以太坊开发简介（下）

上篇介绍了以太坊的诞生、以太币钱包的使用以及如何获取以太币，这篇文档中分别对了编写和部署智能合约、Dapp开发框架Truffle的使用等两个方面作简单介绍，其他的后续再作补充

以太坊官网地址：

```
https://ethereum.org/
```

1、开发工具介绍

智能合约是以太坊中重要的概念，是指运行在区块链上的模块化、可重用、自动执行的脚本。在以太坊平台上的智能合约，使用Solidity语言编写（类似于JavaScript的语言）。Solidity是一种智能合约高级语言，运行在Ethereum虚拟机（EVM）之上。官网地址：

```
http://solidity.readthedocs.io/en
```

【文档翻译系列】Solidity语言

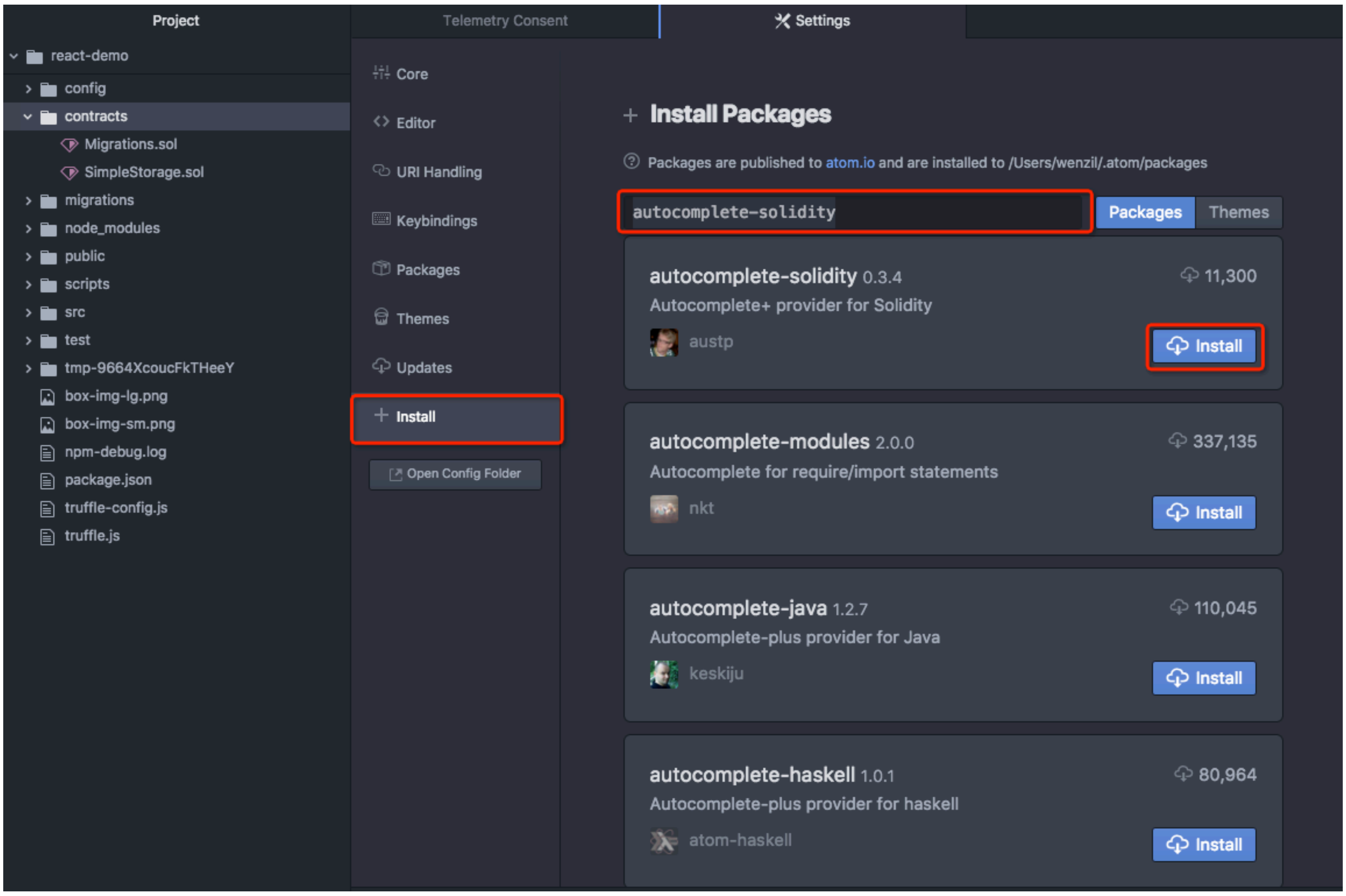
正所谓，“工欲善其事必先利其器”，在开发中选择一款好用的开发工具是非常重要的。

- Atom编辑器

Atom编辑器支持Windows、Mac、Linux，轻量级且界面漂亮，安装插件方便，支持语法高亮，因此推荐使用，当然也可以使用VSCode、Subline等其他编辑器。

