Making Advanced Computing Concepts Accessible for High School Students

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WHAT DO THESE HAVE IN COMMON?

















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NETSBLOX

- A blocks-based programming environment designed for making distributed computing more accessible
- An extension of Snap*!*, a popular blocks-based programming environment from Berkeley
- Two main networking abstractions:
  - Remote Procedure Calls
  - Message Passing
- These also facilitate learning about many other advanced concepts such as:
  - Cybersecurity
  - Robotics
  - Internet of Things

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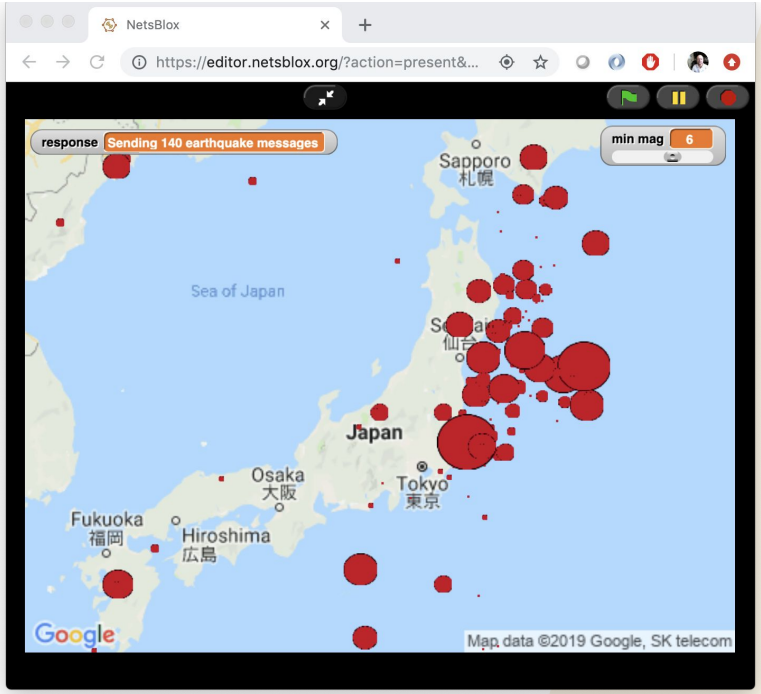
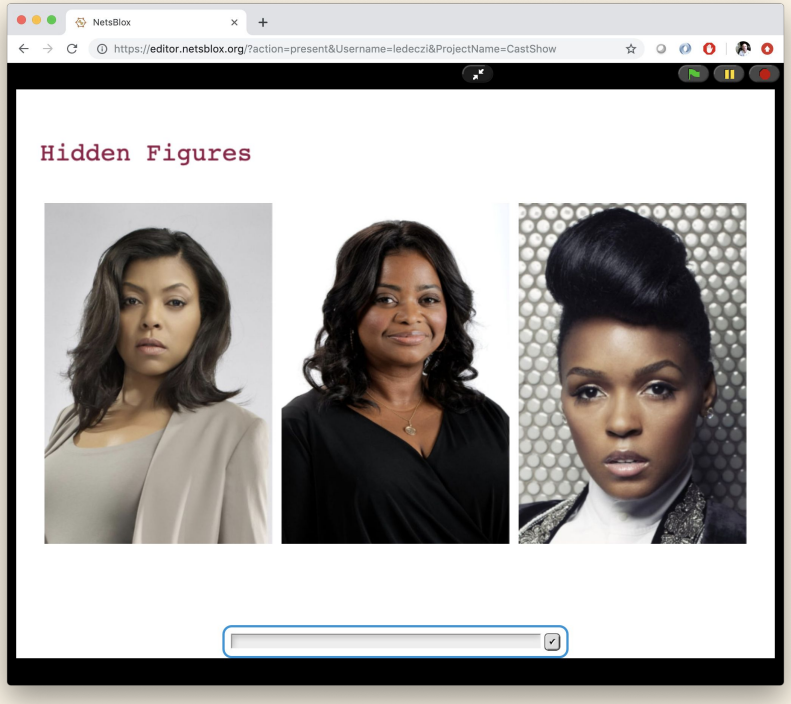
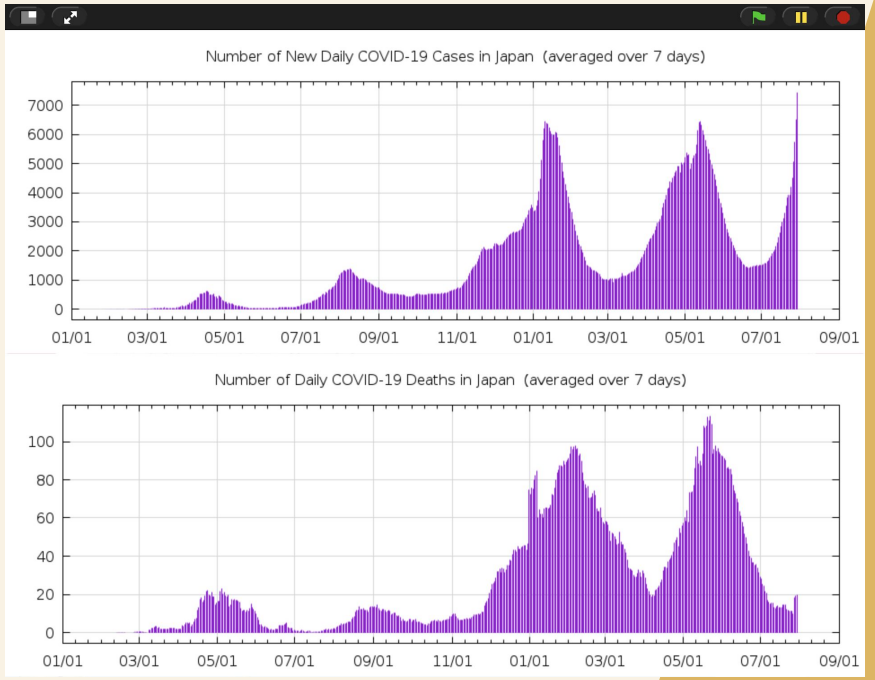
RPC DEMOS



