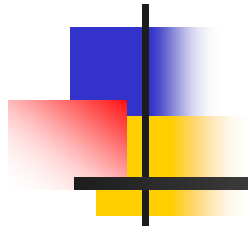


物联网和机器人导论

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/>



Yinong Chen 陈以农



Web Images Video ^{New!} News Maps [more »](#)

Yinong Chen

Google Search

I'm Feeling Lucky

[Advanced Search](#)
[Preferences](#)
[Language Tools](#)

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
In-class exercises, Exams
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
Hand-on, Programming, Experimentation
Lab assignment to complete
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

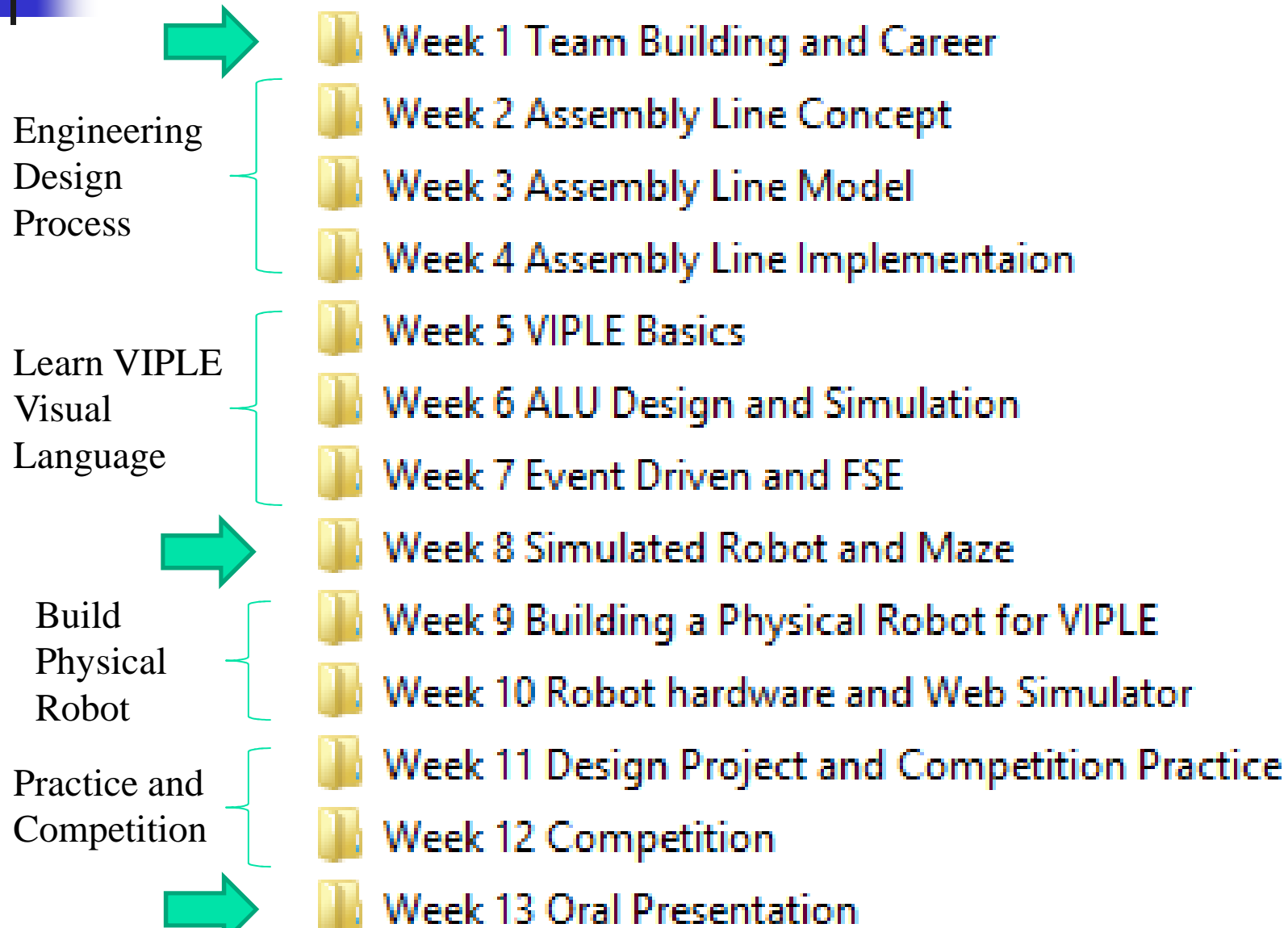
- Read the lecture slides before class
- Read the related book chapter/sections after the class
- Prepare for the lab before the lab session: There is a pre-lab-quiz to enforce the preparation
- Complete homework / project

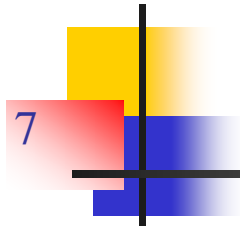
Sample Lectures Available Online

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

- L01 - About the Course and Syllabus
 - L02 - CS Related Disciplines
 - L03 - VIPLE - Visual IoT/Robotics Programming Language
 - L04 - ALU Simulation in VIPLE
 - L05 - Number systems
 - L06 - Finite State Machine and Programming
 - L07 - Algorithms
 - L08 - Event Driven Programming
 - L09 - Programming Languages
 - 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
- 1. Day One Issues FSE100
 - 2. Engineering Design Process 1
 - 3. Engineering Design Process 2
 - 4. Engineering Design Process 3
 - 5. Software Engineering and VIPLE
 - 6. Computer and Logic Design
 - 7 - Finite State Machine and Programming
 - 8 - Algorithms
 - 9 - Operating Systems
 - 10 - Robotics
 - 11 - Teamwork and Meeting
 - 12 - Presentation Techniques 2016
 - 13 - Evaluation in Amdahls Law
 - 14 - Monte Carlo Simulation
-

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)

10

<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

ten

Software Engineers and CS Occupations (There are many more)

11

in U.S. DoL Occupational Outlook Handbook

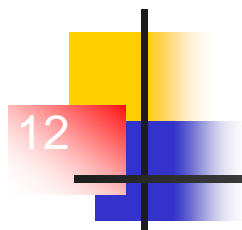
All Engineers

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



BEST JOBS IN AMERICA

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

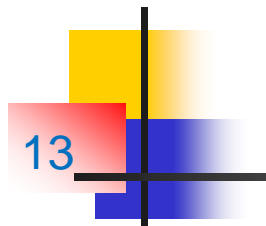
Money
salary.com™

CNNMoney.com™ 2009
A Service of CNN, Fortune & Money

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

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

10
40



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

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.