官网下载地址：https://atom.io/

以MacOS为例，打开Atom，然后打开"Atom"-->"Preferences..."，点击"Install"菜单，在右边的输入框中输入对应的插件名，点击"Install"进行安装。
安装两个插件：autocomplete-solidity、language-ethereum



Install Packages

Packages are published to atom.io and are installed to /Users/wenzil/.atom/packages

autocomplete-solidity

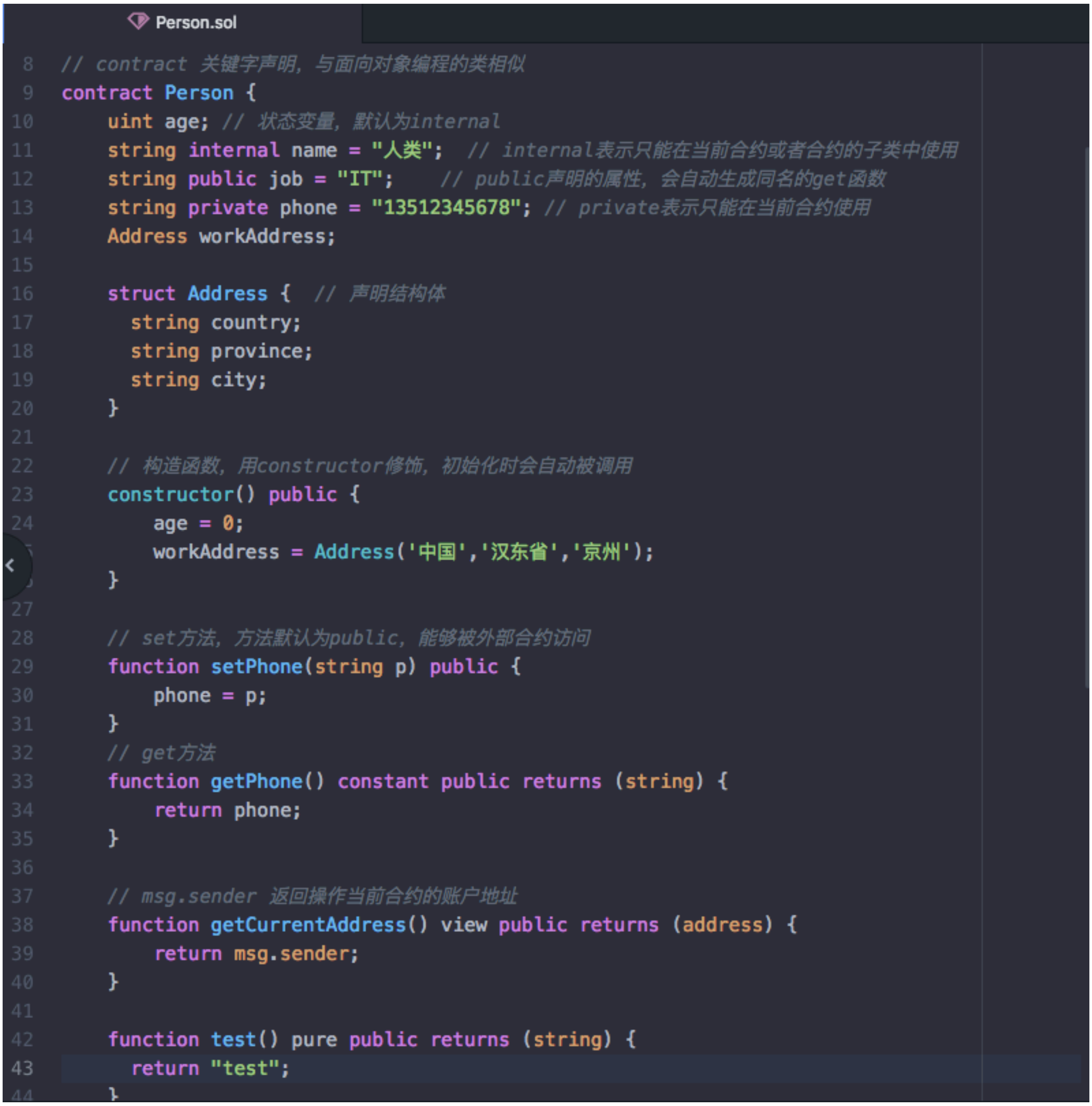
autocomplete-solidity 0.3.4 — 11,300
Autocomplete+ provider for Solidity
austp

autocomplete-modules 2.0.0 — 337,135
Autocomplete for require/import statements
nkt

autocomplete-java 1.2.7 — 110,045
Autocomplete-plus provider for Java
keskiju

autocomplete-haskell 1.0.1 — 80,964
Autocomplete-plus provider for haskell
atom-haskell

