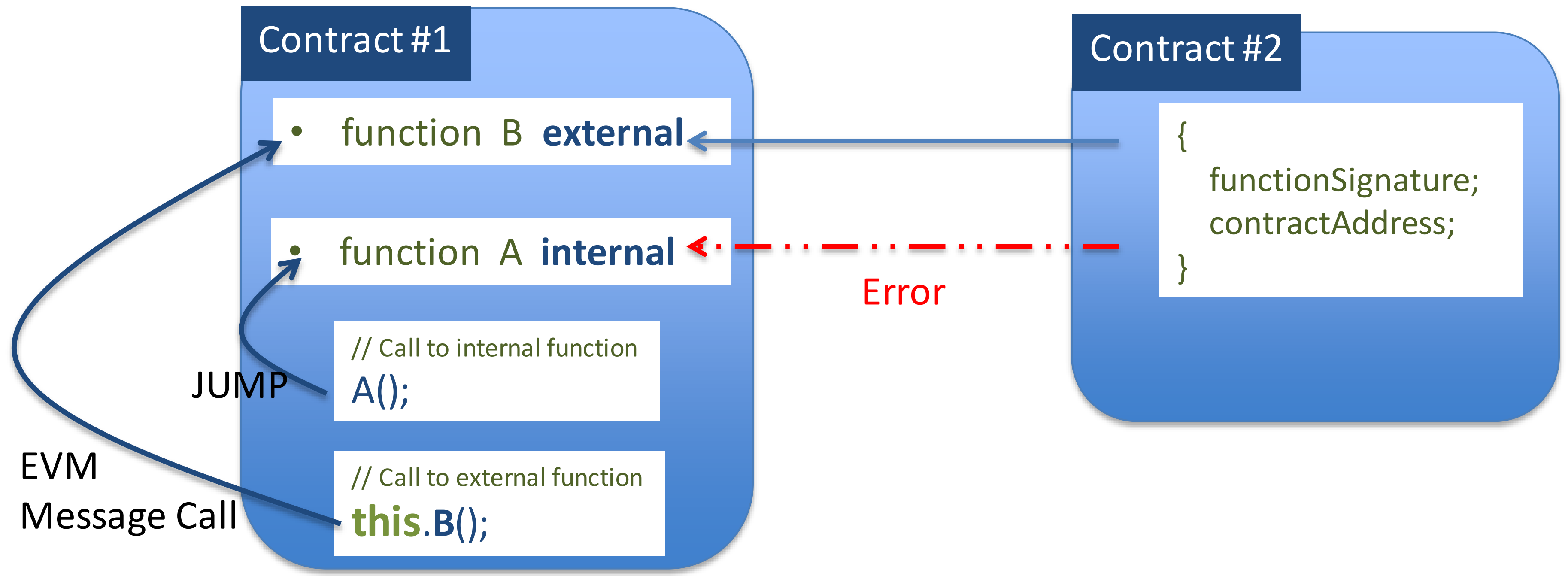
- Part of contract interface
  {abi Definition}
- Automatic *Getter* for state variable
- public Function calls:

  Internal   External

private

- Available within the contract only
- Not available even in derived contract

Internal/External Calls



internal

Default for storage variables

- NOT Part of contract interface i.e., *{abi Definition}*
- Function can be invoked from within the contract
- An internal variable/function is available in derived code

external

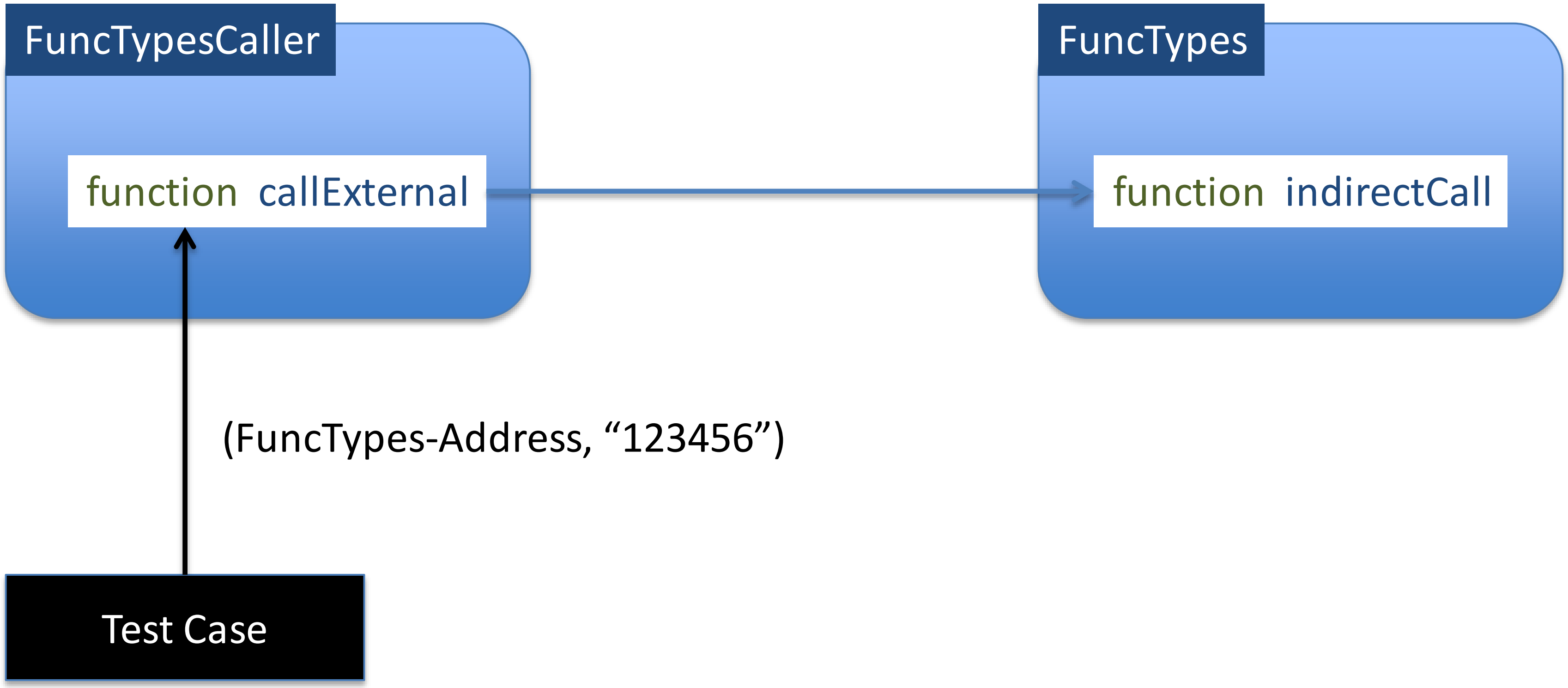
- NOT applicable to storage variables
- Cannot be invoked from within the contract as a regular function
- Need to use keyword **this.**