2016Google 师资培育与课程建设第二期“嵌入式与系统软件开发”研讨班

Y. Chen

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



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



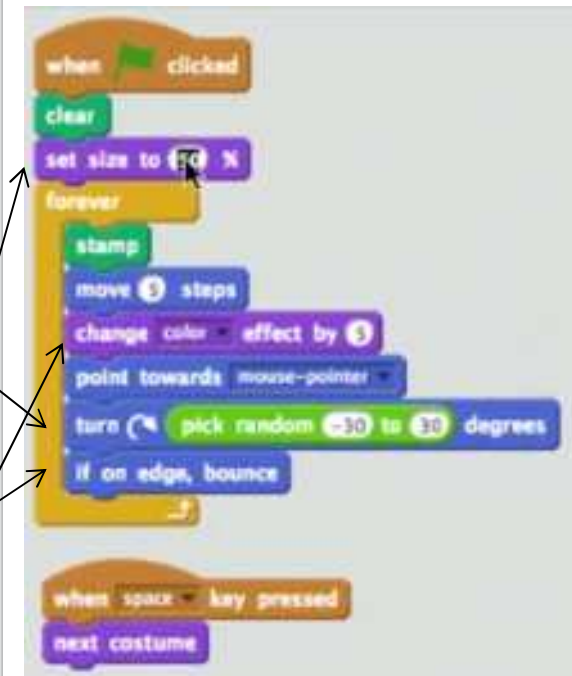
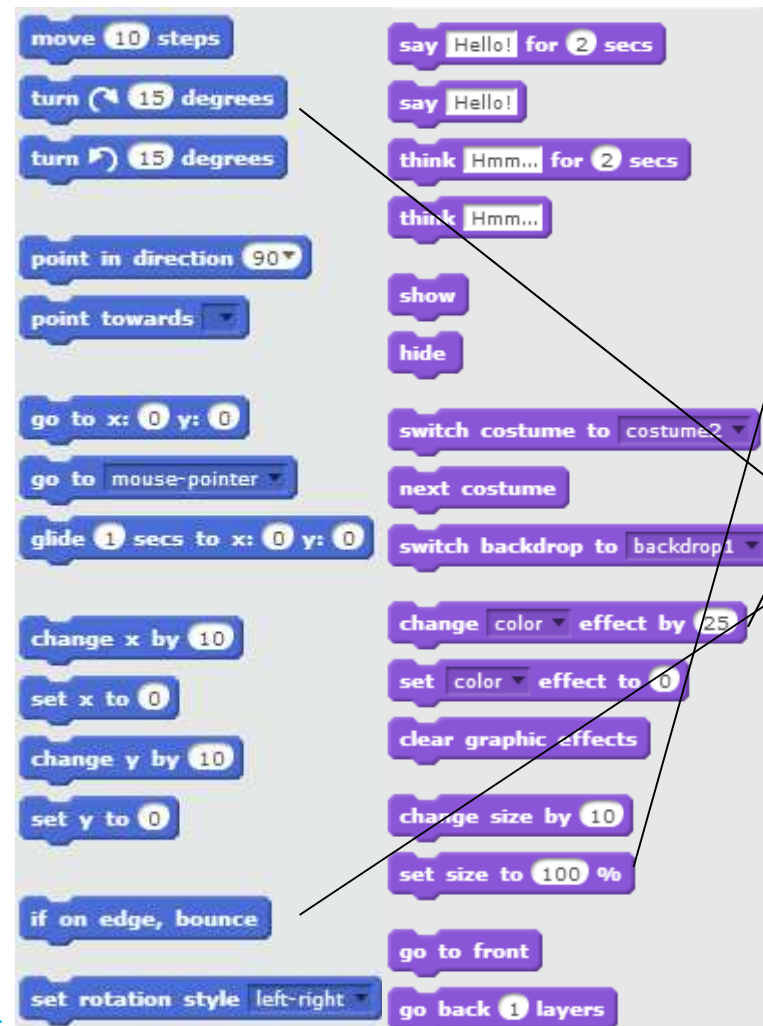
Microsoft Robotics Developer Studio Visual Programming
Language MRDS VPL



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



- Select figures and scene
- Select functions
- Define their combinations



- Suitable for primary school students



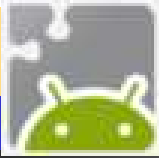
Alice Game Programming Environment

The screenshot displays the Alice 3.1 interface. On the left, a 3D scene window shows three characters: a Mad Hatter, a March Hare, and a Cheshire Cat. Below this is a 'Procedures' panel with a search bar and a list of procedures for 'this.marchHare'. The main area is the 'Script Editor' for a scene named 'myFirstMethod'. It contains a 'do in order' block with a 'turn RIGHT' action for 'this.madHatter' and a 'move' action for 'this.marchHare'. A dropdown menu for the 'move' action shows directions: LEFT, RIGHT, UP, DOWN, FORWARD (selected), and BACKWARD. The 'amount' for FORWARD is set to 0.5. Below this is a 'do together' block with two 'do in order' sub-blocks. The first sub-block contains a 'move FORWARD' action for 'this.marchHare' and a 'move BACKWARD' action for 'this.marchHare'. The second sub-block contains two 'moveToward' actions for 'this.cheshireCat', one targeting 'this.madHatter' and the other 'this.marchHare', both with an amount of 1.0. On the right side of the interface, four yellow boxes with green borders contain the following text:

- Select a scene
- Select actors
- Define the actions for each actor
- Define timing and coordination

