# 物联网和机器人导论
## 可视化编程概述

## Introduction to IoT and Robotics, based on Visual Programming Experiments

Yinong Chen
Arizona State University, U.S.A.

# Yinong Chen (陈以农)

Heinrich **Hertz** worked at Univ. *Karlsruhe from 1885 to 1888, where he discovered* electromagnetic waves

- 重庆大学1982 学士& 1984硕士
- 1993 博士 at University of Karlsruhe （KIT), 德国
- 1995 – 1996 Postdoc at LAAS-CNRS, Toulouse, 法国
- 1994 – 2000: Wits University of Johannesburg, 南非
- 2001 – present: Arizona State University亚利桑那州立大学
- More: http://www.public.asu.edu/~ychen10/


# Syllabus: Course Objectives

ASU Course FSE100 **Introduction to Engineering (工程导论)** for freshman students

1. To discover the excitement and creativity in the practice of engineering and computer science.
2. To learn and use the engineering design process.
3. To learn to work in a team environment.
4. To improve technical communication skills by writing and speaking about the projects in the course.

# Class Format

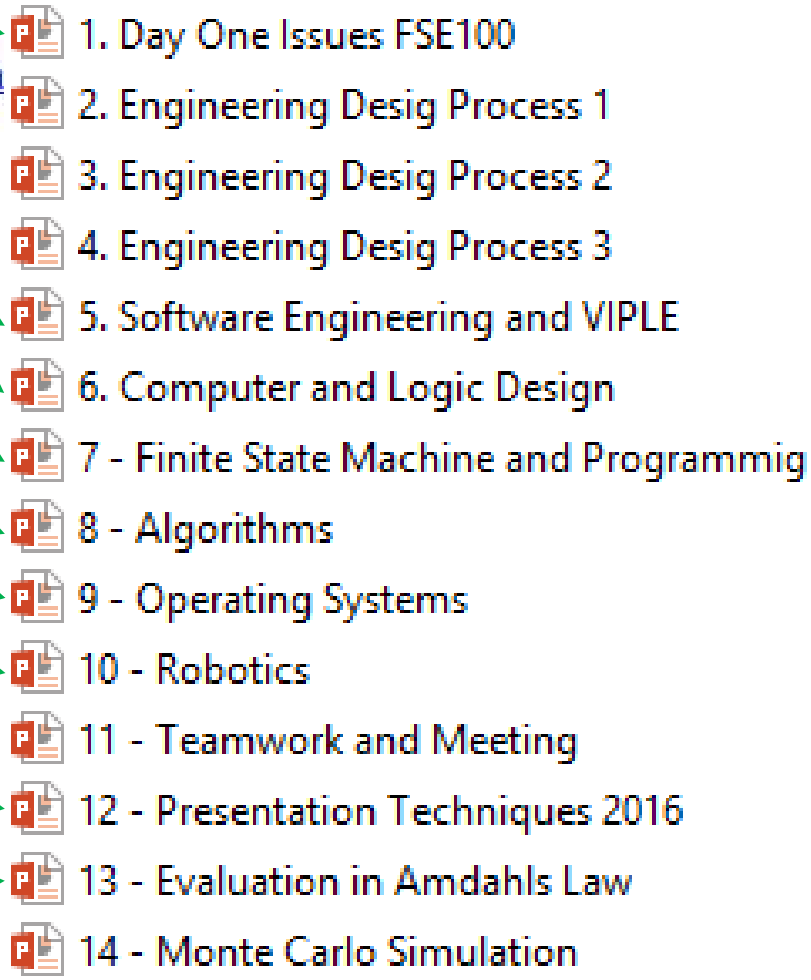
| | |
|---|---|
| One hour of conventional lecture | Concepts, Principles, Methods, Theories<br>In-class exercises, Exams<br>Mandatory topics required by engineering program, such as engineering principles, architecture, design methodology, ethics, etc |
| Three hours of interactive lecture and laboratory | Team work, Interaction<br>Hand-on, Programming, Experimentation<br>Lab assignment to complete<br>The latest technology that are useful and exciting, such as game programming, animation, e-business, robots, etc. |
| At least 4 hours after/before class study / week | - Read the lecture slides before class<br>- Read the related book chapter/sections after the class<br>- Prepare for the lab before the lab session: There is a pre-lab-quiz to enforce the preparation<br>- Complete homework / project |

# Sample Lectures Available Online

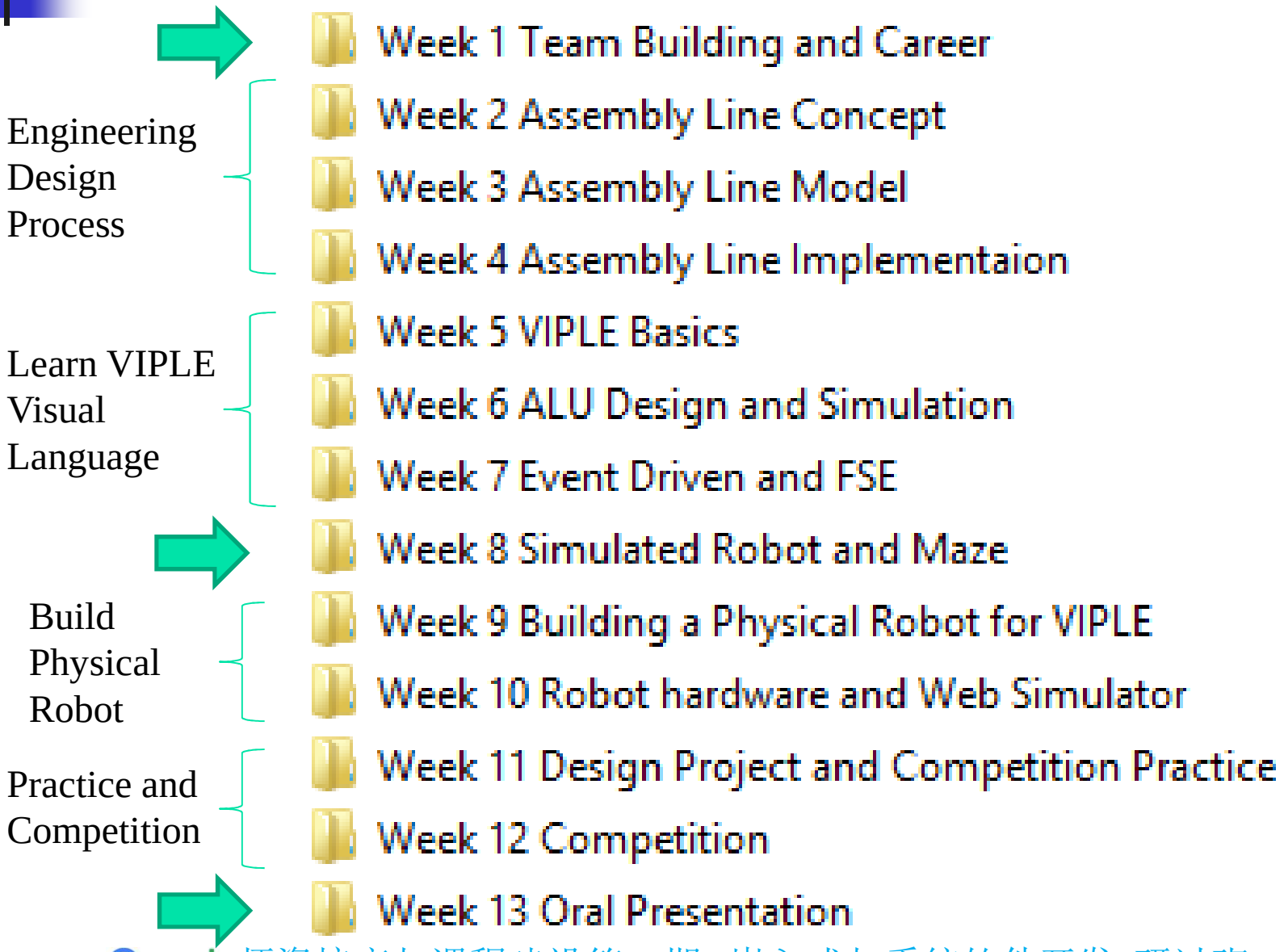
http://neptune.fulton.ad.asu.edu/VIPLE/

- L01 - About the Course and Syllabus
- L02 - CS Related Disciplines
- L03 - VIPLE - Visual IoT/Robotics Programming La
- L04 - ALU Simulation in VIPLE
- L05 - Number systems
- L06 - Finite State Machine and Programming
- L07 - Algorithms
- L08 - Event Driven Programming
- L09 - Programming Langauges
- L10 - Operating System
- L11 - Unix and Edison
- L12 - IoT and RaaS
- L13 - IoT and Augmented Reality
- L14 - from OOC to SOC
- L15 - SOC and Web Software
- L16 - Presentation Techniques
- L17 - Big Data
- L18 - Cloud Computing
- L19 - Amdahls Law
- L20 - Ethics Theories

My Spring 2016 offering



# Weekly Lab Assignments



# Crisis in Computing 计算机专业的危机

Source: **ACM** Computer Science Curriculum 2008
http://www.acm.org//education/curricula/ComputerScience2008.pdf

- **Crisis in Computing**: Computer Science enrollment dropped dramatically after 2000 in many countries; 2000年开始，计算机专业招生人数大幅度下滑。
- ACM 2008 出版危机报告，建议
  - 市场需求：美国95%的增长是在信息技术领域
  - 改变计算机专业的授课方法，特别是一年级的课程：
    - 面向应用
    - 内容要生动
    - 形式要多样：机器人、游戏、手机App、多媒体

# Motivation： 为什么要学习IoT和机器人编程？

- 为什么要学习计算机编程?
- 第一门编程语言教（学）什么？
  - C/C++? Java?
  - Python? Scheme / LISP?
- 您第一个操作系统 用的是什么？
  - iOS（Apple）？
  - Windows（Microsoft）？
  - Android （Google)？
  - DOS 或 LINUX？
- 学编程像学操作系统那样容易吗？
- 那大学四年学什么？
- 学习和锻炼解决问题的能力