Function Type Variables

- Like other variable types
  - Can be a assigned a function
  - Received as parameter
  - Returned from functions

```
function( <parameter list> )  { internal | external }
                              [constant]
                              [payable]
                              returns ( <return types> )
```

Calling external function



Solidity Contracts :

- Datatype conversion
- Global variables
- Global functions

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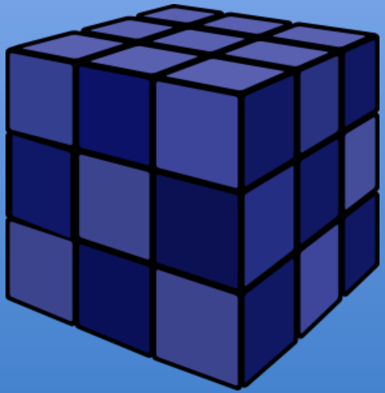


Ether units

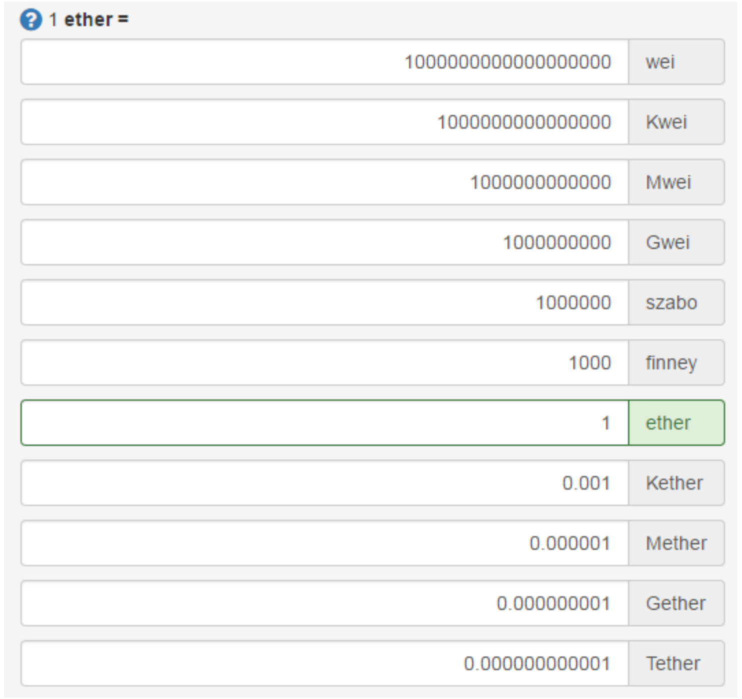
- Conversion by suffixing literal with the *Ether* sub-denomination

wei default

ether finney szabo

```
// True
flag = (1 wei == 0.000000000000000001 ether);

// True
uint amount = 10 ether;
flag = (amount*2 == 20000 finney);
```



1 ether =

1000000000000000000	wei
1000000000000000	Kwei
1000000000000	Mwei
1000000000	Gwei
1000000	szabo
1000	finney
1	ether
0.001	Kether
0.000001	Mether
0.000000001	Gether
0.000000000001	Tether

http://ether.fund/tool/converter

Time

now

- Returns block time in seconds (from 1970)

- Conversion by suffixing literal with the *time* units

seconds default

minutes

hours

days

weeks

years

block

- Current block information

.number

.coinbase

.timestamp

.difficulty

.gaslimit

.blockhash(uint blkNum) returns (bytes32)

Hashes of most recent 256 blocks

Excludes current

msg

.data	• Call data in *bytes*
.sender	• Caller’s *address*
.sig	• Function identifier i.e., first 4 *bytes* of call data
.value	• Number of *wei* sent in the message • Available only in functions that are *payable*

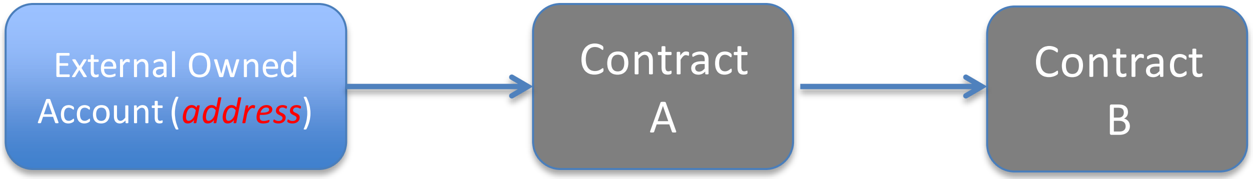
tx

.gasprice

- Gas price for the transaction

.origin

- Address that originated transaction
- DO NOT use this for future compatibility reasons*



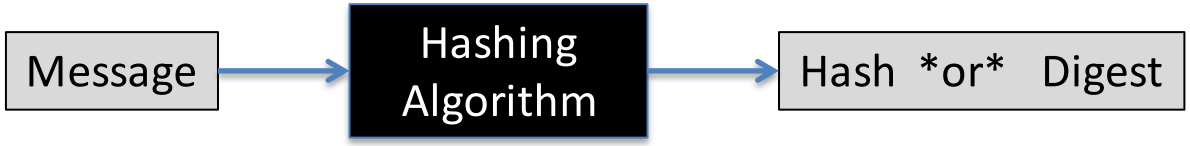
msg.sender = address
tx.origin = address

msg.sender = Address of contract A
tx.origin = address

[* http://ethereum.stackexchange.com/questions/196/how-do-i-make-my-dapp-serenity-proof?noredirect=1&lq=1](http://ethereum.stackexchange.com/questions/196/how-do-i-make-my-dapp-serenity-proof?noredirect=1&lq=1)

Cryptography Hash Functions

- Special types of hash functions



- **Deterministic** : message hash is always the same for the same message
- **Quick**: to compute the hash
- **Infeasible**: to recreate the message from hash
- **Any change**: to message will change the hash
- **Collision resistant**: different messages will never get the same hash

Crypto Functions

- Takes multiple **bytes** parameters and produces **bytes32**

keccak256(…)

sha3(…)

- Alias to **keccak256(…)**

sha256(…)

- Takes multiple **bytes** parameters and produces **bytes20**

ripemd160(…)

Solidity Contracts :

- Exceptions

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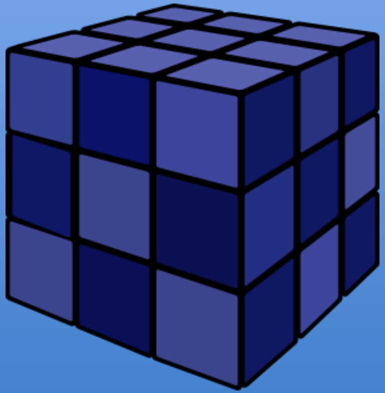


throw;