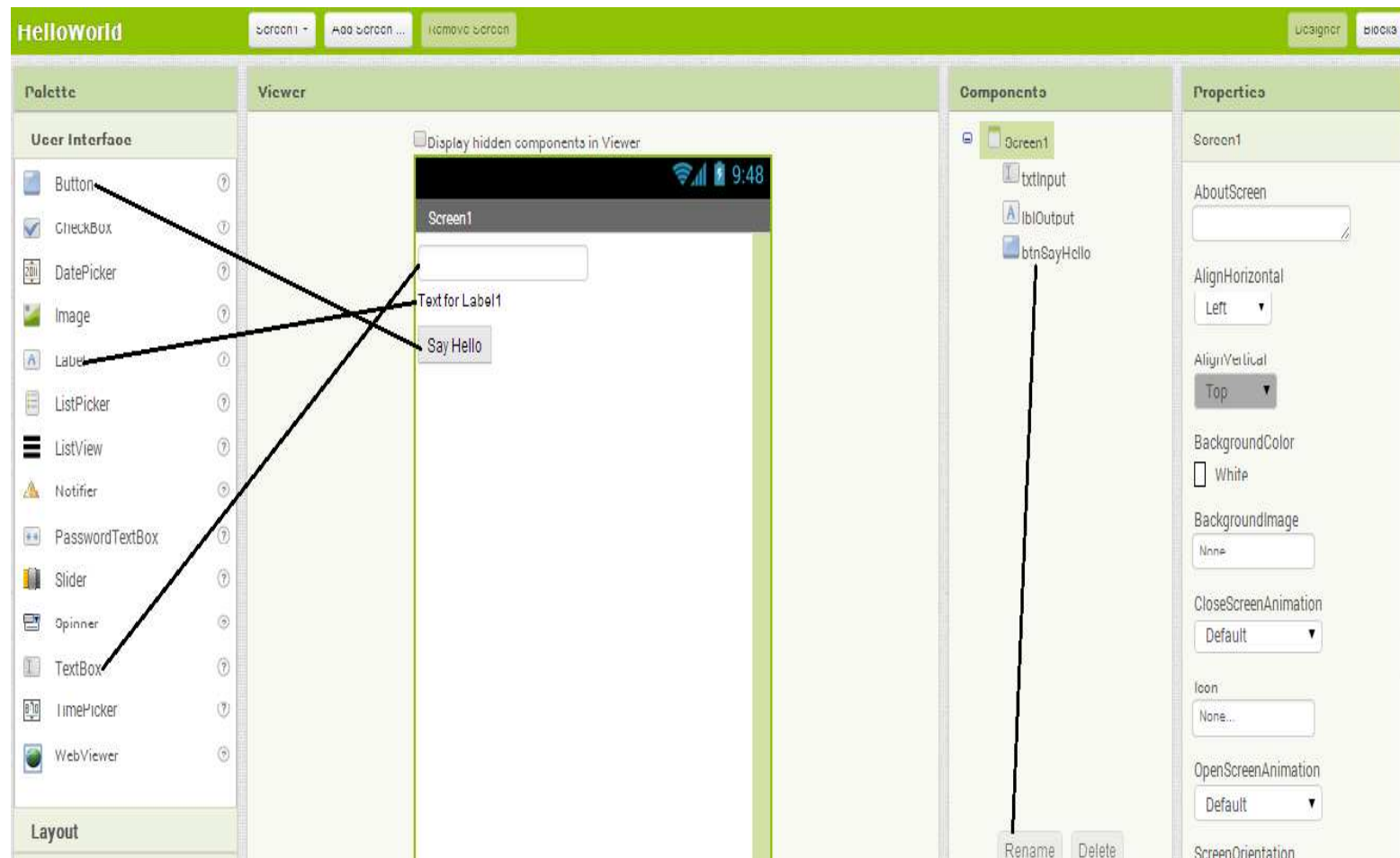
Below these boxes, a blue square bullet point is followed by the text:

Suitable for middle school students



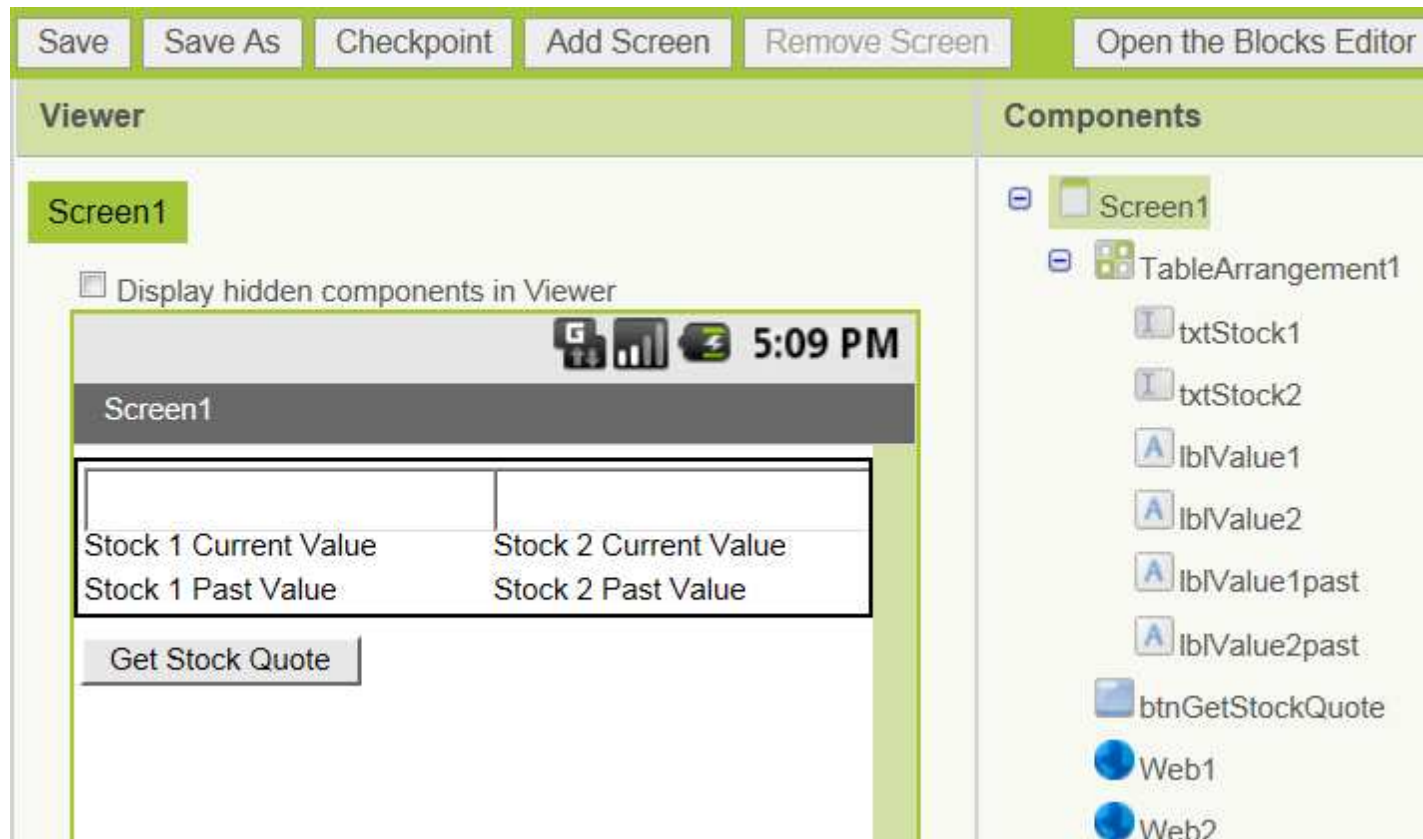
MIT/Google App Inventor for Android Phone

- 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



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

Blocks

- Built-in
 - Control
 - Logic
 - Math
 - Text
 - Lists
 - Colors
 - Variables
 - Procedures
- Screen1
 - TableArrangement1
 - txtStock1
 - txtStock2
 - lblValue1
 - lblValue2
 - lblValue1past
 - lblValue2past
 - btnGetStockQuote
 - Web1

Viewer

```
initialize global Past1 to "0"
initialize global Past2 to "0"

when btnGetStockQuote .Click
do
  set Web1 . Url to join " http://finance.yahoo.com/d/quotes.csv?f=l1&s="
  txtStock1 . Text
  call Web1 .Get
  set Web2 . Url to join " http://finance.yahoo.com/d/quotes.csv?f=l1&s="
  txtStock2 . Text
  call Web2 .Get
  set lblValue1past . Text to get global Past1
  set lblValue2past . Text to get global Past2

Returns the value of this variable.
```