# Motivation：为什么要学习计算机科学？

- 读大学、选专业很重要
- 根据兴趣选专业
  - 根据兴趣选专业
  - 没有工作机会怎么办？
- 根据市场需求选专业
  - 没有兴趣绝对学不好专业、混学、辍学
  - 怎么办？
- 根据市场需求、培养兴趣、选专业
  - 可行吗？
  - 当然可行。ACM推荐，我的经历和经验

# Engineers (U.S. DoL OCO Handbook 2010-2011)

http://www.bls.gov/oco/

| Occupational Title | Employment, 2008 | Projected Employment, 2018 | Change, 2008-18 | |
|---|---|---|---|---|
| | | | Number | Percent |
| Engineers | 1,571,900 | 1,750,300 | 178,300 | 11 |
| **All Engineers** | **1,571,900** | **1,750.300** | | **11** |
| Biomedical engineers | 16,000 | 27,600 | 11,600 | 72 |
| Chemical engineers | 31,700 | 31,000 | -600 | -2 |
| Civil engineers | 278,400 | 345,900 | 67,600 | 24 |
| Computer hardware engineers | 74,700 | 77,500 | 2,800 | 4 |
| Electrical and electronics engineers | 301,500 | 304,600 | 3,100 | 1 |
| Electrical engineers | 157,800 | 160,500 | 2,700 | 2 |
| Electronics engineers, except computer | 143,700 | 144,100 | 400 | 0 |
| Environmental engineers | 54,300 | 70,900 | 16,600 | 31 |
| Industrial engineers, including health and safety | 240,400 | 273,700 | 33,200 | 14 |
| Health and safety engineers, except mining safety engineers and inspectors | 25,700 | 28,300 | 2,600 | 10 |
| Industrial engineers | 214,800 | 245,300 | 30,600 | 14 |
| Marine engineers and naval architects | 8,500 | 9,000 | 500 | 6 |
| Materials engineers | 24,400 | 26,600 | 2,300 | 9 |
| Mechanical engineers | 238,700 | 253,100 | 14,400 | 6 |
| Mining and geological engineers, including mining safety engineers | 7,100 | 8,200 | 1,100 | 15 |
| Nuclear engineers | 16,900 | 18,800 | 1,900 | 11 |
| Petroleum engineers | 21,900 | 25,900 | 4,000 | 18 |
| All other engineers | 183,200 | 195,400 | 12,200 | 7 |

*ıen*

# Software Engineers and CS Occupations (There are many more)
## in U.S. DoL Occupational Outlook Handbook

| | | | |
|---|---|---|---|
| All Engineers | 1,571,900 | 1,750.300 | 11 |

| Occupational title | Employment in 2008 | Employment in 2018 | Change in number | Change in percentage |
|---|---|---|---|---|
| Software Engineers | 909,600 | 1,204,800 | 295,200 | 32 |
| **Computer systems analysts** | 532,200 | 640,300 | 108,100 | 20 |
| **Computer network, systems, and database administrators** | 961,200 | 1,247,800 | 286,600 | 30 |
| Computer programmers | 426,700 | 414,400 | -12,300 | -3 |
| Computer support specialists | 565,700 | 643,700 | 78,000 | 14 |
| **Computer and information systems managers** | 293,000 | 342,500 | 49,500 | 17 |

2,7788 3,2887

# BEST JOBS IN AMERICA

MONEY Magazine and Salary.com rate careers on salary and job prospects.

CNNMoney.com A Service of CNN, Fortune & Money

## 2009

http://money.cnn.com/magazines/moneymag/bestjobs/2009/sectors/

| Job Sector | Job Title | Growth | Rank |
|---|---|---|---|
| Information Technology | Systems Engineer | 45% | 1 |
| Information Technology | Information Technology Project Manager | 16% | 5 |
| Information Technology | Computer/Network Security Consultant | 27% | 8 |
| Information Technology | Software Developer | 28% | 12 |
| Information Technology | Software Product Manager | 28% | 16 |
| Information Technology | Business Analyst, IT | 29% | 17 |
| Information Technology | Technical Writer | 20% | 28 |
| Information Technology | Telecommunications Network Engineer | 53% | 30 |
| Information Technology | Computer Software Program Manager | 28% | 39 |
| Information Technology | Applications Systems Analyst | 29% | 40 |

**10**
**40**

CNNMoney.com A Service of CNN, Fortune & Money

# BEST JOBS IN AMERICA 2010

http://money.cnn.com/magazines/moneymag/bestjobs/2010/sectors/#I

| Sector | Job Title | Rank in top 40 |
|---|---|---|
| Information Technology | Software Architect | 1 |
| | Database Administrator | 7 |
| | Information Systems Security Engineer | 17 |
| | Software Engineering / Development Director | 18 |
| | Information Technology Manager | 20 |
| | Telecommunications Network Engineer | 21 |
| | Network Operations Project Manager | 24 |
| | Information Technology Business Analyst | 26 |
| | Information Technology Consultant | 28 |
| | Test Software Development Engineer | 30 |
| | Information Technology Network Engineer | 31 |
| | Information Technology Program Manager | 33 |
| | Computer and Information Scientist | 35 |
| | Programmer Analyst | 37 |
| | Applications Engineer | 38 |

15/40

CNNMoney.com A Service of CNN, Fortune & Money

# BEST JOBS IN AMERICA 2012

| Rank | Job Title | Median Salary | 2011 Job number | 10 year growth rate | 2021 Job number |
|---|---|---|---|---|---|
| 1 | Biomedical Engineer | $79,500 | 15,700 | 61.7% | 25,387 |
| 2 | Marketing Consultant | $92,100 | 282,700 | 41.2% | 399,172 |
| 3 | **Software Architect** | **$119,000** | **3,426,000** | **24.6%** | **4,268,796** |
| 4 | Clinic Research Associate | $90,700 | 100,000 | 36.4% | 136,400 |
| 5 | **Database Administrator** | **$87,200** | **110,800** | **30.6%** | **144,705** |
| 6 | Financial Adviser | $90,200 | 206,800 | 32.1% | 273,183 |
| 7 | Market Research Analyst | $63,100 | 282,700 | 41.2% | 399,172 |
| 8 | Physical Therapist | $76,700 | 198,600 | 39.0% | 276,054 |
| 9 | **Software Developer** | **$84,200** | **3,426,000** | **24.6%** | **4,268,796** |
| 10 | Occupational Therapist | $74,900 | 108,800 | 33.5% | 145,248 |
| 11 | Management Consultant | $110,000 | 718,800 | 21.9% | 876,217 |
| 12 | Optometrist | $105,000 | 34,200 | 33.1% | 455,20 |
| 13 | **IT Consultant** | **$96,400** | **544,400** | **22.1%** | **664,712** |
| 14 | **IT Network Engineer** | **$73,400** | **347,200** | **27.8%** | **443,722** |
| 15 | **IT Security Consultant** | **$102,000** | **347,200** | **27.8%** | **443,722** |

# What does the data mean?

- Biomedical Engineer: 25,387 jobs in 10 years

Biomedical Engineer

- 50 states: 25,387 / 50 = 508
- Assume each person holds the job for 30 years
  New jobs available will be 508/ 30 = 17
- Arizona Universities graduate 100 students
  The chance of finding a job is: 17%

---

- **Software Architect: 4,268,796** in 10 years

Software Architect

- 50 states: 4,268,796 / 50 = 85375
- Assume each person holds the job for 30 years
  New jobs available will be 85375 / 30 = 2845
- Even if Arizona Universities graduate 1000 students
  there are 1845 positions cannot be filled.
- What about the other CS jobs?

CNNMoney.com A Service of CNN, Fortune & Money BEST JOBS IN AMERICA 2015

http://money.cnn.com/pf/best-jobs/

Top Ten Jobs

See the full list


Software Architect


Video Game Designer


Landman


Patent Agent


Hospital Administrator


Continuous Improvement Mgr.


Clinical Nurse Specialist


Database Developer


Info Assurance Analyst

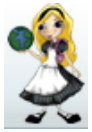

Pilates/Yoga Instructor

# Salary Data of Computer Science Related

| | |
|---|---|
| Database manager | $84,750 - $116,000 |
| Network architect | 78,000 - 112,250 |
| Database developer | 73,500 - 103,000 |
| Senior web developer | 71,000 - 102,000 |
| Database administrator | 70,250 - 102,000 |
| Network manager | 68,750 - 93,000 |
| Web developer | 54,750 - 81,500 |
| LAN/WAN administrator | 51,000 - 71,500 |
| Web administrator | 49,750 - 74,750 |
| Web designer | 47,000 - 71,500 |

# 可视化编程环境


MIT: Scratch - Visual Game Programming


University of Virginia & Carnegie Mellon University: Alice Visual Game Programming


MIT/Google App Inventor: Phone App Visual Programming


Lego NXT & EV3 – Visual Robotics Application Development

Intel IoT Services Orchestration Layer

Microsoft Robotics Developer Studio Visual Programming Language MRDS VPL

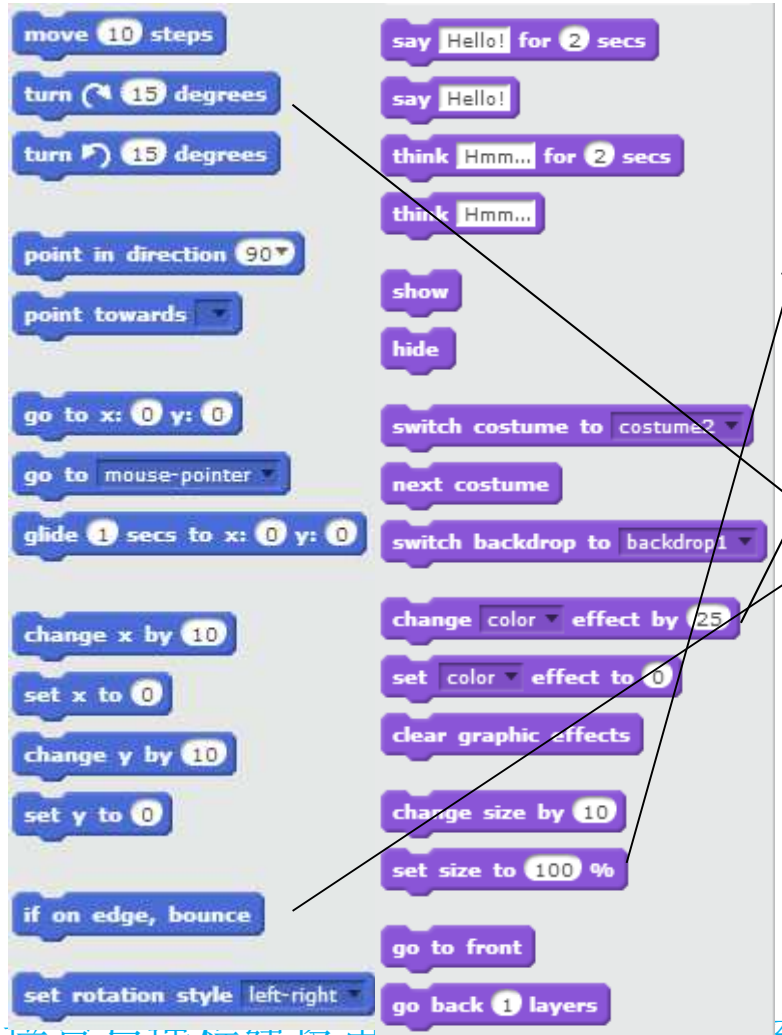
ASU **VIPLE**: Visual IoT/Robotics Programming Language Environment