Earthquake Visualization



Cast of Any Movie



COVID-19 Data

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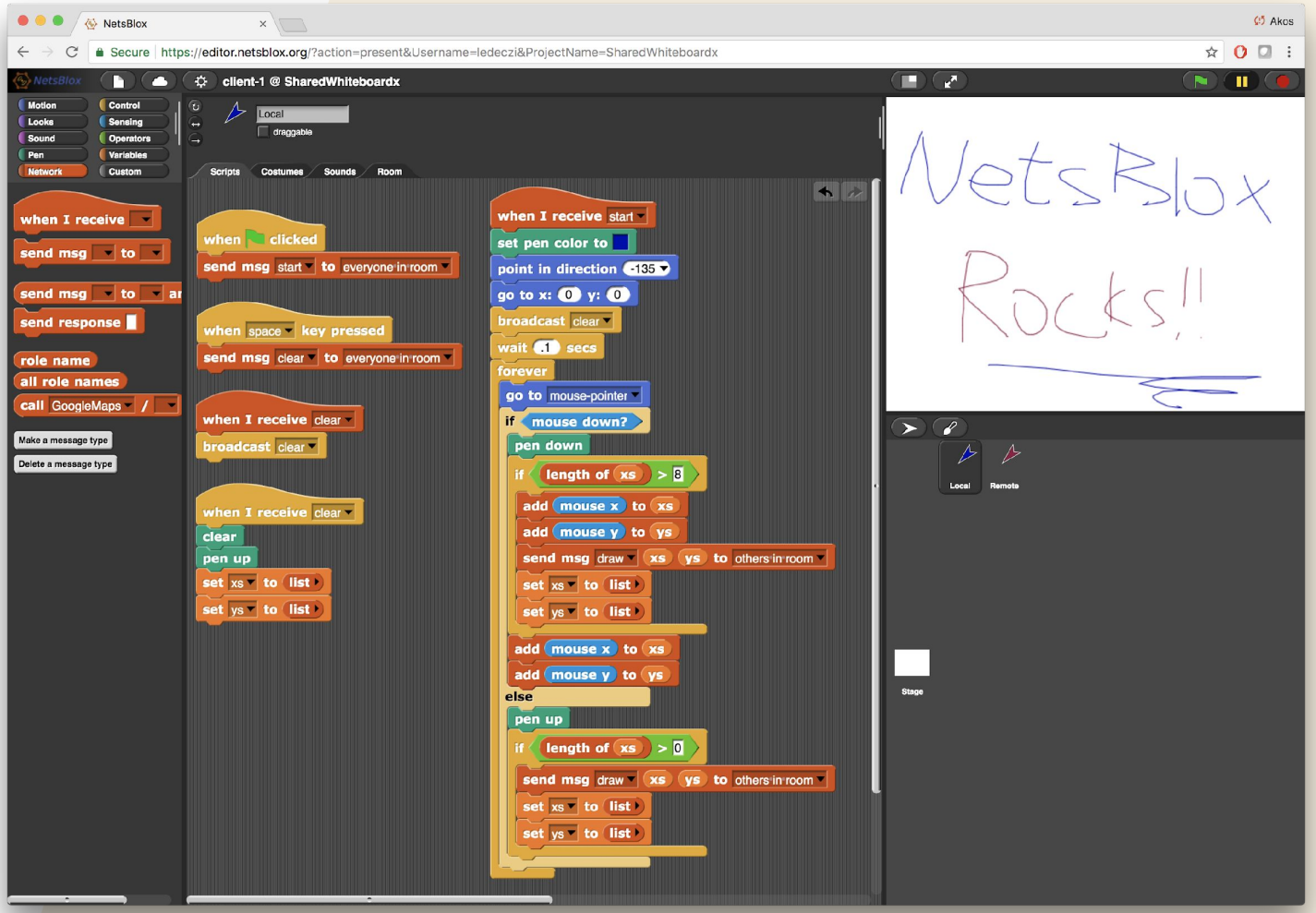
MESSAGE PASSING DEMOS