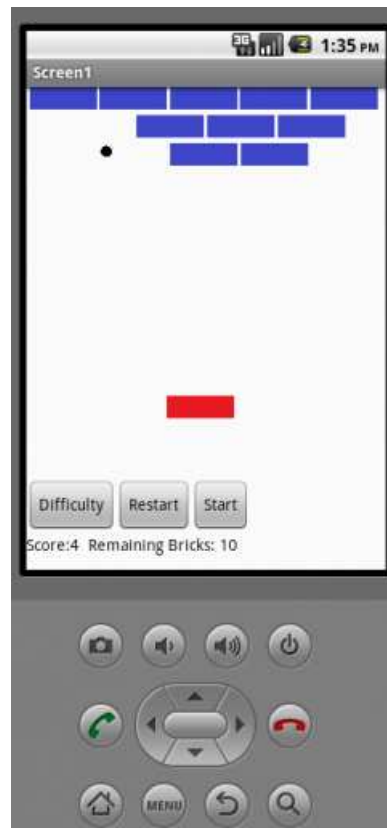
0 0
Show Warnings

Call
RESTful

Processing return
value from Web
service

育与课程

Implementing a Game: BrickPong



```

to updateScore
do
  if (get global remainingBricks = 0)
  then
    set Score . Text to (join "You Win! Score: "
                              (get global score)
                              " Remaining Bricks: "
                              (get global remainingBricks))
    set Ball1 . Speed to 0
  else
    set Score . Text to (join "Score: "
                              (get global score)
                              " Remaining Bricks: "
                              (get global remainingBricks))
  end
end
  
```

```

to addtoscore
do
  set global score to (get global score + get global brickValue)
  set global remainingBricks to (get global remainingBricks - 1)
  call updateScore
end
  
```

```

when Restart . Click
do
  set global gameStarted to false
  set Ball1 . Speed to 0
  call Ball1 . MoveTo
    x 150
    y 260
  call PlayerBrick . MoveTo
    x 125
    y 275
  call ResetBrickPosition
  set global score to 0
  set global remainingBricks to 12
  call updateScore
end
  
```

```

when BScoreBrick . CollidedWith
  other
do
  set BScoreBrick . Visible to false
  set global brickValue to 3
  call addtoscore
end
  
```

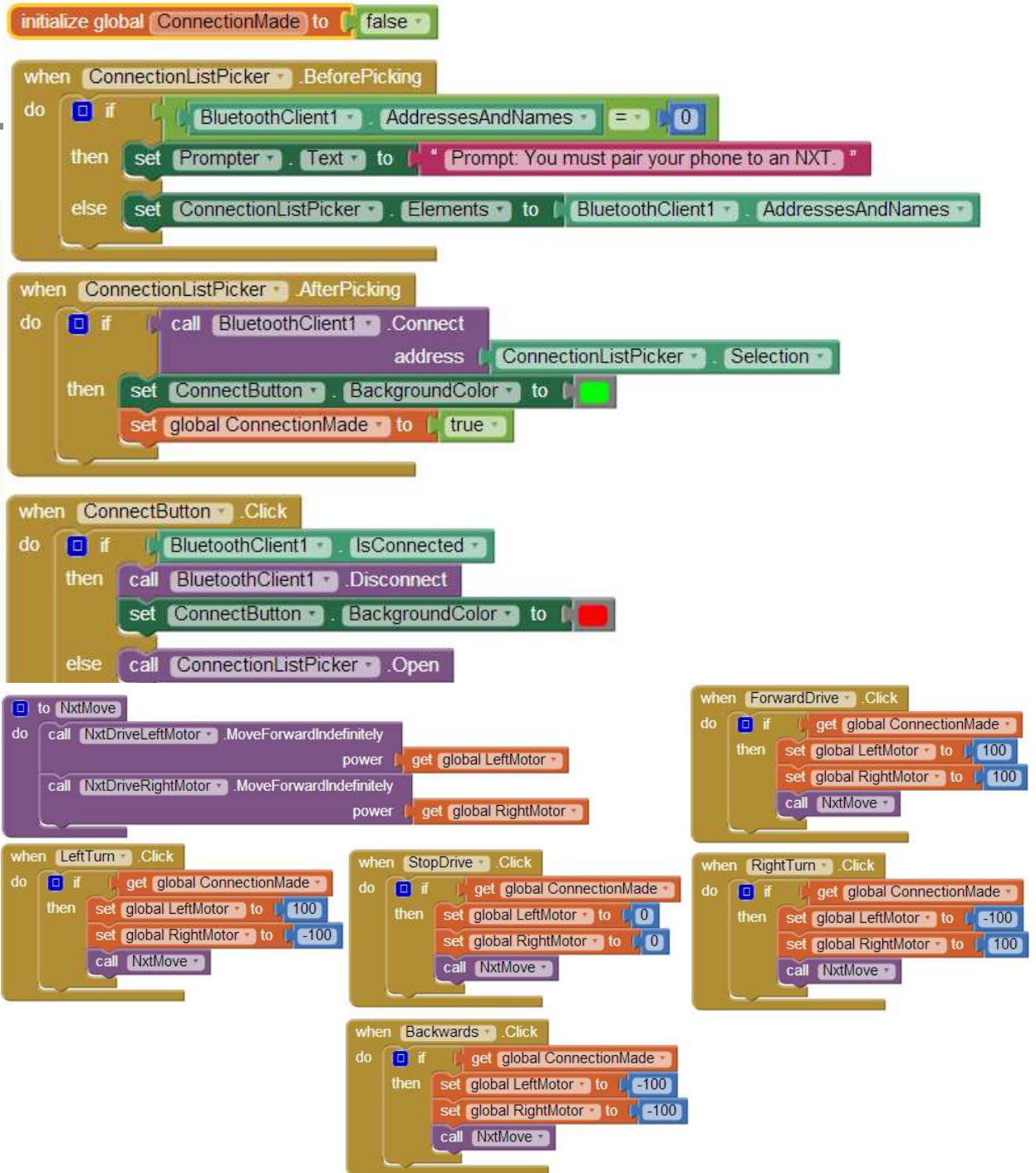
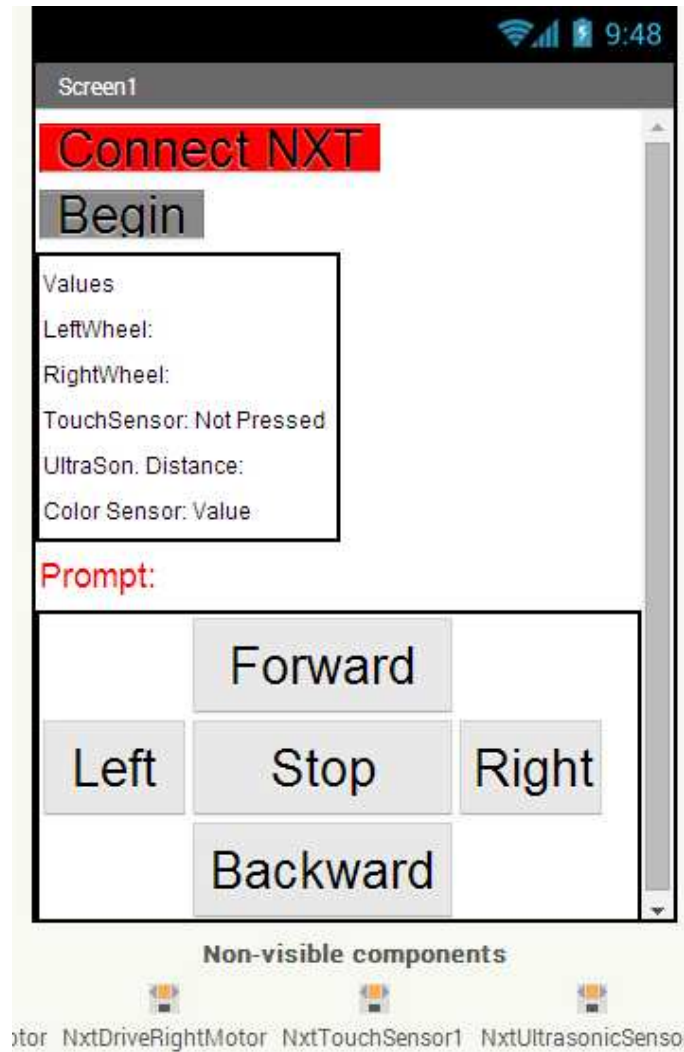
```

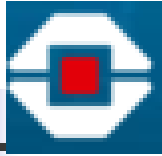
when MScoreBrick7 . CollidedWith
  other
do
  set MScoreBrick7 . Visible to false
  set global brickValue to 3
  call addtoscore
end
  