安装插件后效果如图：



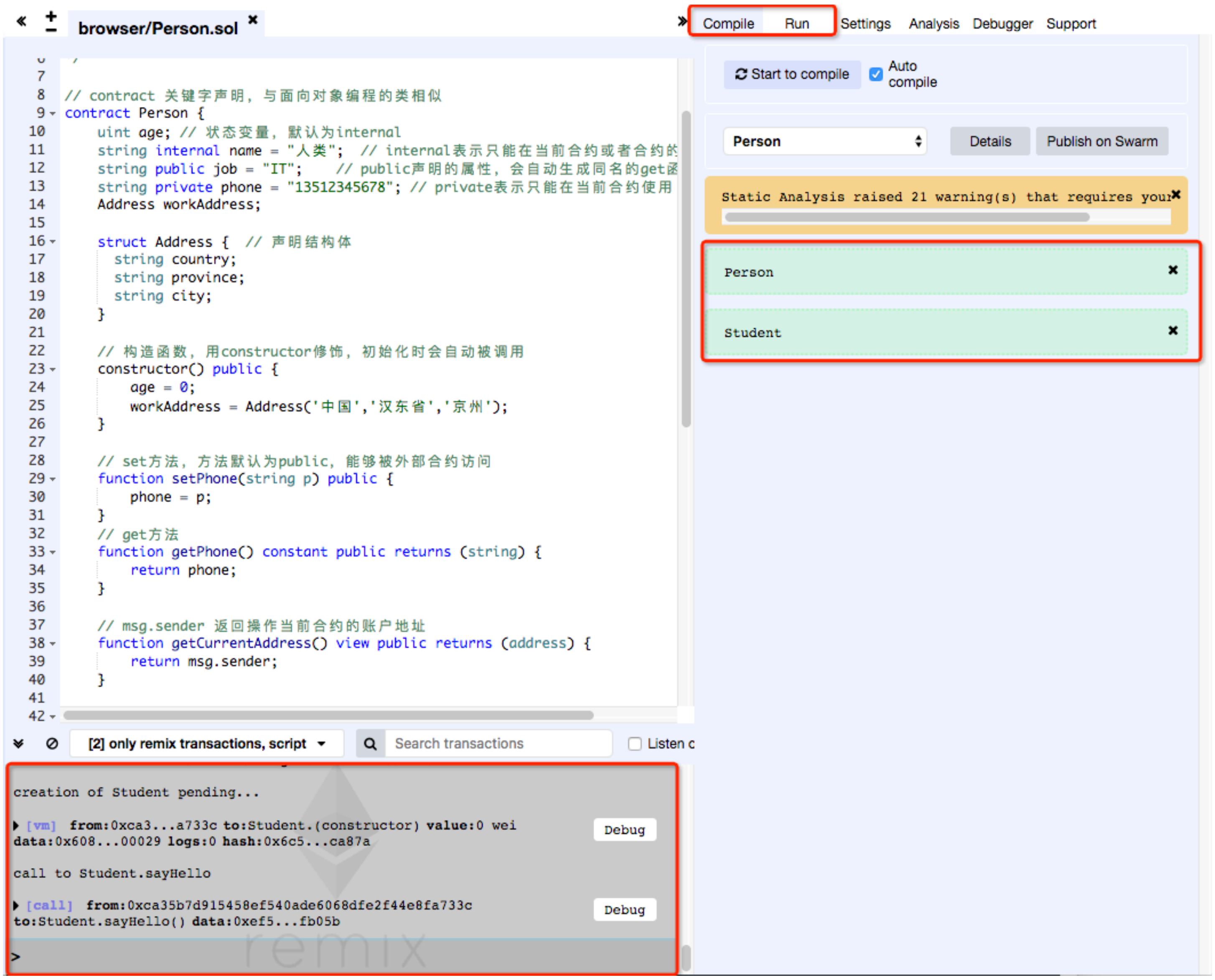
```
// contract 关键字声明，与面向对象编程的类相似
contract Person {
    uint age; // 状态变量，默认为internal
    string internal name = "人类";  // internal表示只能在当前合约或者合约的子类中使用
    string public job = "IT";    // public声明的属性，会自动生成同名的get函数
    string private phone = "13512345678"; // private表示只能在当前合约使用
    Address workAddress;

    struct Address {  // 声明结构体
      string country;
      string province;
      string city;
    }

    // 构造函数，用constructor修饰，初始化时会自动被调用
    constructor() public {
        age = 0;
        workAddress = Address('中国','汉东省','京州');
    }

    // set方法，方法默认为public，能够被外部合约访问
    function setPhone(string p) public {
        phone = p;
    }
    // get方法
    function getPhone() constant public returns (string) {
        return phone;
    }

    // msg.sender 返回操作当前合约的账户地址
    function getCurrentAddress() view public returns (address) {
        return msg.sender;
    }

    function test() pure public returns (string) {
      return "test";
    }
```