DEPRECATED
Use require() or revert()

- Aborts the transaction execution
  - All state changes are reverted
  - No ethers are sent out
  - Ethers received in transaction returned
  - Gas is spent i.e., there is a cost
  - Transaction is recorded on the chain; nonce is valid & recorded
  - No catch

revert()

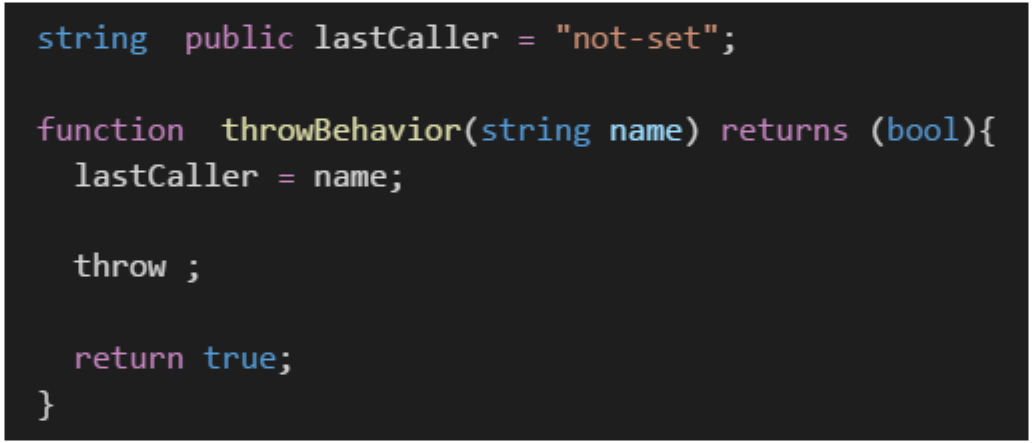
- Behaves like throw;
  - *throw*; uses up all of the gas
  - *revert()* refunds the unused gas

Throw; is deprecated....start using revert()

August 2017

assert(condition)

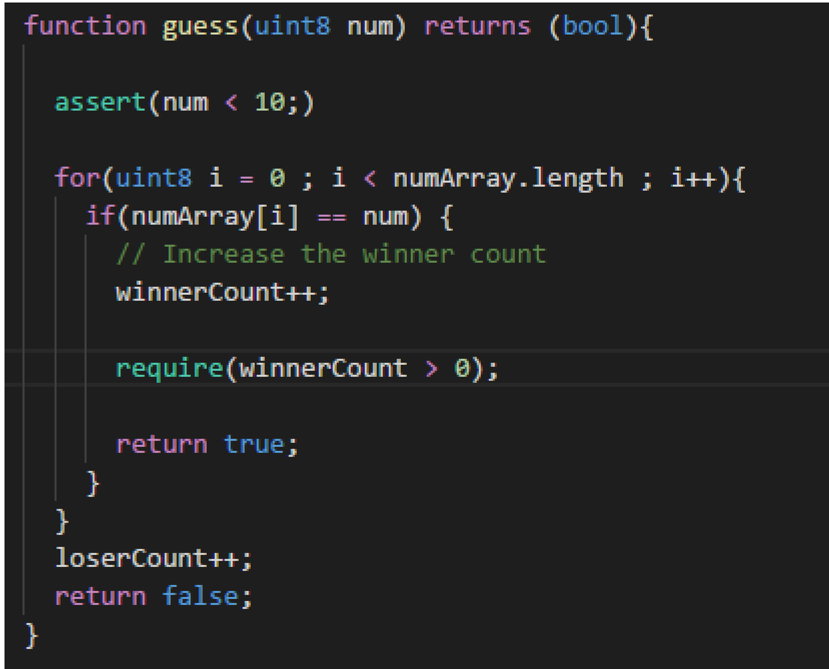
- Throws if condition is NOT met



```
string  public lastCaller = "not-set";

function  throwBehavior(string name) returns (bool){
  lastCaller = name;

  throw ;

  return true;
}
```

require(condition)

- Like assert it throws an exception
    - assert() & require() are style exception



```
function guess(uint8 num) returns (bool){

  assert(num < 10;)

  for(uint8 i = 0 ; i < numArray.length ; i++){
    if(numArray[i] == num) {
      // Increase the winner count
      winnerCount++;

      require(winnerCount > 0);

      return true;
    }
  }
  loserCount++;
  return false;
}
```

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Solidity Contracts :

- Constant Functions | Variables
- Fallback functions
- Payable functions

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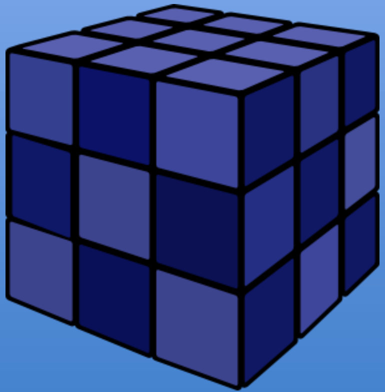
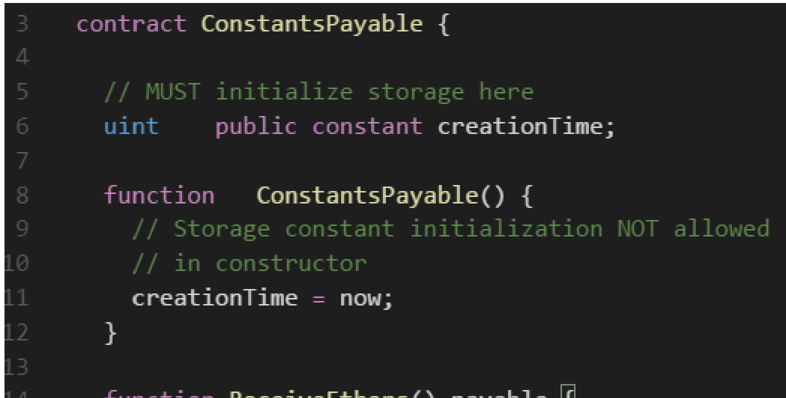


Constant Variable

- **Constant** variable MUST be initialized at compile time
  - No storage allocated by compiler; copies the literal for references
  - Built in functions may be called e.g., *keccak256(..)*
  - Unlike JAVA initialization in constructor NOT allowed