```

```

when FScoreBrick11 . CollidedWith
  other
do
  set FScoreBrick11 . Visible to false
  set global brickValue to 1
  call addtoscore
end
  
```


Lego NXT Robot App

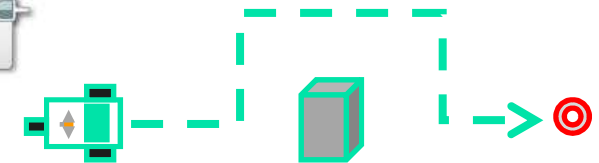




Lego EV3 Programming Environment

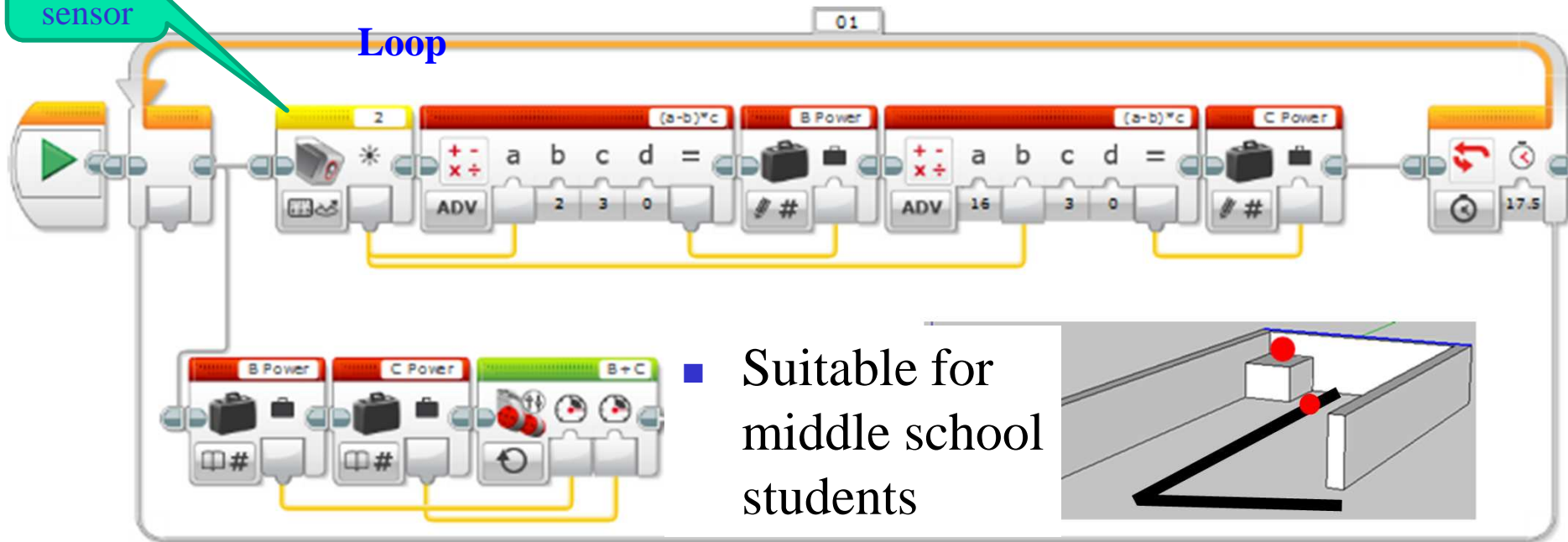


EV3 program for avoiding an obstacle

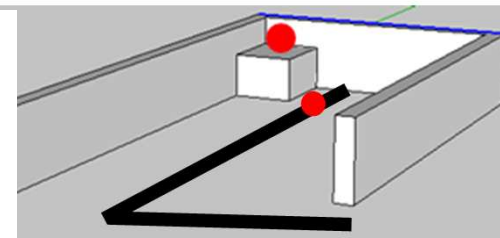


Color
sensor

Loop



- Suitable for middle school students