# MIT: Scratch - Visual Game Programming

https://scratch.mit.edu/

- Select figures and scene

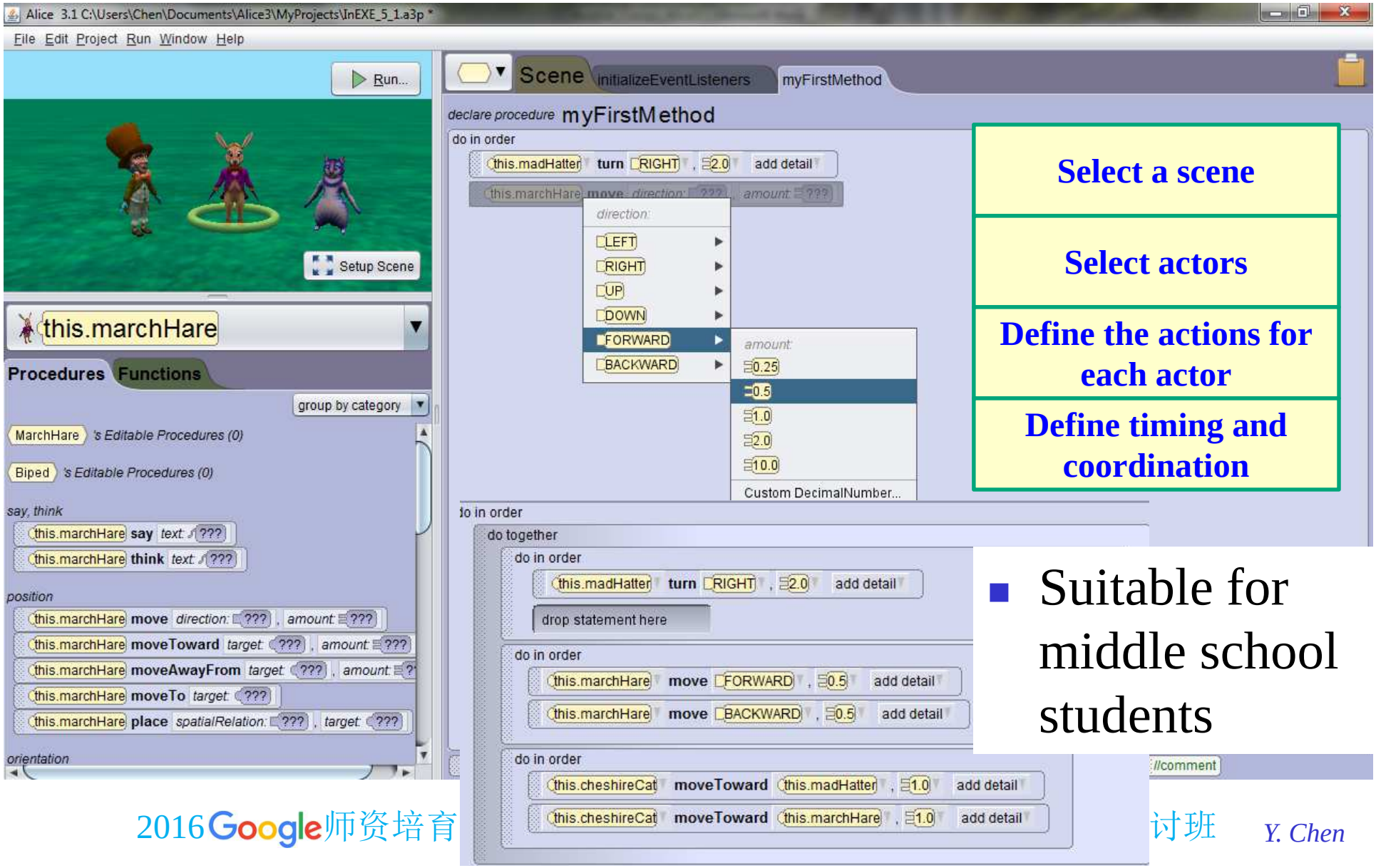
- Select functions




- Define their combinations


- Suitable for primary school students

# Alice Game Programming Environment

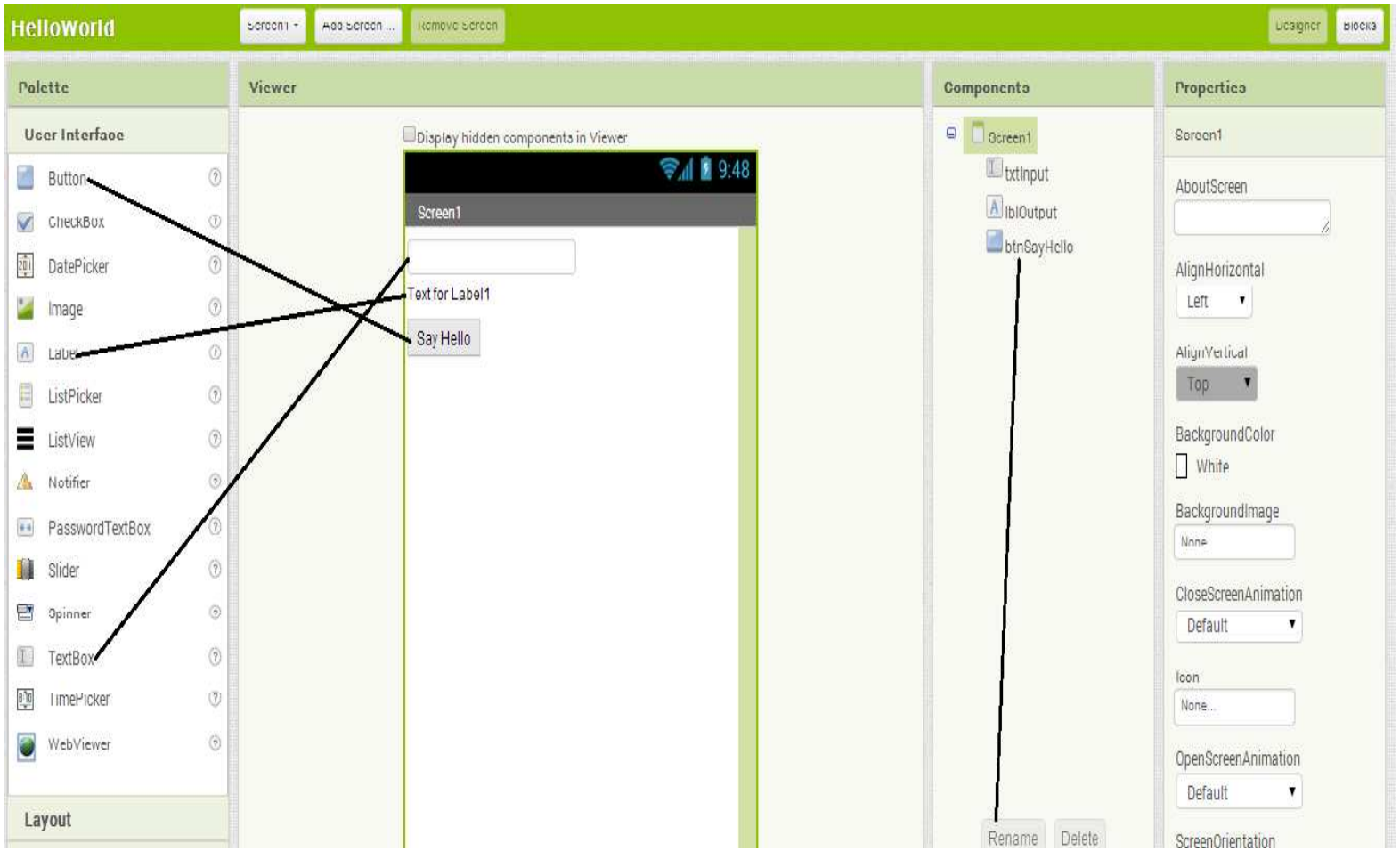



- Suitable for middle school students

# MIT/Google App Inventor for Android Phone

- Web based GUI design
- Visual programming using drag and drop
- Emulator or physical Android phone
- Web site: http://appinventor.mit.edu