Compiler error >>>

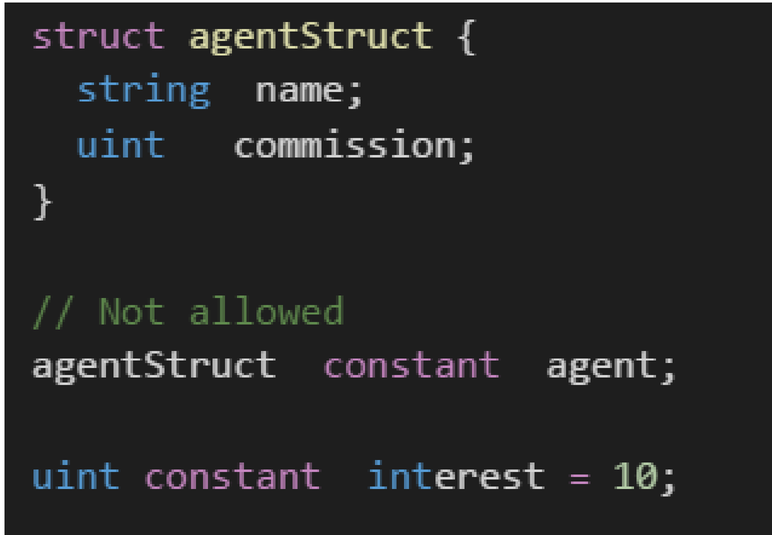


```
contract ConstantsPayable {

  // MUST initialize storage here
  uint    public constant creationTime;

  function   ConstantsPayable() {
    // Storage constant initialization NOT allowed
    // in constructor
    creationTime = now;
  }

  function ReceiveEthers() payable {
```

Constant Variable

- Not allowed for function variables
- Allowed for value types & string

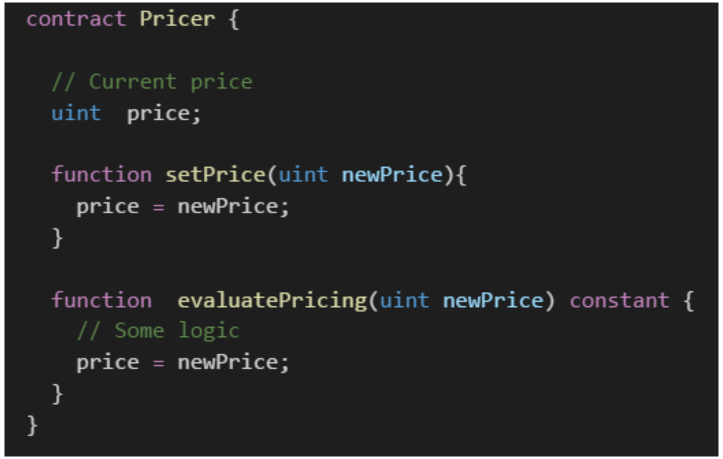
Compiler error >>>



```
struct agentStruct {
  string  name;
  uint    commission;
}

// Not allowed
agentStruct  constant  agent;

uint constant  interest = 10;
```

Constant Functions

- **Constant** functions Promises not to change state of the contract



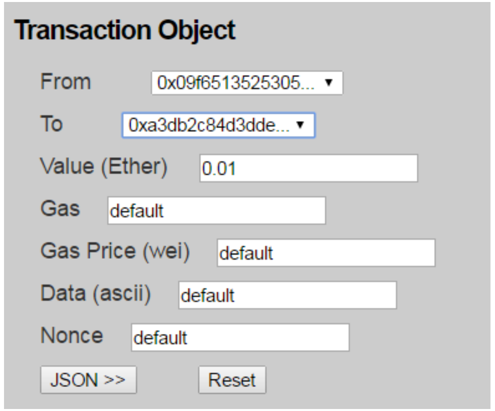
```
contract Pricer {

  // Current price
  uint  price;

  function setPrice(uint newPrice){
    price = newPrice;
  }

  function  evaluatePricing(uint newPrice) constant {
    // Some logic
    price = newPrice;
  }
}
```

<<< Not enforced by compiler

Fallback Function

- An un-named function in the contract
  - Invoked without the data i.e., the function signature
  - Restrictions:
    - No arguments
    - Cannot return anything
    - Maximum gas spend = 2300 gas

Receiving Ethers



Transaction Object

From	0x09f6513525305... ▾
To	0xa3db2c84d3dde... ▾
Value (Ether)	0.01
Gas	default
Gas Price (wei)	default
Data (ascii)	default
Nonce	default

- A Contract like EOA can receive Ethers
- A Function invocation can receive Ethers

Receiving Ethers

Contract

- Contract can receive ethers by way of *payable* fallback function
- Invoked when ethers are received (msg.value) without data
  - Exceeding the gas if tries to update storage or call a function

Throws exception

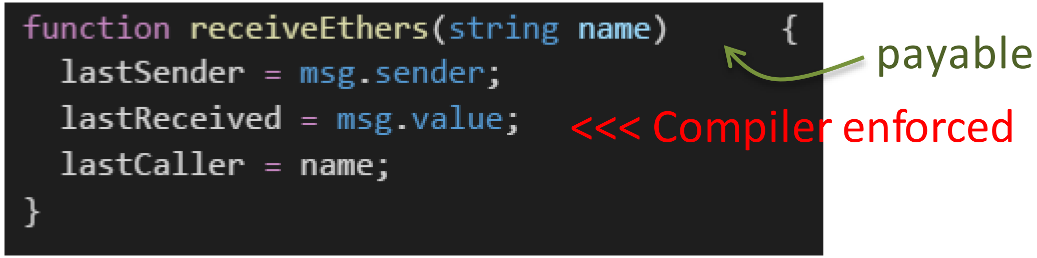
Sends back the ethers

Best Practice: Just log an event in the fallback function

Receiving Ethers

Function

- A function MUST be marked *payable* to receive ethers
  - Amount sent available in msg.value



```
function receiveEthers(string name)        {
  lastSender = msg.sender;
  lastReceived = msg.value;
  lastCaller = name;
}
```

- Unlike fallback function, NO restriction on gas usage
- Ethers held in the contract

Solidity Contracts :

- Function modifiers

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This deck is part of a online course on "Ethereum: Design and Development of Decentralized Apps.

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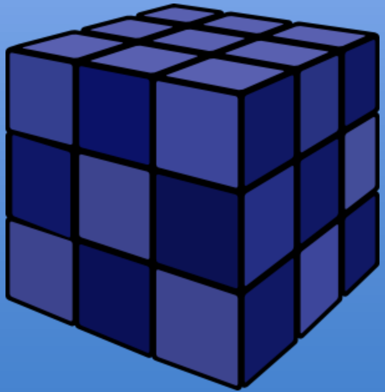


Modifiers?