- Remix在线编辑器

Remix 是一个开源的 Solidity 智能合约开发环境，提供基本的编译、部署至本地或测试网络、执行合约等功能，另外还有调试功能。有个Bug，就是输入中文显示会有问题。
网址：http://remix.ethereum.org/

也可以在GitHub下载离线版

```
https://github.com/ethereum/remix-ide
```

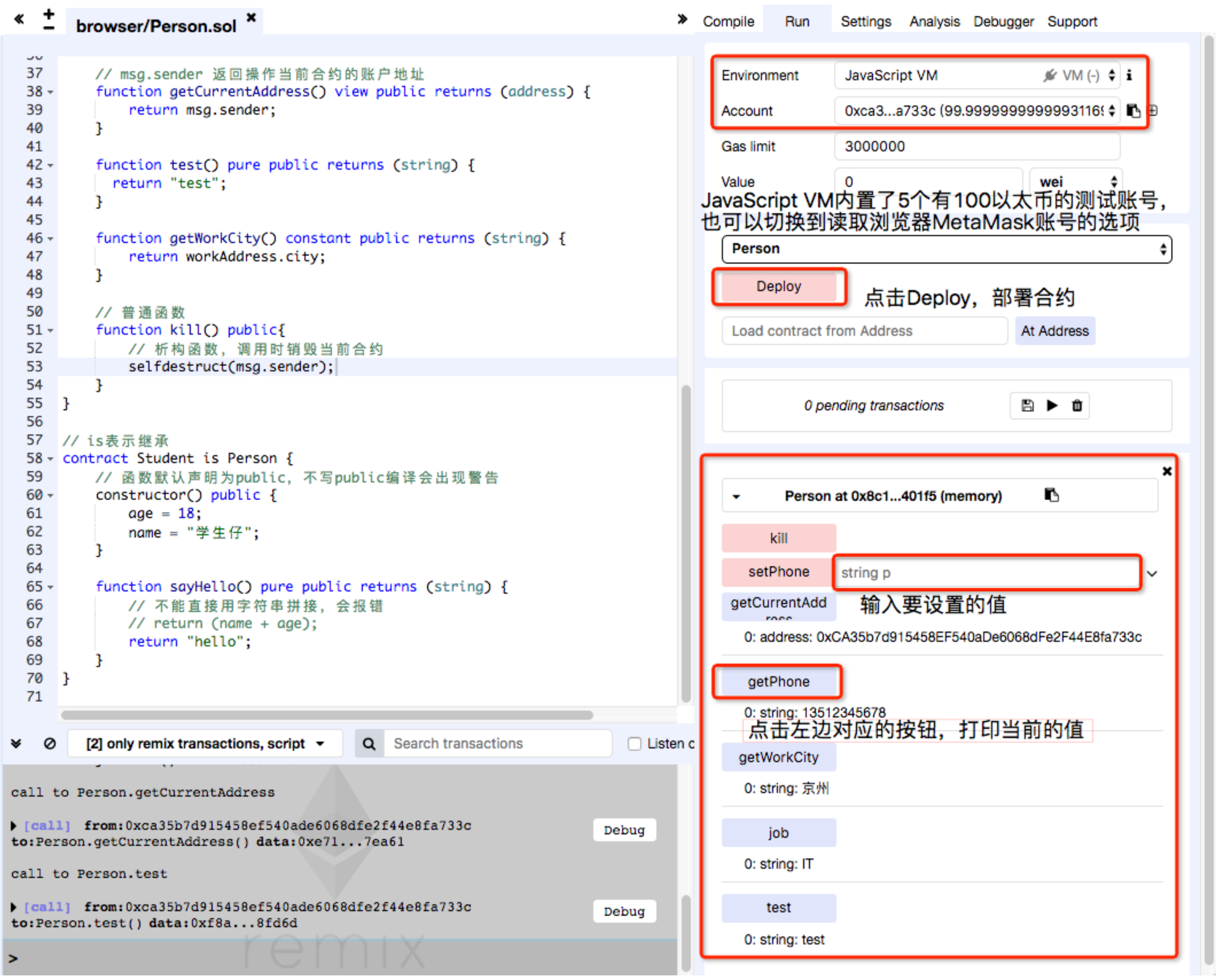


```
// contract 关键字声明，与面向对象编程的类相似
contract Person {
    uint age; // 状态变量，默认为internal
    string internal name = "人类";  // internal表示只能在当前合约或者合约的
    string public job = "IT";    // public声明的属性，会自动生成同名的get函
    string private phone = "13512345678"; // private表示只能在当前合约使用
    Address workAddress;

    struct Address {  // 声明结构体
      string country;
      string province;
      string city;
    }

    // 构造函数，用constructor修饰，初始化时会自动被调用
    constructor() public {
        age = 0;
        workAddress = Address('中国','汉东省','京州');
    }

    // set方法，方法默认为public，能够被外部合约访问
    function setPhone(string p) public {
        phone = p;
    }
    // get方法
    function getPhone() constant public returns (string) {
        return phone;
    }

    // msg.sender 返回操作当前合约的账户地址
    function getCurrentAddress() view public returns (address) {
        return msg.sender;
    }
```

```
Static Analysis raised 21 warning(s) that requires your
```

```
creation of Student pending...

[vm]  from:0xca3...a733c to:Student.(constructor) value:0 wei
data:0x608...00029 logs:0 hash:0x6c5...ca87a

call to Student.sayHello

[call]  from:0xca35b7d915458ef540ade6068dfe2f44e8fa733c
to:Student.sayHello() data:0xef5...fb05b

>
```