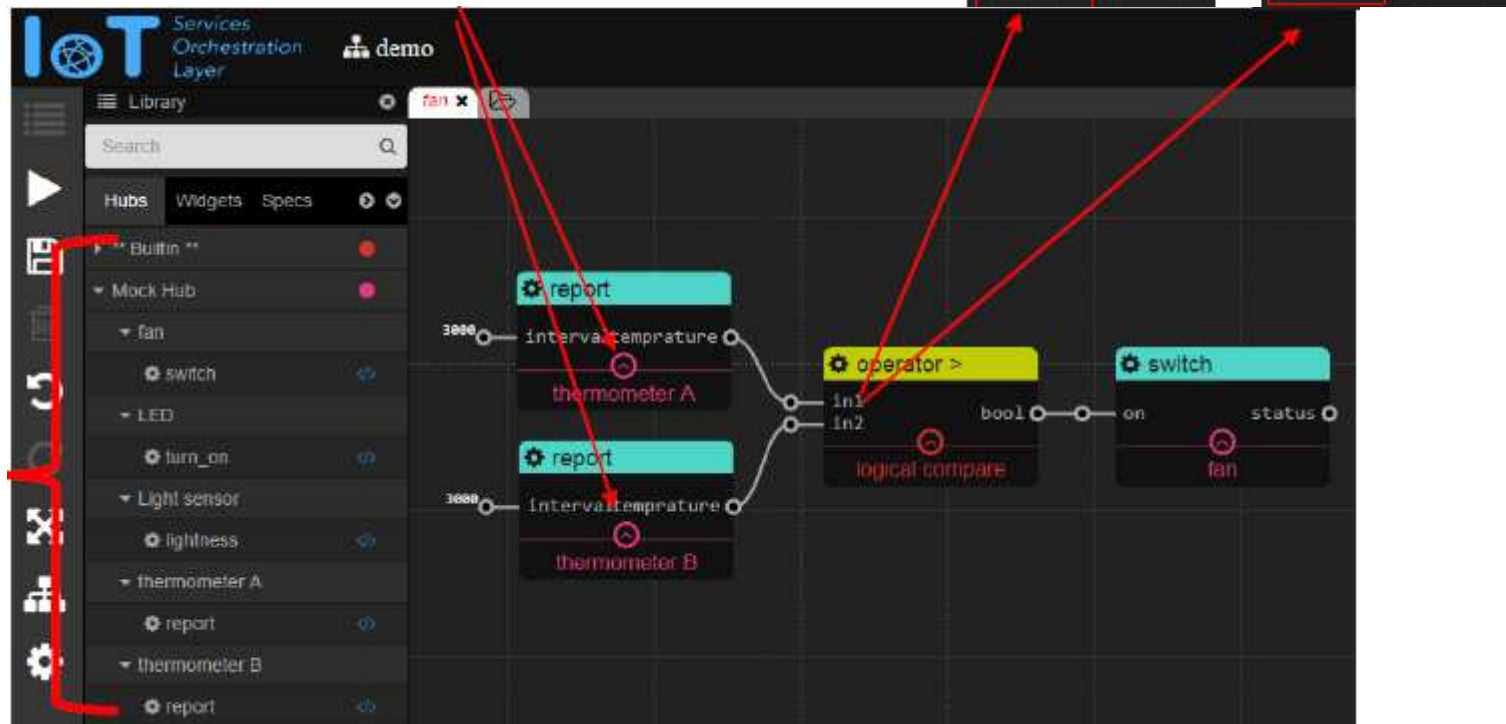




Intel IoT Service Orchestration Layer

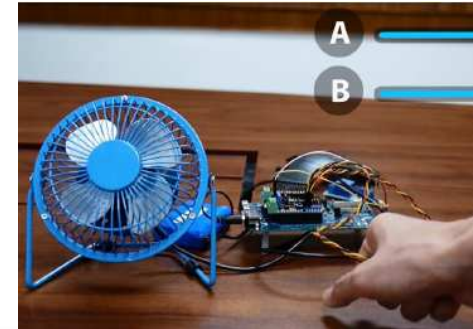
- Deliver a robust, extensible, high quality Solution for creating IoT Apps in minutes

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



Intel IoT Service Orchestration Layer

■ Demo –Add UI into Workflow

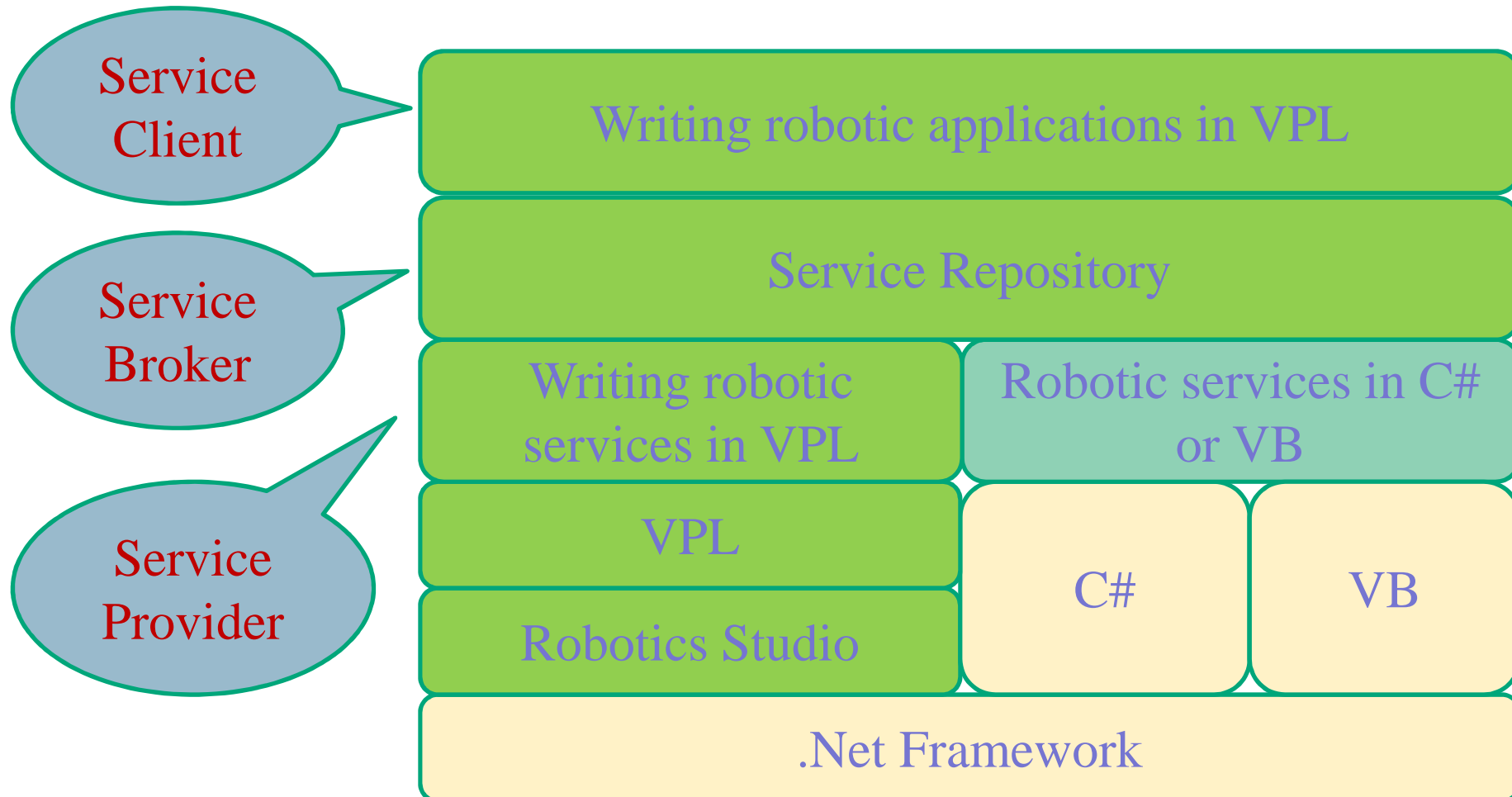
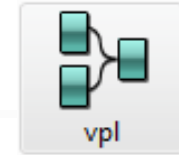