- Changes the behavior of a function

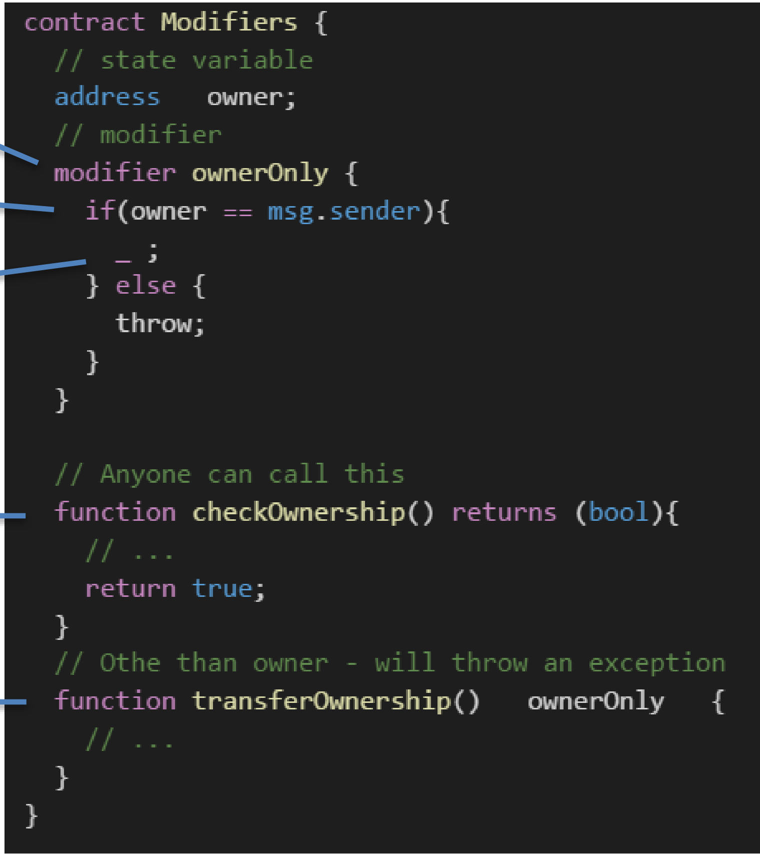
Defines a modifier

Condition executed before function body

Function body

Anyone can execute
Modifier not applied

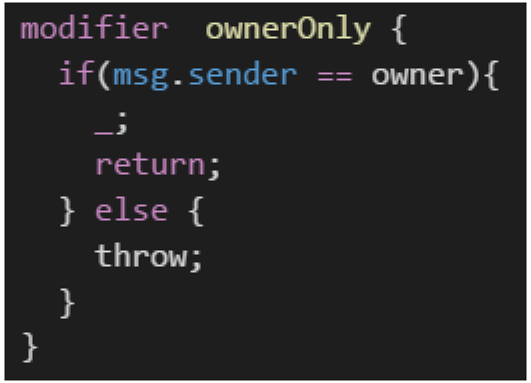
Only owner can execute



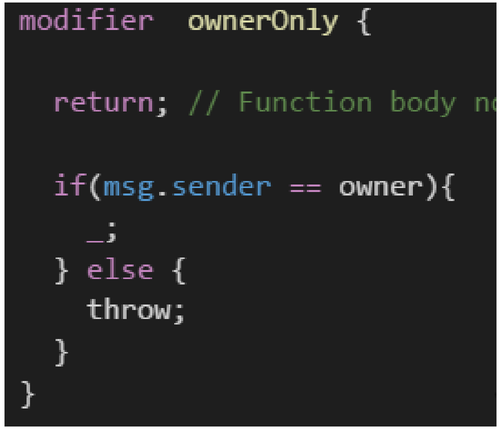
```
contract Modifiers {
  // state variable
  address   owner;
  // modifier
  modifier ownerOnly {
    if(owner == msg.sender){
      _ ;
    } else {
      throw;
    }
  }

  // Anyone can call this
  function checkOwnership() returns (bool){
    // ...
    return true;
  }
  // Othe than owner - will throw an exception
  function transferOwnership()   ownerOnly   {
    // ...
  }
}
```

Return Vs Throw

- A revert() (earlier throw) in modifier halts the execution
- A return in modifier returns from modifier body



```
modifier  ownerOnly {
  if(msg.sender == owner){
    _;
    return;
  } else {
    throw;
  }
}
```

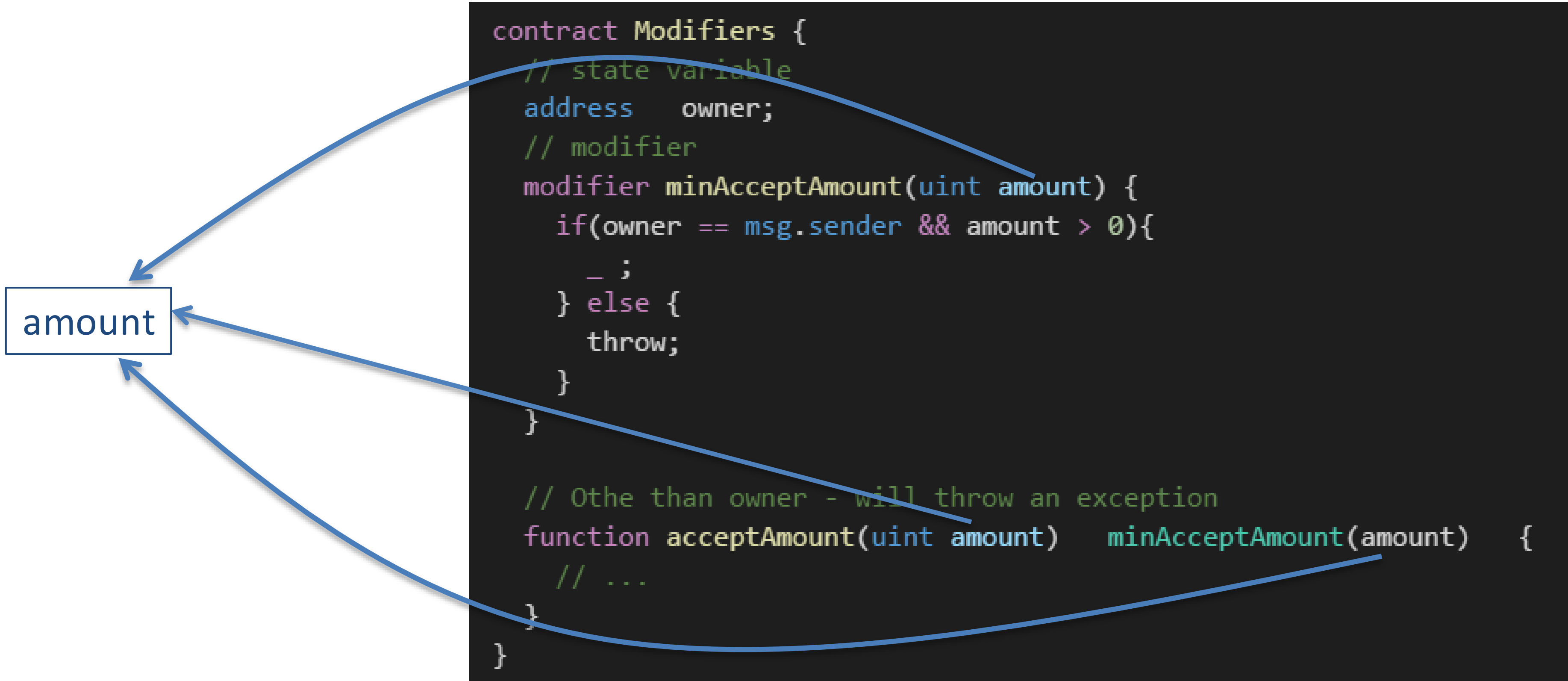


```
modifier  ownerOnly {

  return; // Function body no

  if(msg.sender == owner){
    _;
  } else {
    throw;
  }
}
```