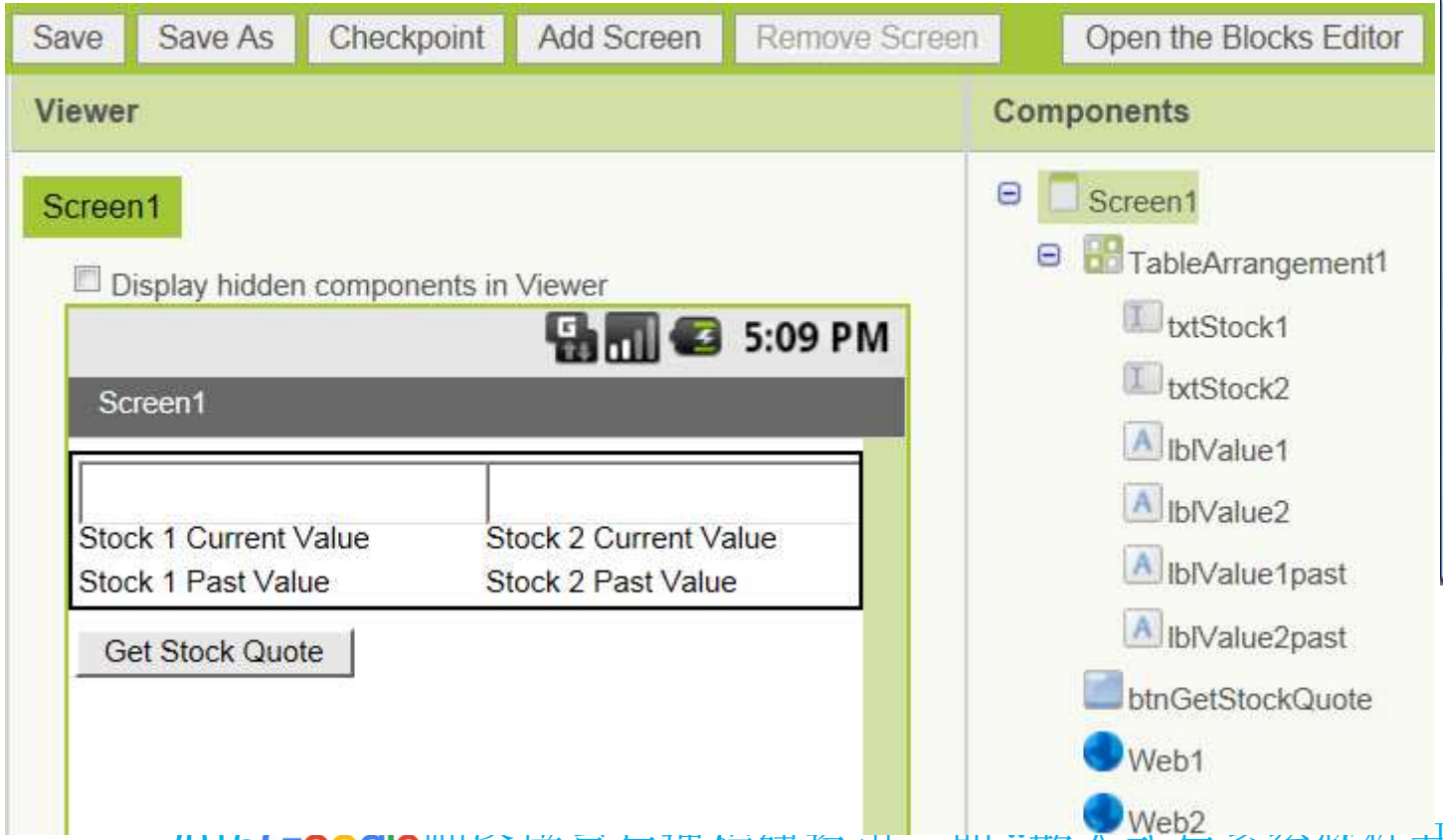
- Suitable for high school & college students



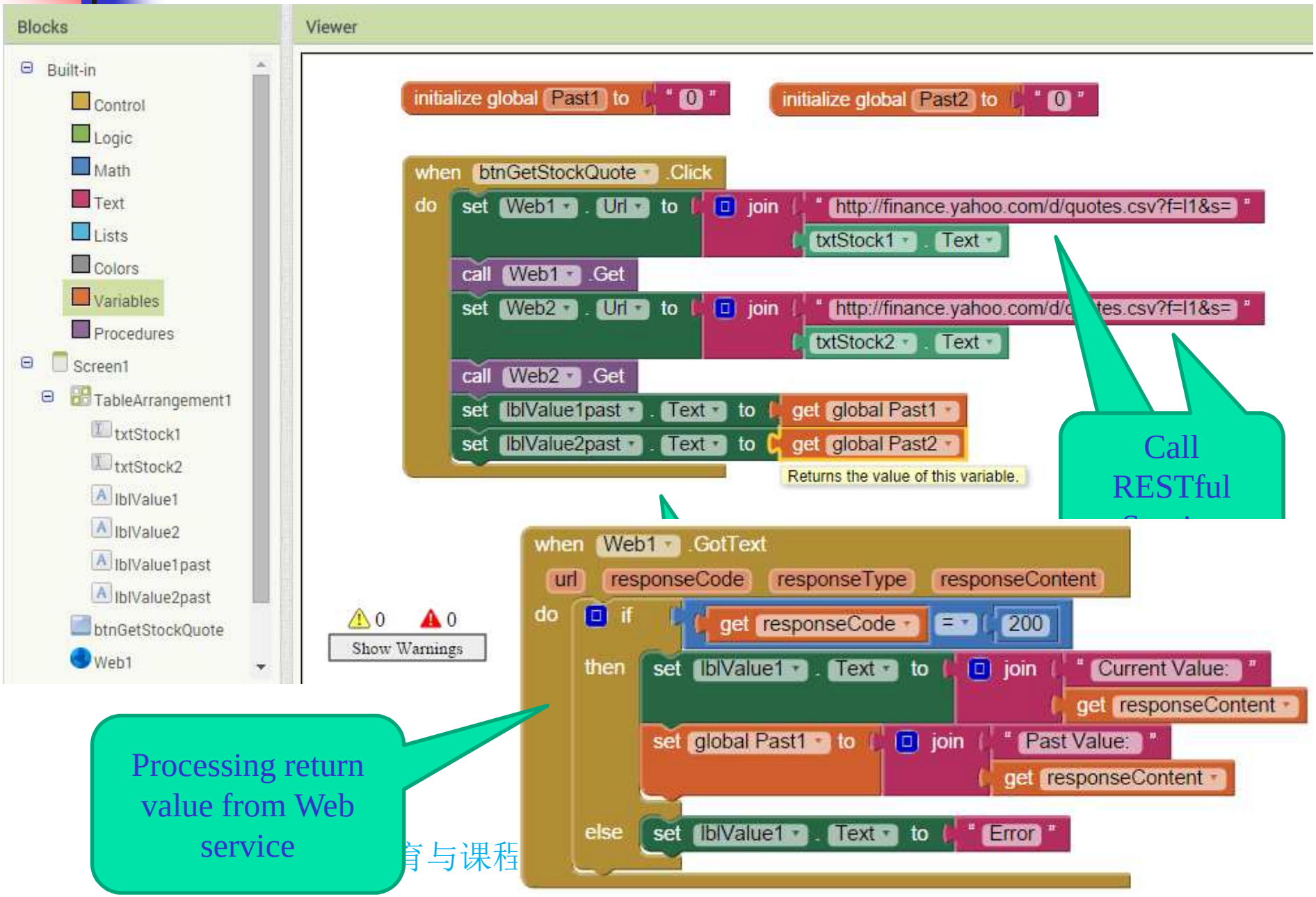

*Y. Chen*

# MIT App Inventor for Android Phone

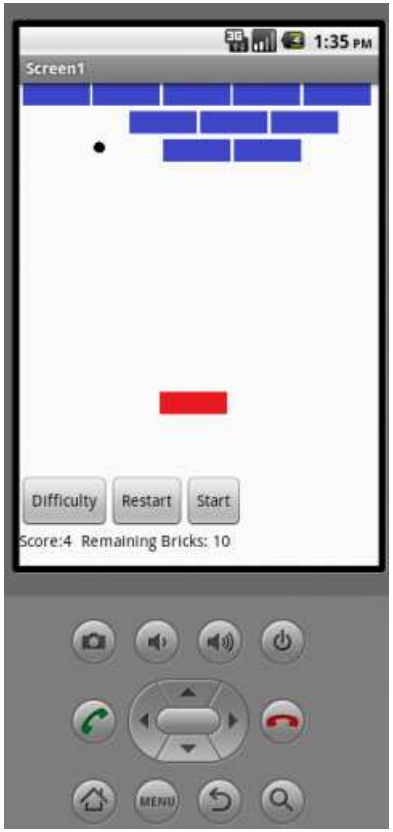
- Used for developing Android phone apps
- Service-oriented: call services to get job done
- Example: A simple stock app