Design what End User would see

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>

2016Google师资培育与课程建设第二期“嵌入式与系统软件开发”研讨班

Y. Chen

MRDS and VPL focus on Vendor-Specific Robots



Coroware



Kuka



Robosoft



NXT Mindstorms



WhiteBoxRobotics



Robotics Connection

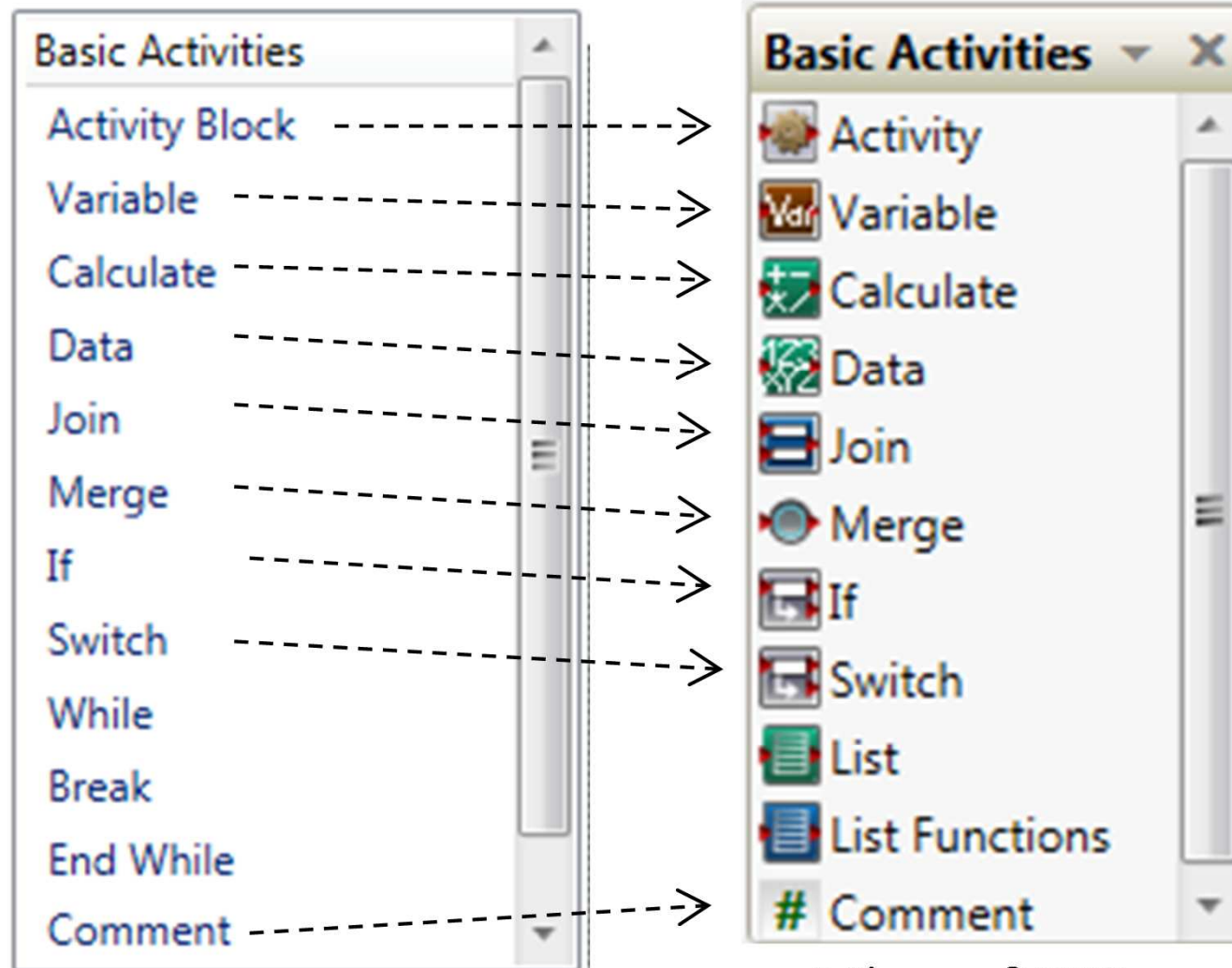




Problems with MRDS - VPL

- 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 ESE100 in 2014.

VIPLE is developed to Help VPL Community



ASU VIPLE Basic Activities

Microsoft VPL
Basic Activities



VIPLE vs. VPL Services

Code Activity	Robot
Custom Event	Robot Color Sensor
Key Press Event	Robot Distance Sensor
Key Release Event	Robot Drive
Print Line	Robot Holonomic Drive
Random	Robot Light Sensor
RESTful Service	Robot Motor
Simple Dialog	Robot Motor Encoder
Text to Speech	Robot Sound Sensor
Timer	Robot Touch Sensor
Lego EV3 Brick	Robot+ Move at Power
Lego EV3 Color	Robot+ Turn by Degrees
Lego EV3 Drive	
Lego EV3 Drive for Time	
Lego EV3 Gyro	
Lego EV3 Motor	
Lego EV3 Motor by Degrees	
Lego EV3 Motor for Time	
Lego EV3 Touch Pressed	
Lego EV3 Touch Released	
Lego EV3 Ultrasonic	



Services		
General Purpose IO P	iRobot® Generic Drive	Simulated Compass Sensor
Generic Analog Sens	iRobot® Sensors	Simulated Depth Camera
Generic Analog Sens	iRobot® Stream Com	Simulated Four By Four Drive Servic
Generic Articulated A	Joint Mover	Simulated Generic Contact Sensors
Generic Battery	Kinect	Simulated Generic Differential Drive
Generic Contact Sens	KinectMicArraySpeech	Simulated GPS Sensor
Generic Depth Camer	KinectMicArraySpeech	Simulated IR Distance Sensor
Generic Differential D	Lego NXT Battery (v2)	Simulated Kinect
Generic Encoder	Lego NXT Brick (v2)	Simulated KUKA LBR3 Robotic Arm
Generic Infrared Dista	Lego NXT Buttons (v2)	Simulated Laser Range Finder
Generic Motor	Lego NXT Color Senso	Simulated PhotoCell Brightness Sen
Generic Sonar	Lego NXT Contact Ser	Simulated PhotoCell Color Sensor
Generic Stream	Lego NXT Drive (v2)	Simulated Reference Platform Robo
Generic WebCam	Lego NXT Light Senso	Simulated Sonar
Generic WebCamSen	Lego NXT Motor (v2)	Simulated Webcam
HiTechnic Acceleratio	Lego NXT Sound Sens	Simulation Empty Project
HiTechnic Compass S	Lego NXT Touch Sensi	Simulation Engine
	Lego NXT Ultrasonic S	SonarSensorArray