- Function not executed

Arguments

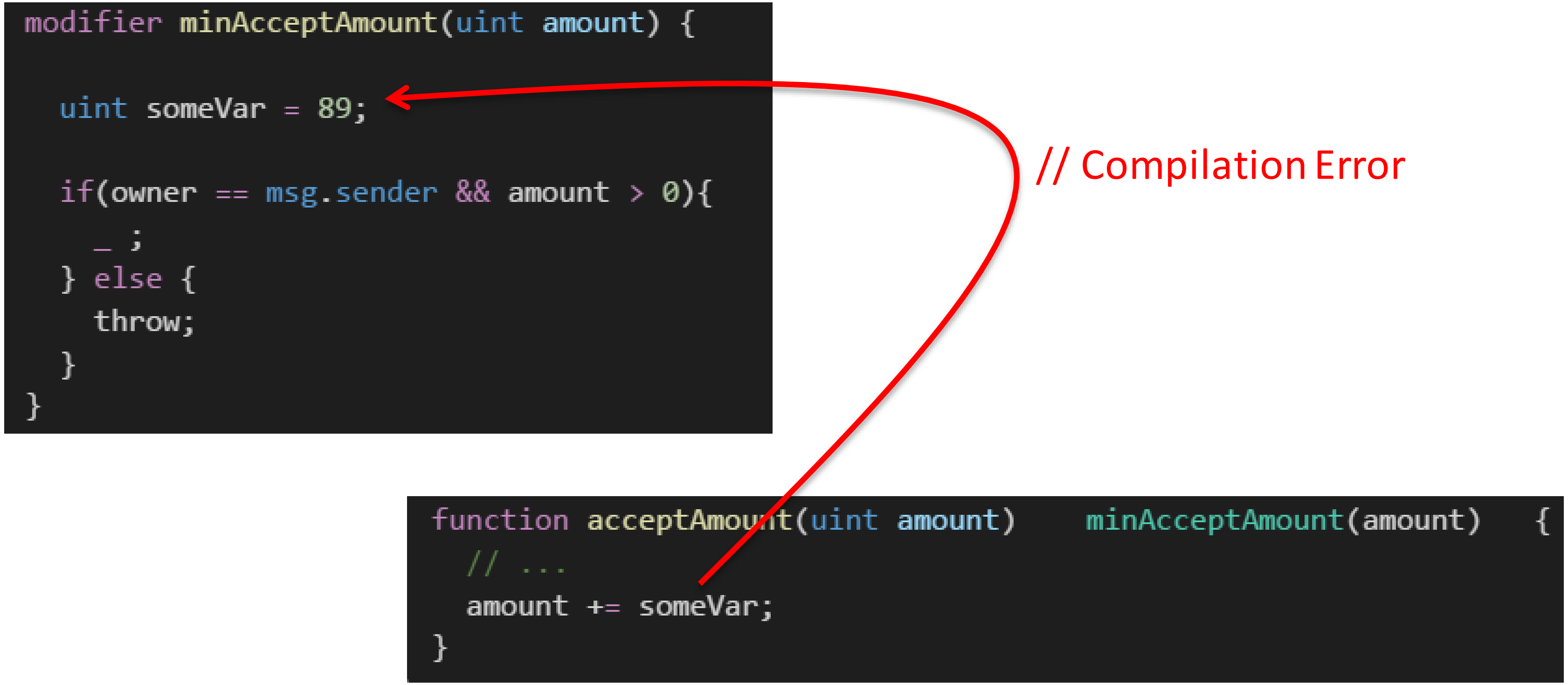
- Modifiers can take arguments



```
contract Modifiers {
  // state variable
  address   owner;
  // modifier
  modifier minAcceptAmount(uint amount) {
    if(owner == msg.sender && amount > 0){
      _ ;
    } else {
      throw;
    }
  }

  // Othe than owner - will throw an exception
  function acceptAmount(uint amount)   minAcceptAmount(amount)   {
    // ...
  }
}
```

Local Variables

- Local variables from within modifiers NOT available in functions

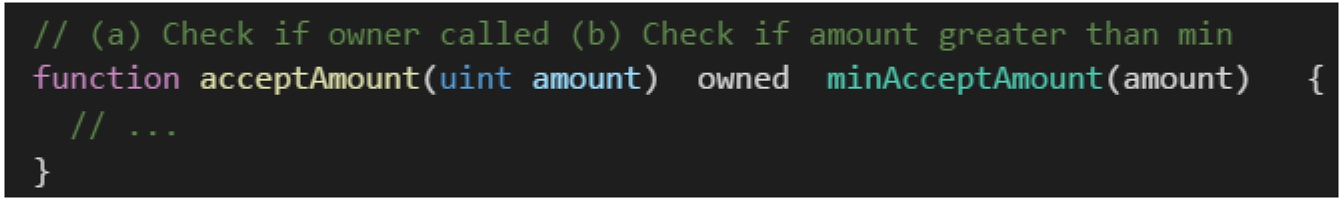


```
modifier minAcceptAmount(uint amount) {

  uint someVar = 89;

  if(owner == msg.sender && amount > 0){
    _ ;
  } else {
    throw;
  }
}
```

```
function acceptAmount(uint amount)   minAcceptAmount(amount)   {
  // ...
  amount += someVar;
}
```

Applying Modifiers

- Multiple modifiers may be applied to functions
  - Order is important



```
// (a) Check if owner called (b) Check if amount greater than min
function acceptAmount(uint amount)  owned  minAcceptAmount(amount)   {
  // ...
}
```

- Inheritable & may be overridden by child contract

Solidity Contracts :