如图，左上角可以编辑Solidity代码，左下角显示部署智能合约时的生成的相关区块信息，编写代码时会自动编译，黄色的显示一些警告信息（暂时可以不用理会），绿色表示编译成功。可以点击"Run"切换到部署智能合约的界面，"Debugger"可以进行调试等等。



```
    // msg.sender 返回操作当前合约的账户地址
    function getCurrentAddress() view public returns (address) {
        return msg.sender;
    }

    function test() pure public returns (string) {
       return "test";
    }

    function getWorkCity() constant public returns (string) {
        return workAddress.city;
    }

    // 普通函数
    function kill() public{
        // 析构函数，调用时销毁当前合约
        selfdestruct(msg.sender);
    }
}

// is表示继承
contract Student is Person {
    // 函数默认声明为public，不写public编译会出现警告
    constructor() public {
        age = 18;
        name = "学生仔";
    }

    function sayHello() pure public returns (string) {
        // 不能直接用字符串拼接，会报错
        // return (name + age);
        return "hello";
    }
}
```

```
Environment    JavaScript VM    VM (-)
Account        0xca3...a733c (99.9999999999993116!
Gas limit      3000000
Value          0    wei
```

JavaScript VM内置了5个有100以太币的测试账号，也可以切换到读取浏览器MetaMask账号的选项

点击Deploy，部署合约

Person at 0x8c1...401f5 (memory)

输入要设置的值

```
getCurrentAddress
0: address: 0xCA35b7d915458EF540aDe6068dFe2F44E8fa733c
getPhone
0: string: 13512345678
getWorkCity
0: string: 京州
job
0: string: IT
test
0: string: test
```

点击左边对应的按钮，打印当前的值

```
call to Person.getCurrentAddress

[call] from:0xca35b7d915458ef540ade6068dfe2f44e8fa733c
to:Person.getCurrentAddress() data:0xe71...7ea61

call to Person.test

[call] from:0xca35b7d915458ef540ade6068dfe2f44e8fa733c
to:Person.test() data:0xf8a...8fd6d

>
```

Person.sol 源码：

```
pragma solidity ^0.4.23;
/*
   pragma:版本声明
   solidity: 开发语言
   0.4.23: 当前合约的版本 ，向上兼容，(0.4.23~0.49)均可编译
*/

// contract 关键字声明，与面向对象编程的类相似
contract Person {
     uint age; // 状态变量，默认为internal
     string internal name = "人类";  // internal表示只能在当前合约或者合约的子类中使
用
     string public job = "IT";     // public声明的属性，会自动生成同名的get函数
     string private phone = "13512345678"; // private表示只能在当前合约使用
     Address workAddress;

     struct Address {  // 声明结构体
```

```
      string country;
      string province;
      string city;
    }

    // 构造函数，用constructor修饰，初始化时会自动被调用
    constructor() public {
        age = 0;
        workAddress = Address('中国','汉东省','京州');
    }

    // set方法，方法默认为public，能够被外部合约访问
    function setPhone(string p) public {
        phone = p;
    }
    // get方法
    function getPhone() constant public returns (string) {
        return phone;
    }

    // msg.sender 返回操作当前合约的账户地址
    function getCurrentAddress() view public returns (address) {
        return msg.sender;
    }

    function test() pure public returns (string) {
      return "test";
    }

    function getWorkCity() constant public returns (string) {
        return workAddress.city;
    }

    // 普通函数
    function kill() public{
        // 析构函数，调用时销毁当前合约
        selfdestruct(msg.sender);
    }
}

// is表示继承
contract Student is Person {
    // 函数默认声明为public，不写public编译会出现警告
    constructor() public {
        age = 18;
        name = "学生仔";
    }
    function sayHello() pure public returns (string) {
        // 不能直接用字符串拼接，会报错
        // return (name + age);
        return "hello";
    }
}
```