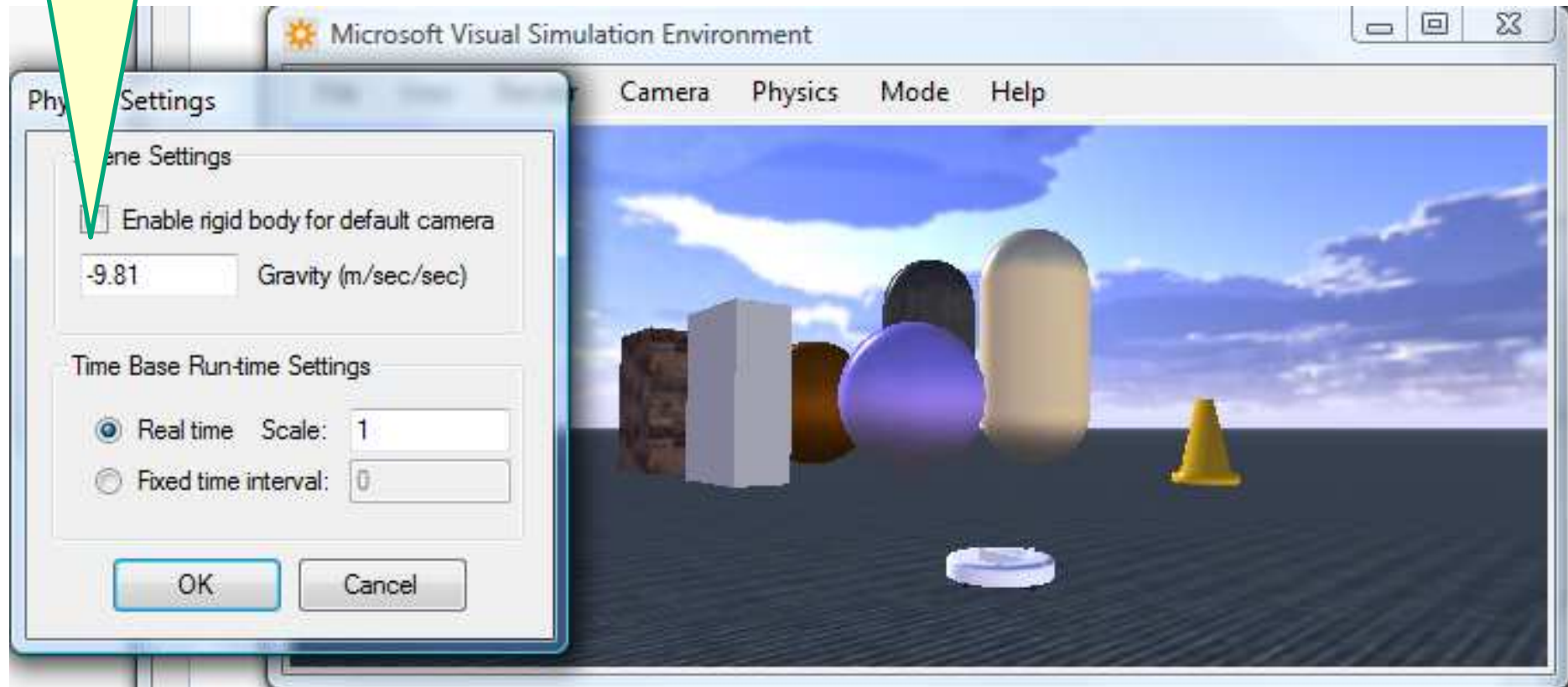
Microsoft VPL Generic, Vendor, and Simulated Services



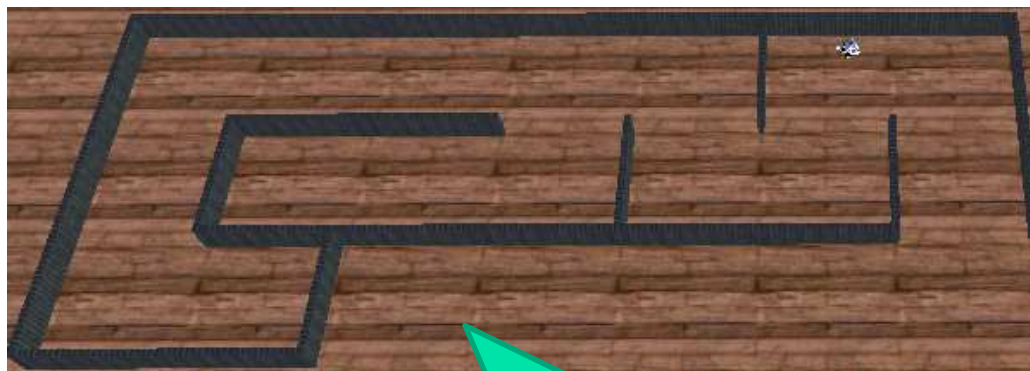
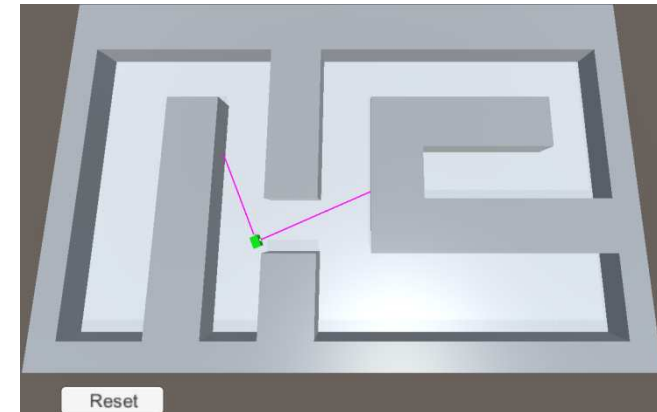
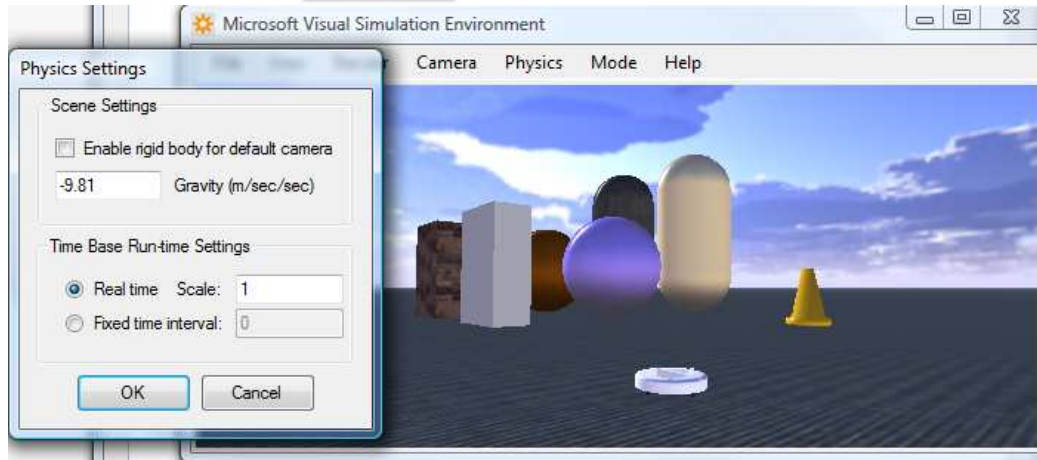
ASU VIPLE basic service, Simulated services, EV3 services, and Generic Services

MRDS VPL Simulation

Change the value
and see the
behavior of the
objects



VPL vs. VIPLE Simulation Environment



Statically
reconfiguration

Dynamically
reconfiguration

- 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