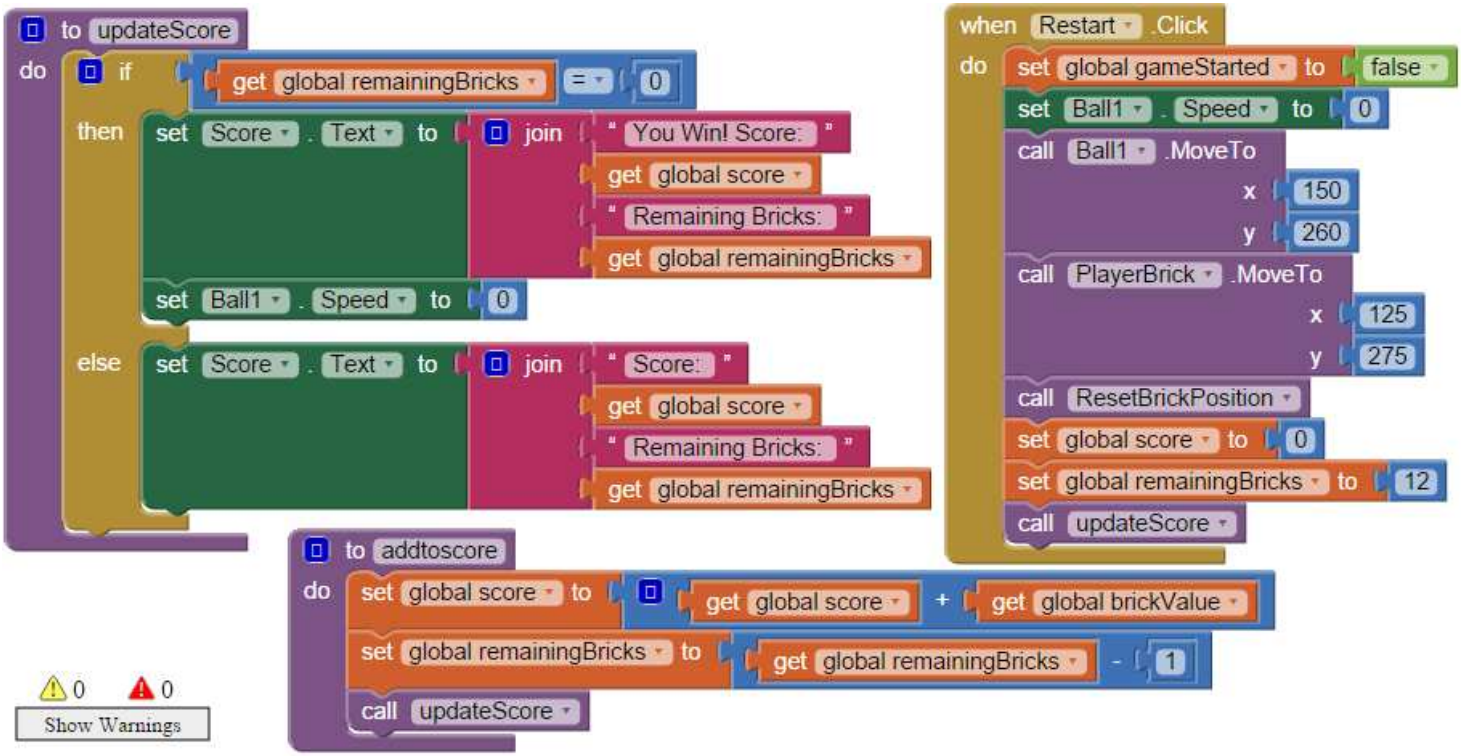


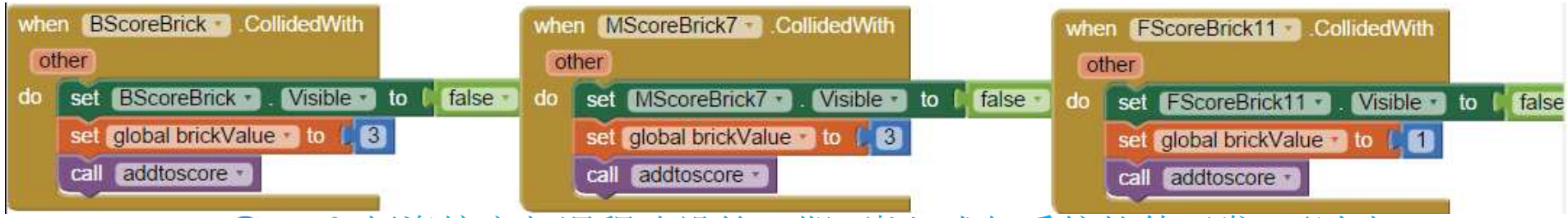

# Code Behind the Stock App



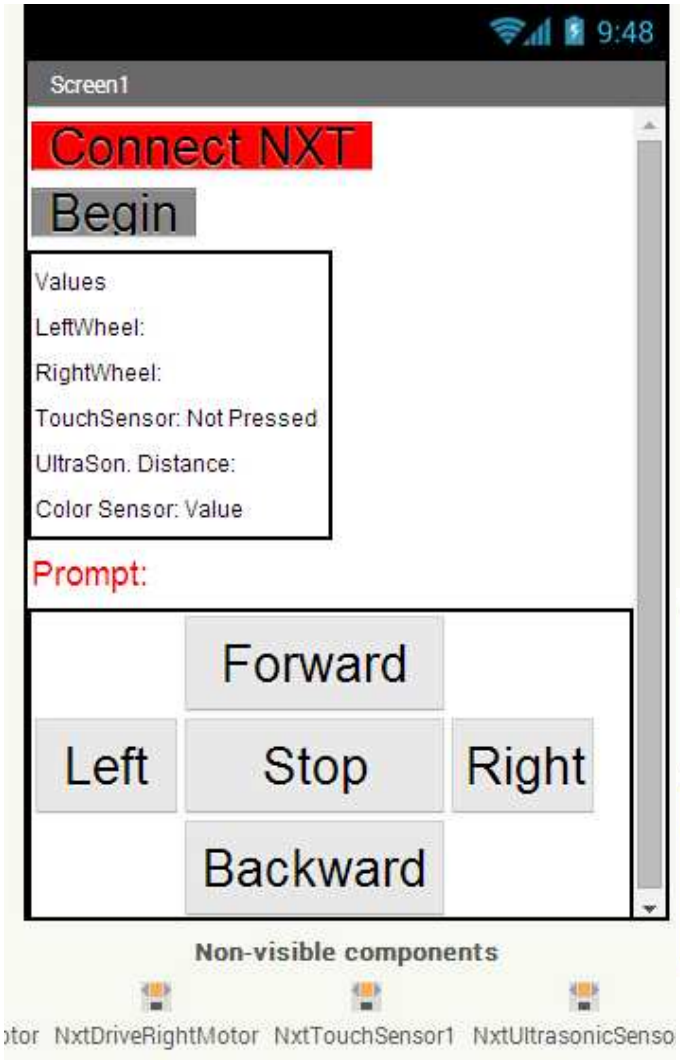
# Implementing a Game: BrickPong

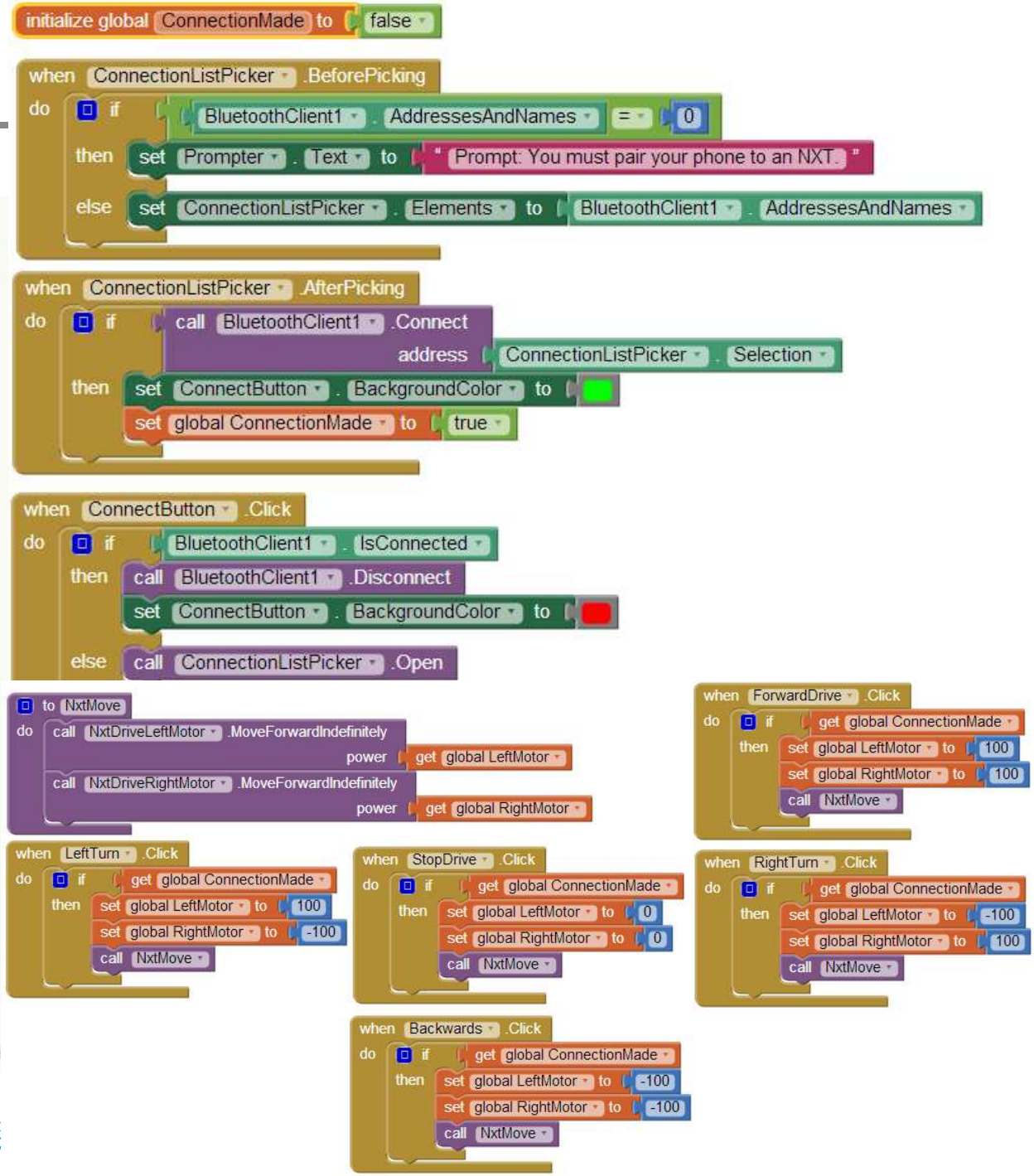


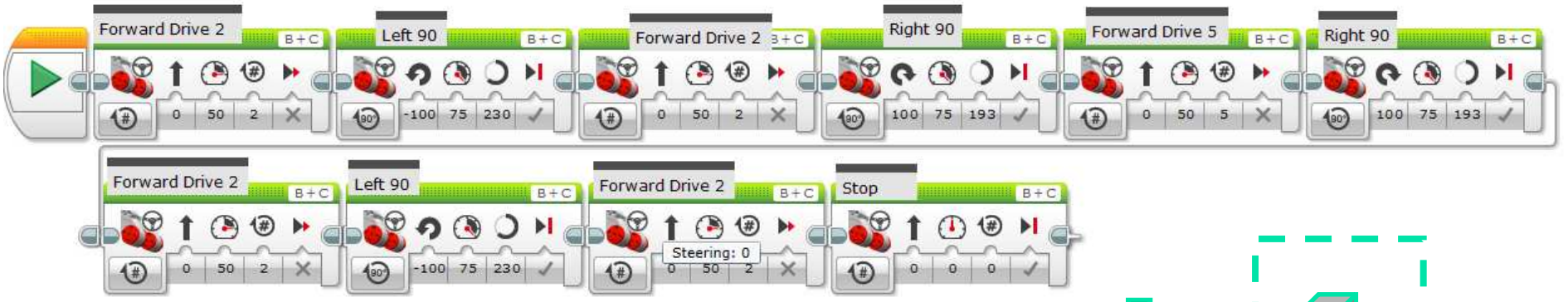



# Lego NXT Robot App



# Lego EV3 Programming Environment

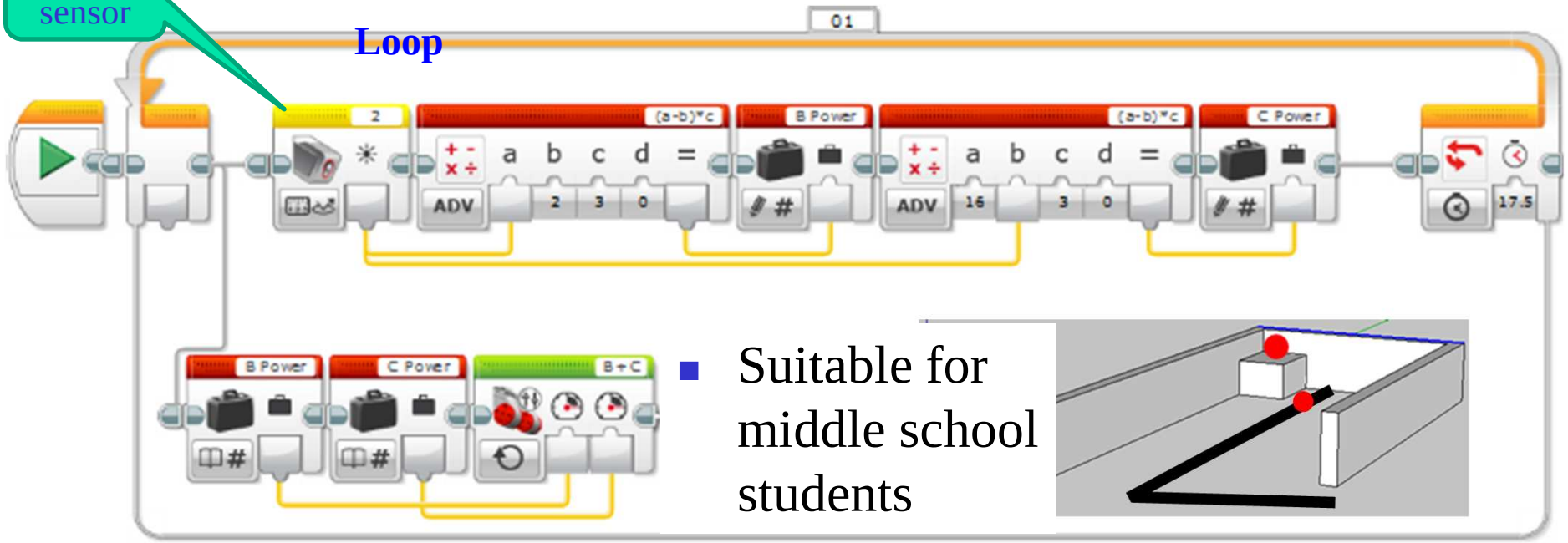