2、DApp开发框架Truffle的使用

DApp：去中心化应用
DApp官网地址：

```
https://dapp.readthedocs.io/en/latest/
```

Truffle是目前比较流行的Solidity智能合约开发框架，功能十分强大，可以帮助开发者快速地开发一个DApp。

Truffle官网地址：

```
http://truffleframework.com/
```

- 1.安装Truffle：

```
$ npm install -g truffle
```

- 2.创建Truffle项目：

```
wenzildeiMac:truffle_demo wenzil$ truffle init
Downloading...
Unpacking...
Setting up...
Unbox successful. Sweet!

Commands:

  Compile:        truffle compile
  Migrate:        truffle migrate
  Test contracts: truffle test
```

- 3.启动Truffle内置客户端：

```
wenzildeiMac:truffle_demo wenzil$ truffle develop
Truffle Develop started at http://127.0.0.1:9545/

Accounts:
(0) 0x627306090abab3a6e1400e9345bc60c78a8bef57
(1) 0xf17f52151ebef6c7334fad080c5704d77216b732
(2) 0xc5fdf4076b8f3a5357c5e395ab970b5b54098fef
(3) 0x821aea9a577a9b44299b9c15c88cf3087f3b5544
(4) 0x0d1d4e623d10f9fba5db95830f7d3839406c6af2
(5) 0x2932b7a2355d6fecc4b5c0b6bd44cc31df247a2e
(6) 0x2191ef87e392377ec08e7c08eb105ef5448eced5
(7) 0x0f4f2ac550a1b4e2280d04c21cea7ebd822934b5
(8) 0x6330a553fc93768f612722bb8c2ec78ac90b3bbc
(9) 0x5aeda56215b167893e80b4fe645ba6d5bab767de

Private Keys:
(0) c87509a1c067bbde78beb793e6fa76530b6382a4c0241e5e4a9ec0a0f44dc0d3
(1) ae6ae8e5ccbfb04590405997ee2d52d2b330726137b875053c36d94e974d162f
(2) 0dbbe8e4ae425a6d2687f1a7e3ba17bc98c673636790f1b8ad91193c05875ef1
(3) c88b703fb08cbea894b6aeff5a544fb92e78a18e19814cd85da83b71f772aa6c
(4) 388c684f0ba1ef5017716adb5d21a053ea8e90277d0868337519f97bede61418
(5) 659cbb0e2411a44db63778987b1e22153c086a95eb6b18bdf89de078917abc63
(6) 82d052c865f5763aad42add438569276c00d3d88a2d062d36b2bae914d58b8c8
(7) aa3680d5d48a8283413f7a108367c7299ca73f553735860a87b08f39395618b7
(8) 0f62d96d6675f32685bbdb8ac13cda7c23436f63efbb9d07700d8669ff12b7c4
(9) 8d5366123cb560bb606379f90a0bfd4769eecc0557f1b362dcae9012b548b1e5

Mnemonic: candy maple cake sugar pudding cream honey rich smooth crumble swe
et treat

⚠️  Important ⚠️  : This mnemonic was created for you by Truffle. It is not
secure.
Ensure you do not use it on production blockchains, or else you risk losing
funds.
```

注意看："http://127.0.0.1:9545/"
为当前服务的IP和端口，会自动生成10个有100个以太币的测试账号，都带有对应的私钥“Private Keys”，这个可以用来导入恢复账号（如在MetaMask设置对应的IP和端口号，然后导入钱包）