- Events
- Logs

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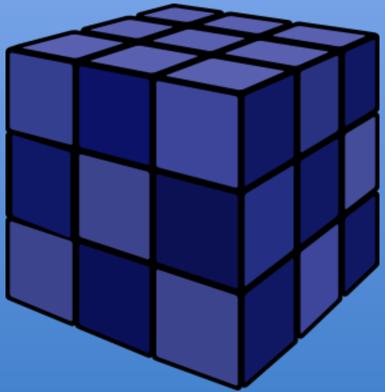
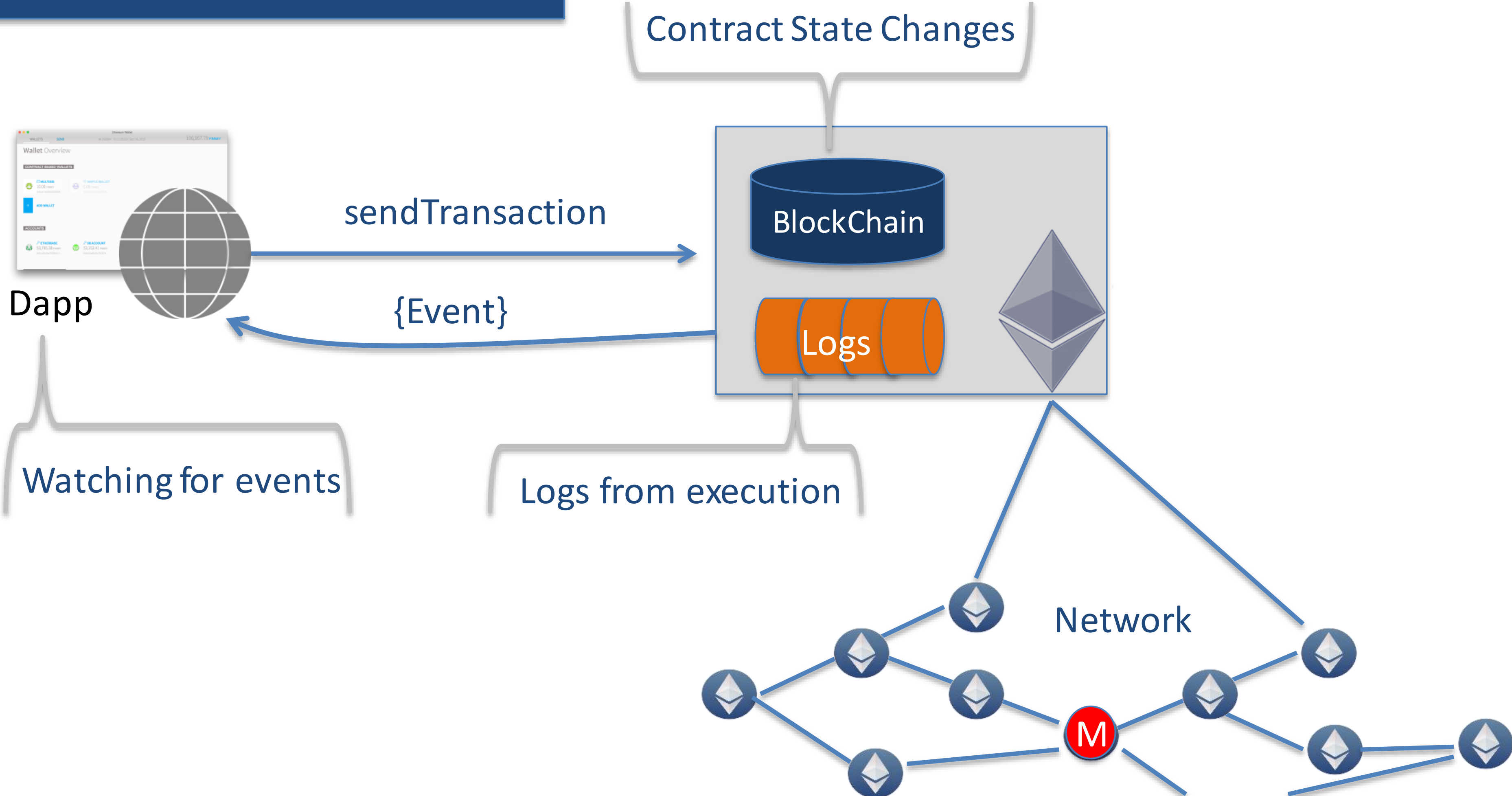


RECAP: Logs & Events

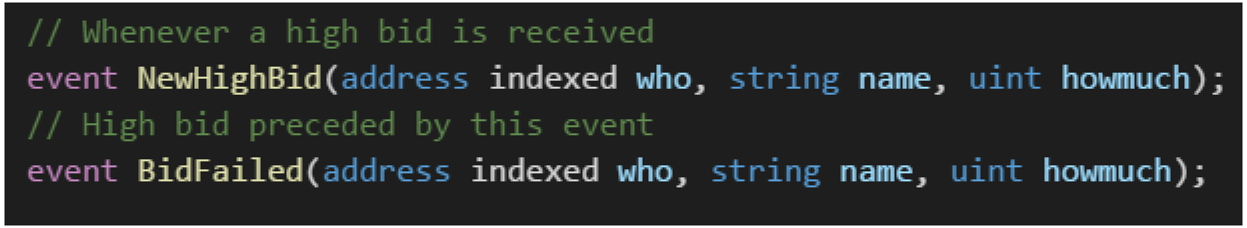


RECAP: Events

- Events are part of abi definition
- Event arguments are stored in the logs
- Logs can be read using topic filters
  - Event arguments marked as indexed can be used as criteria/filter
  - A maximum of 3 indexed arguments allowed