EV3 program for avoiding an obstacle



Color sensor

Loop




- Suitable for middle school students

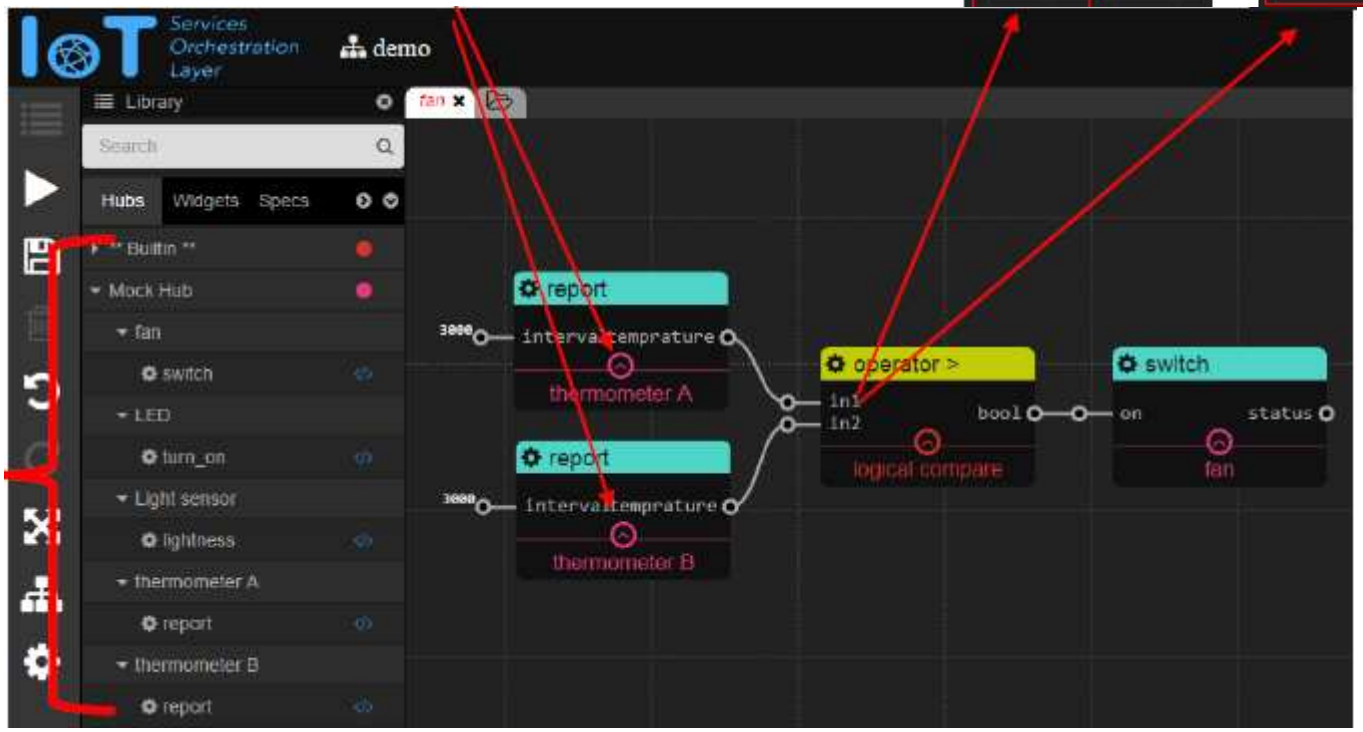


A line following program using the color sensor

# Intel IoT Service Orchestration Layer

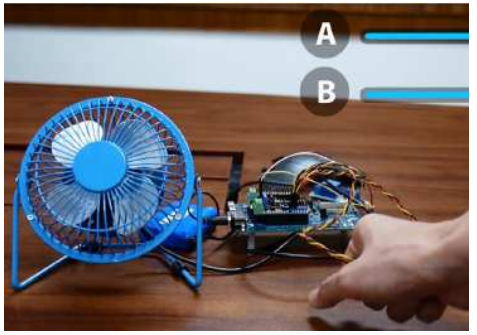
- Deliver a robust, extensible, high quality Solution for creating IoT Apps in minutes