- 4.Web3.js api的使用：

```
truffle(develop)> web3.eth.accounts;
[ '0x627306090abab3a6e1400e9345bc60c78a8bef57',
  '0xf17f52151ebef6c7334fad080c5704d77216b732',
  '0xc5fdf4076b8f3a5357c5e395ab970b5b54098fef',
  '0x821aea9a577a9b44299b9c15c88cf3087f3b5544',
  '0x0d1d4e623d10f9fba5db95830f7d3839406c6af2',
  '0x2932b7a2355d6fecc4b5c0b6bd44cc31df247a2e',
  '0x2191ef87e392377ec08e7c08eb105ef5448eced5',
  '0x0f4f2ac550a1b4e2280d04c21cea7ebd822934b5',
  '0x6330a553fc93768f612722bb8c2ec78ac90b3bbc',
  '0x5aeda56215b167893e80b4fe645ba6d5bab767de' ]
truffle(develop)> web3.eth.coinbase;
'0x627306090abab3a6e1400e9345bc60c78a8bef57'
truffle(develop)> web3.eth.accounts[0];
'0x627306090abab3a6e1400e9345bc60c78a8bef57'
truffle(develop)> web3.fromWei(2000000000000000000,'ether')
'2'
truffle(develop)> web3.toWei(2,'ether');
'2000000000000000000'
truffle(develop)> web3.eth.getBalance(web3.eth.coinbase)
{ [String: '100000000000000000000'] s: 1, e: 20, c: [ 1000000 ] }
truffle(develop)> web3.eth.getBalance(web3.eth.coinbase).toNumber();
100000000000000000000
truffle(develop)> web3.fromWei(web3.eth.getBalance(web3.eth.coinbase).toNumb
er(), 'ether');
'100'
truffle(develop)> var coinbaseAmount = web3.eth.getBalance(web3.eth.coinbase
);
undefined
truffle(develop)> web3.fromWei(coinbaseAmount.toNumber(), 'ether')
'100'
truffle(develop)> web3.net.peerCount;
0
truffle(develop)> web3.net.listening
true
truffle(develop)> web3.eth.defaultBlock
'latest'
truffle(develop)> web3.eth.getBalance("0x5aeda56215b167893e80b4fe645ba6d5bab
767de")
{ [String: '100000000000000000000'] s: 1, e: 20, c: [ 1000000 ] }
```

- 5.Web3.js 演示转账：

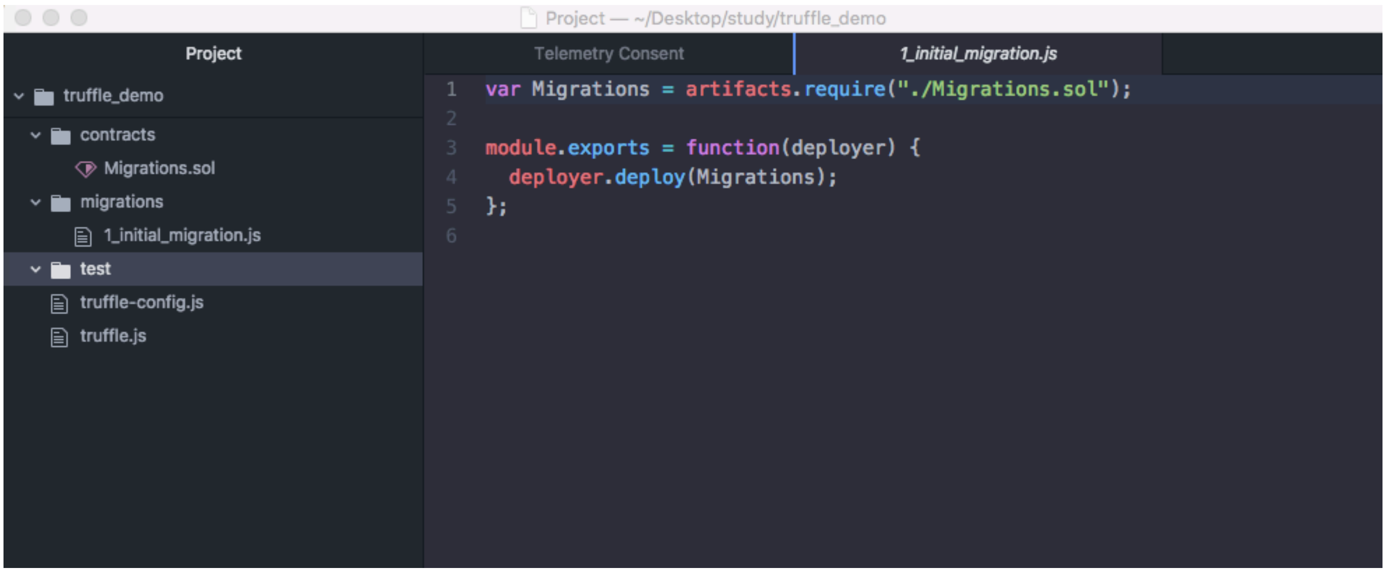
  挖矿的账号(coinbase)向另外一个账号转20个以太币

  ```
  truffle(develop)> var account1 = web3.eth.coinbase;
  undefined
  truffle(develop)> var account2 = web3.eth.accounts[2];
  undefined
  truffle(develop)> web3.fromWei(web3.eth.getBalance(account1).toNumber(),
   'ether')
  '79.99999999999998'
  ```

```
truffle(develop)> web3.fromWei(web3.eth.getBalance(account2).toNumber(),
 'ether')
'100'
truffle(develop)>  web3.eth.sendTransaction({from:account1, to:account2,
 value:sendEtherNumber});
'0x6aae64d0cdce1695730083ee0ffe8a82d777f1cf2278499f6e030ead71a47702'
truffle(develop)> web3.fromWei(web3.eth.getBalance(account1).toNumber(),
 'ether')
'59.99999999999996'
truffle(develop)> web3.fromWei(web3.eth.getBalance(account2).toNumber(),
 'ether')
'120'
truffle(develop)>
```