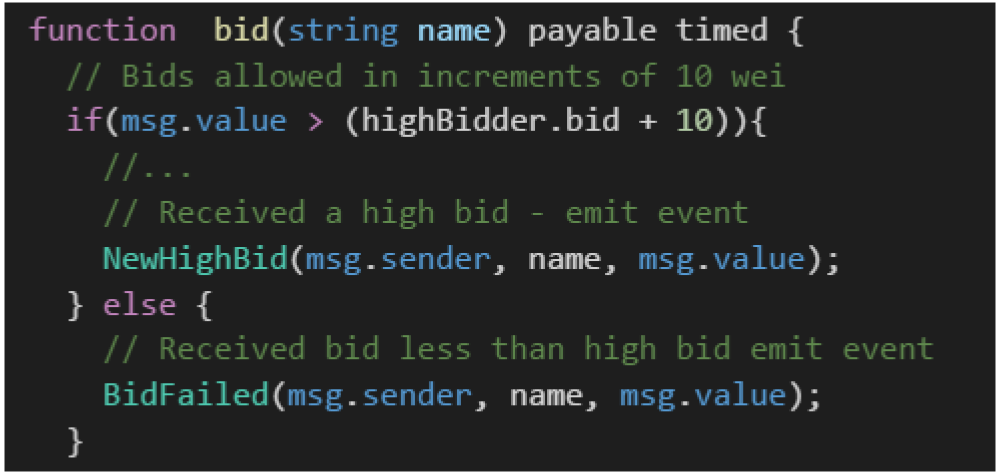
Coding

- Declared like a function without body

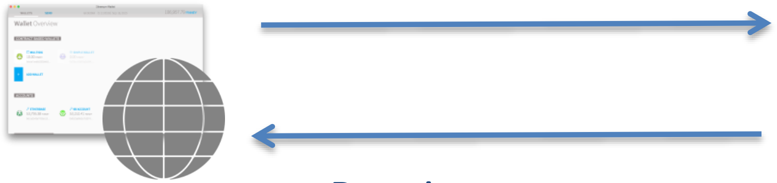


```
// Whenever a high bid is received
event NewHighBid(address indexed who, string name, uint howmuch);
// High bid preceded by this event
event BidFailed(address indexed who, string name, uint howmuch);
```

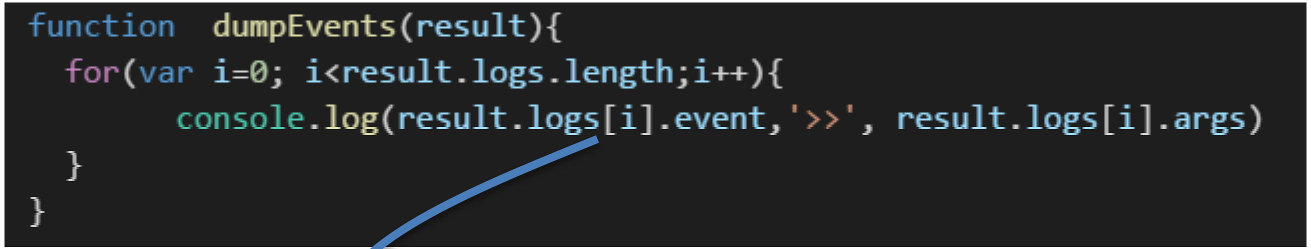
- Invoked like functions



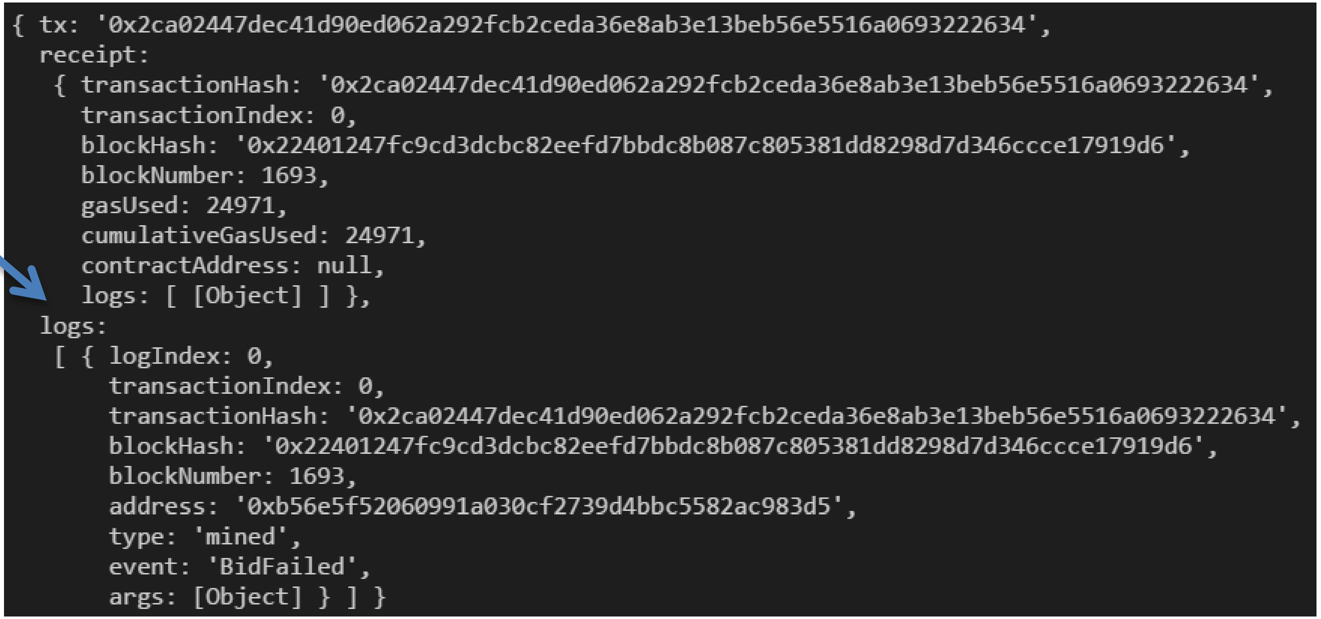
```
function  bid(string name) payable timed {
  // Bids allowed in increments of 10 wei
  if(msg.value > (highBidder.bid + 10)){
    //...
    // Received a high bid - emit event
    NewHighBid(msg.sender, name, msg.value);
  } else {
    // Received bid less than high bid emit event
    BidFailed(msg.sender, name, msg.value);
  }
```



Testing: Log Access



```
function  dumpEvents(result){
  for(var i=0; i<result.logs.length;i++){
        console.log(result.logs[i].event,'>>', result.logs[i].args)
  }
}
```



```
{ tx: '0x2ca02447dec41d90ed062a292fcb2ceda36e8ab3e13beb56e5516a0693222634',
  receipt:
   { transactionHash: '0x2ca02447dec41d90ed062a292fcb2ceda36e8ab3e13beb56e5516a0693222634',
     transactionIndex: 0,
     blockHash: '0x22401247fc9cd3dcbc82eefd7bbdc8b087c805381dd8298d7d346ccce17919d6',
     blockNumber: 1693,
     gasUsed: 24971,
     cumulativeGasUsed: 24971,
     contractAddress: null,
     logs: [ [Object] ] },
  logs:
   [ { logIndex: 0,
       transactionIndex: 0,
       transactionHash: '0x2ca02447dec41d90ed062a292fcb2ceda36e8ab3e13beb56e5516a0693222634',
       blockHash: '0x22401247fc9cd3dcbc82eefd7bbdc8b087c805381dd8298d7d346ccce17919d6',
       blockNumber: 1693,
       address: '0xb56e5f52060991a030cf2739d4bbc5582ac983d5',
       type: 'mined',
       event: 'BidFailed',
       args: [Object] } ] }
```