https//github.com/01org/intel-iot-services-orchestration-layer

# Intel IoT Service Orchestration Layer

- Demo –Add UI into Workflow

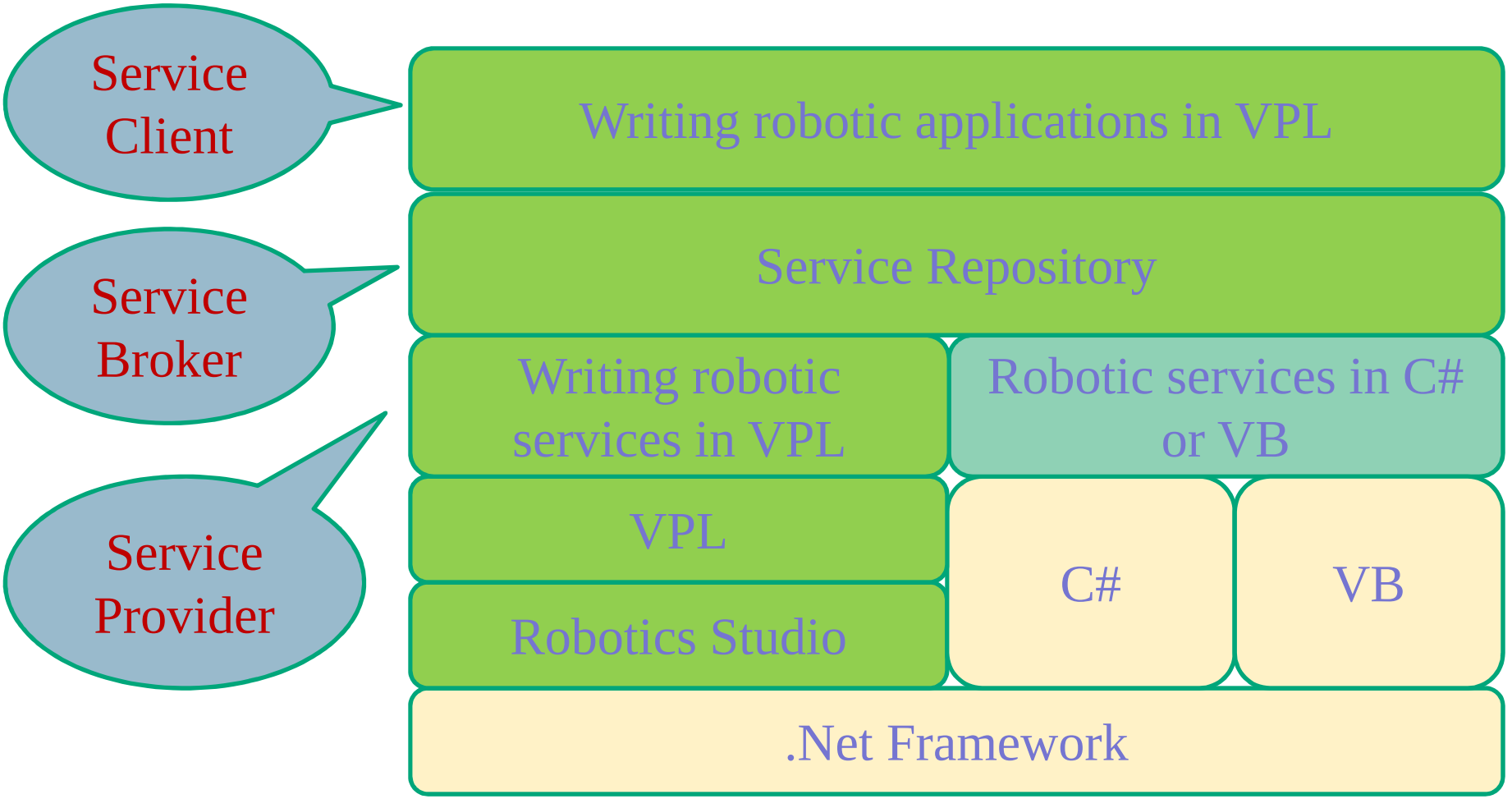




Design what End User would see

HTML5 UI widgets behave like a virtual IoT Thing

# Microsoft Robotics Developer Studio MRDS and VPL


Download Microsoft Robotics Developer Studio 4
http://msdn.microsoft.com/en-us/robotics/aa731520

# MRDS and VPL focus on Vendor-Specific Robots

Coroware

Kuka

Robosoft

NXT Mindstorms

WhiteBoxRobotics

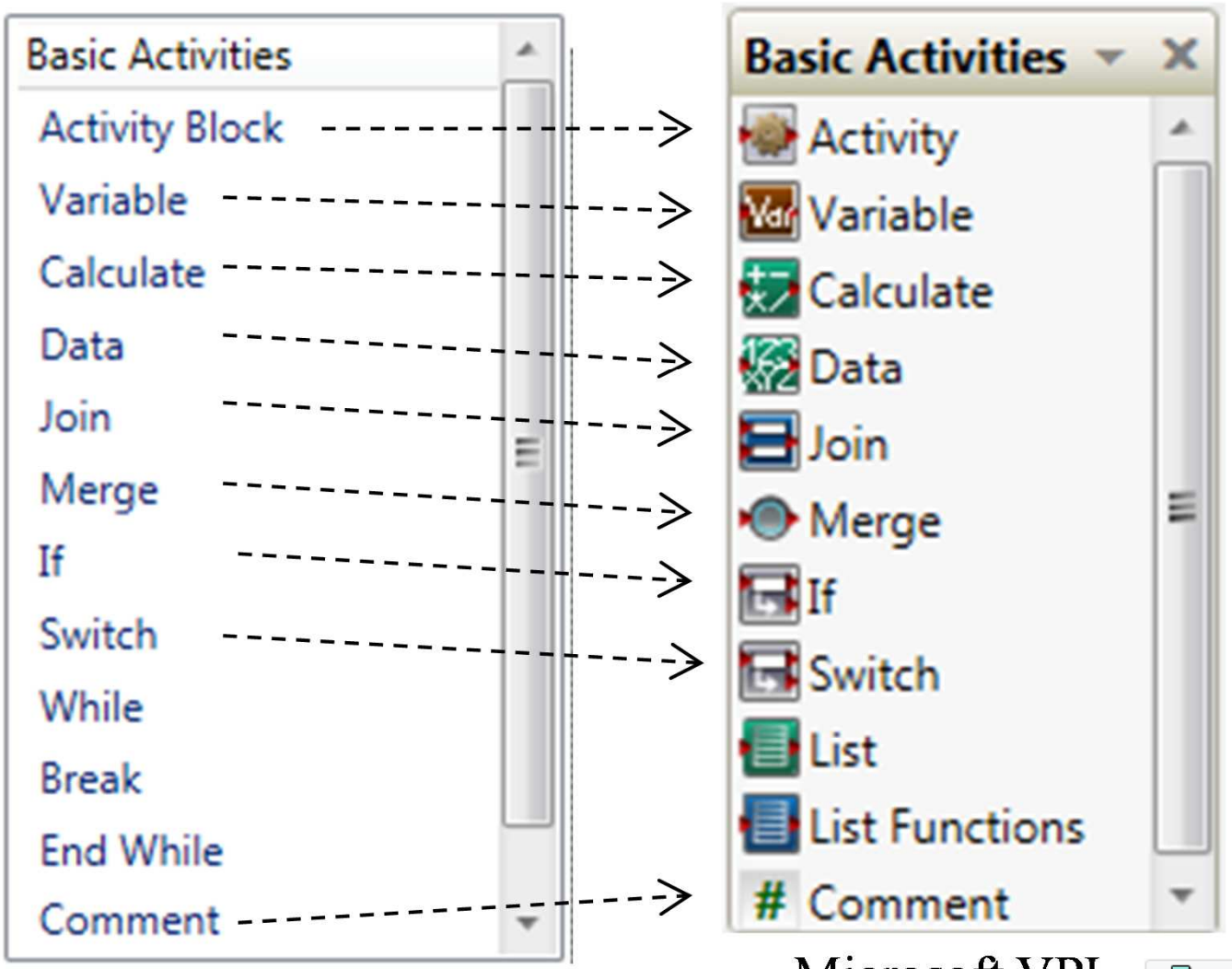
Robotics Connection

PARALLAX INC
www.parallax.com


# Problems with MRDS - VPL

- MRDS - VPL is service-oriented, uses workflow-based visual programming, and supports many robotics platforms.
- It is a milestone and flagship in software engineering and in computer science education.
- Many universities and high schools have adopted VPL as a tool for teaching computing and engineering concepts and for programming robots.
- Unfortunately, as part of Microsoft's restructuring plan, MRDS – VPL was suspended on September 22, 2014, leaving the VPL community without updates and support.
- No support for new platforms, such as EV3.
- ASU is among the schools that adopted VPL since its first release in 2006.
- We started to find a solution to our FSE100 in 2014.

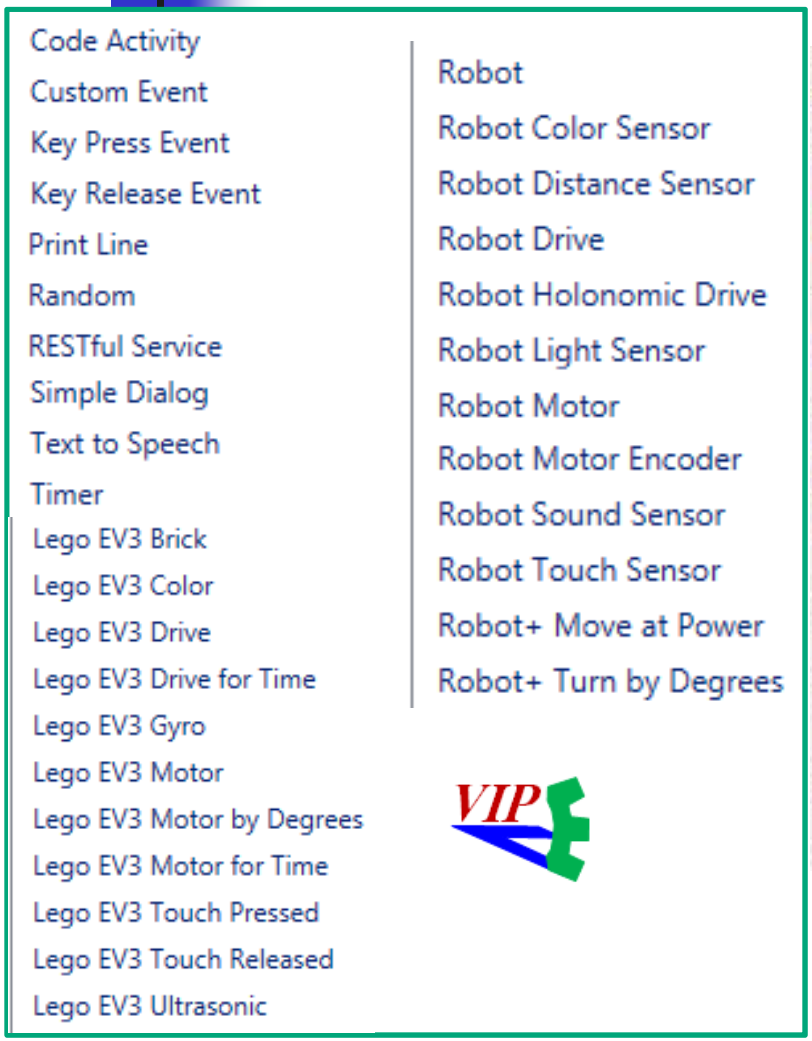
# VIPLE is developed to Help VPL Community