- 6.添加智能合约和部署文件：

  在Atom打开项目，如图



```
var Migrations = artifacts.require("./Migrations.sol");

module.exports = function(deployer) {
  deployer.deploy(Migrations);
};
```

  文件说明：
  contrcts/：智能合约代码文件夹
  migrations/：部署智能合约的脚本
  tests/：存放用于测试的智能合约文件
  truffle.js：Truffle默认的配置文件

  将之前创建的Person.sol文件复制到contrcts文件夹，然后在migrations文件夹新建"2_initial_person.js"文件（名字随意，要以数字开头带下划线），输入如下内容（主要copy已存在的js文件内容作修改）：

```
var Person = artifacts.require("./Person.sol");

module.exports = function(deployer) {
  deployer.deploy(Person);
};
```

- 7、编译智能合约源文件
  执行"compile"命令，发现出现了一个警告：

```
truffle(develop)> compile
Compiling ./contracts/Migrations.sol...
Compiling ./contracts/Person.sol...

Compilation warnings encountered:

/Users/wenzil/Desktop/study/truffle_demo/contracts/Migrations.sol:11:3:
Warning: Defining constructors as functions with the same name as the co
ntract is deprecated. Use "constructor(...) { ... }" instead.
  function Migrations() public {
  ^ (Relevant source part starts here and spans across multiple lines).

Writing artifacts to ./build/contracts
```

```
Migrations.sol文件里面的
function Migrations() public {
    owner = msg.sender;
}
修改为
constructor() public {
    owner = msg.sender;
}
```

- 8、重新编译
  删除当前项目工程中的"build"目录，可以直接在Atom中直接删除，也可以通过在终端中进入项目根目录，然后执行如下命令：

```
wenzildeiMac:truffle_demo wenzil$ cd /Users/wenzil/Desktop/study/truffle
_demo
wenzildeiMac:truffle_demo wenzil$ rm -rf build/
wenzildeiMac:truffle_demo wenzil$ ls
contracts       test            truffle.js
migrations      truffle-config.js
```

发现"build/"目录已删除，然后再次编译，警告消失了

```
truffle(develop)> compile
```

```
Compiling ./contracts/Migrations.sol...
Compiling ./contracts/Person.sol...
Writing artifacts to ./build/contracts
```

- 9、部署合约
  执行"migrate"命令，如下：

```
truffle(develop)> migrate
Using network 'develop'.

Running migration: 1_initial_migration.js
  Deploying Migrations...
  ... 0x25dd44b419f19c62d0c8538bcb4078738e3a957db9520a2cb9d272cf6b245763
  Migrations: 0x345ca3e014aaf5dca488057592ee47305d9b3e10
Saving successful migration to network...
  ... 0xcc6faa4193f59d7da676c7557e13271f41a8a97ca0ce171911aaf0355b92f11d
Saving artifacts...
Running migration: 2_initial_person.js
  Deploying Person...
  ... 0x204a52f8cb115cf6e222d4f367fd5e94127846e1eb8534c24e2f2dc974b3107e
  Person: 0x8f0483125fcb9aaaefa9209d8e9d7b9c8b9fb90f
Saving successful migration to network...
  ... 0x61826f086be719997aa398ef8cbc8ba8d3fb9cdd04f7486fb0f2e0c7565d2b59
Saving artifacts...
```

- 10、调用并查看合约：

```
truffle(develop)> var contract;
undefined
truffle(develop)> contract = Person.deployed().then(instance => contract
 = instance);
...//后面打印了一大堆信息，已省略

truffle(develop)> contract.getWorkCity();
'京州'
truffle(develop)> contract.job();
'IT'
truffle(develop)> contract.getPhone();
'13512345678'
truffle(develop)> contract.test();
'test'
```

搞定，收工。。。