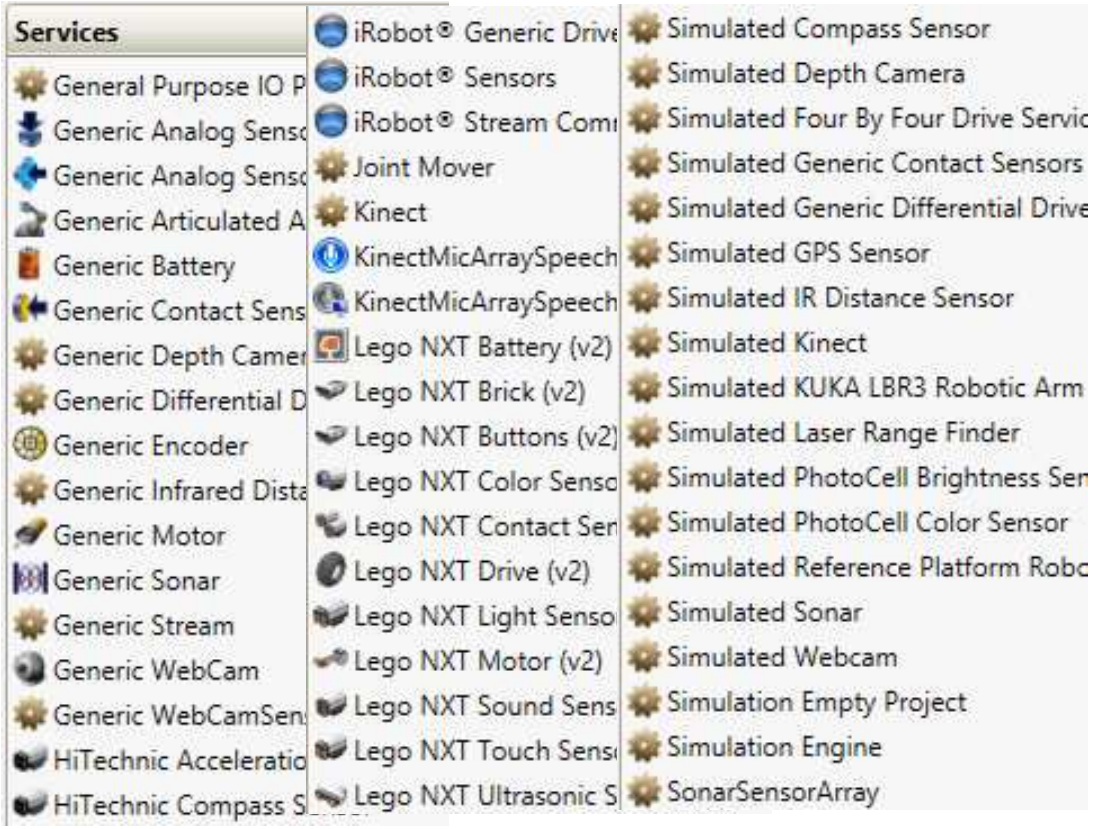

ASU VIPLE Basic Activities

Microsoft VPL Basic Activities

# VIPLE vs. VPL Services



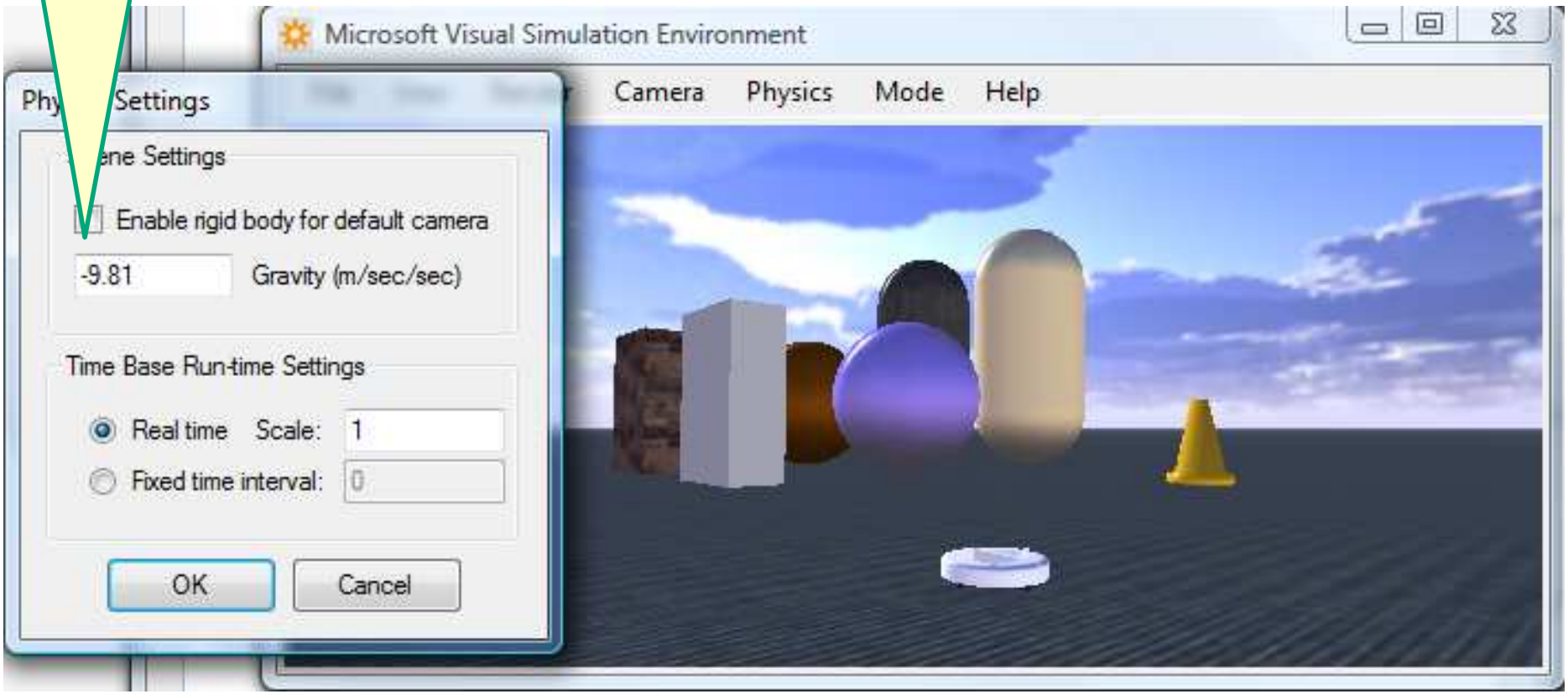

ASU VIPLE basic service, Simulated services, EV3 services, and Generic Services




Microsoft VPL Generic, Vendor, and Simulated Services

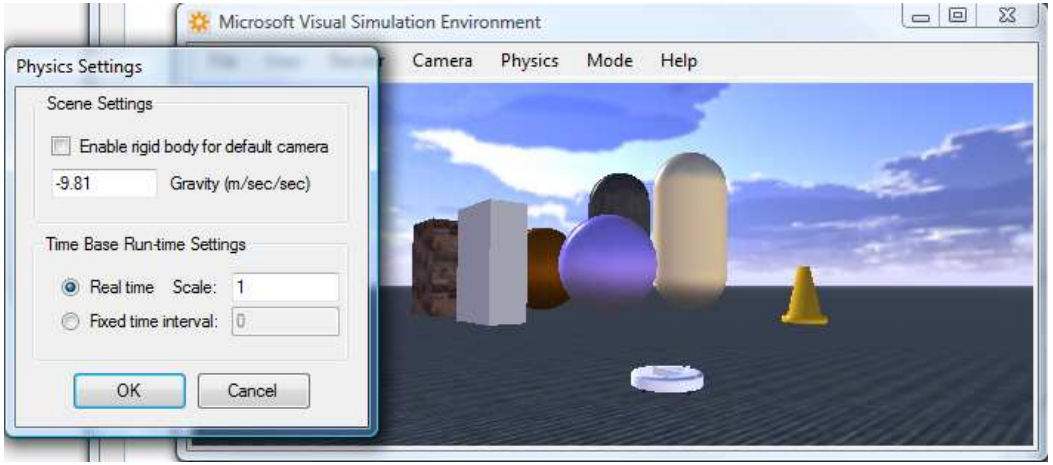
# MRDS VPL Simulation

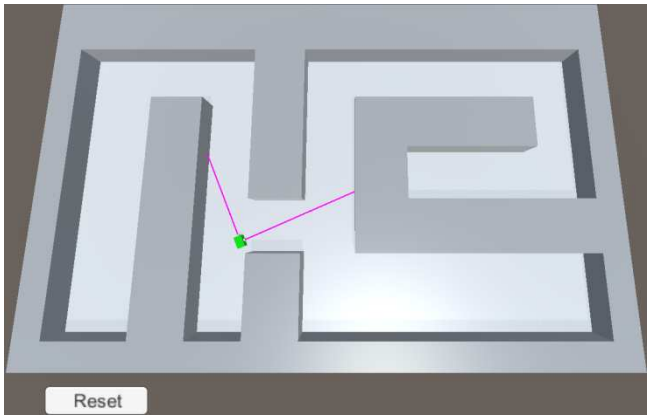
Change the value and see the behavior of the objects

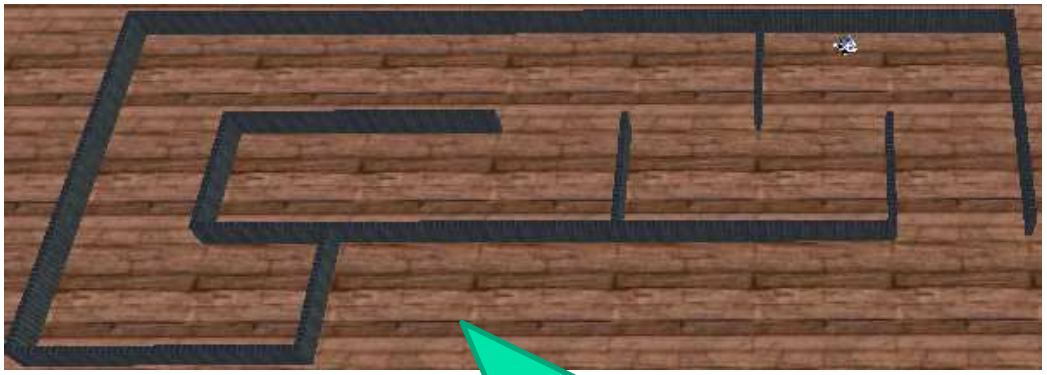


# VPL vs. VIPLE Simulation Environment





Statically reconfiguration

Dynamically reconfiguration

# ASU Crisis and Solution -- ASU 危机和解决方案

- Crisis in Computing was experienced at ASU.
- CSE enrollments dropped 50% from 200 between 2002 and 2004. from 200 students to less than 100 students.
- Recruitment and retention become an issue for the first time
- Developing a new course to serve the purpose of recruitment and retention.
- CSE101 was first offered in with **70** students in two sections in Fall 2006.
- In Fall 2011, **350** students enrolled in 8 parallel sections
- CSE101 model (lecture + hands-on lab) is extended to FSE100 for all engineering students: CSE version emphasizes on robotics and programming. Other majors have different emphases.
- FSE100 for CS in Fall 2016: 15 sections, with **645** students