2-User Shared Whiteboard

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PhoneIoT

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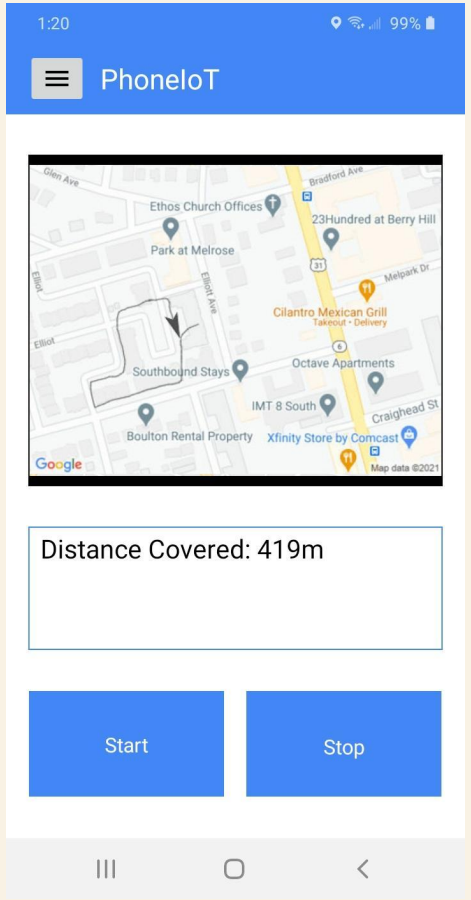
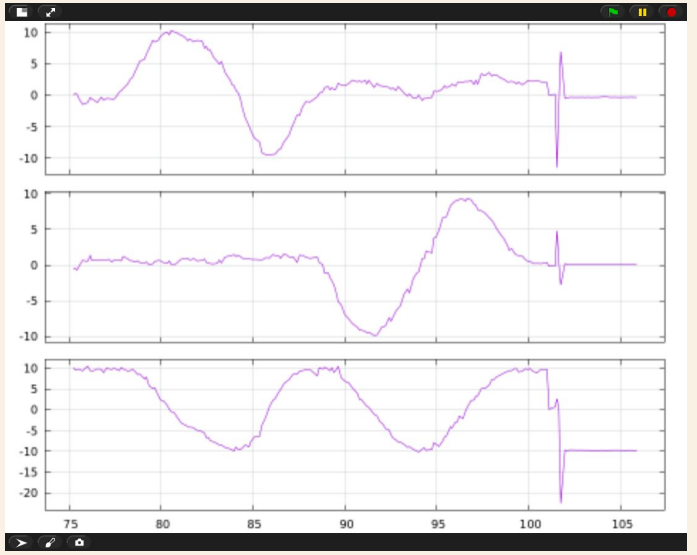
PhoneIoT
Education
OPEN

YOUR PHONE AS A SENSOR

- PhoneIoT, an iOS and Android app, provides access to all phone sensors for NetsBlox
- Get value (RPC) or turn on streaming (messages)
- NetsBlox programs can also place GUI widgets on the phone
- GUI events are NetsBlox messages
- Can be used to teach IoT and distributed computation
- Not a mobile app development environment!



Exercise Tracker
(phone display)



Plot 3-axis acceleration
(stage)

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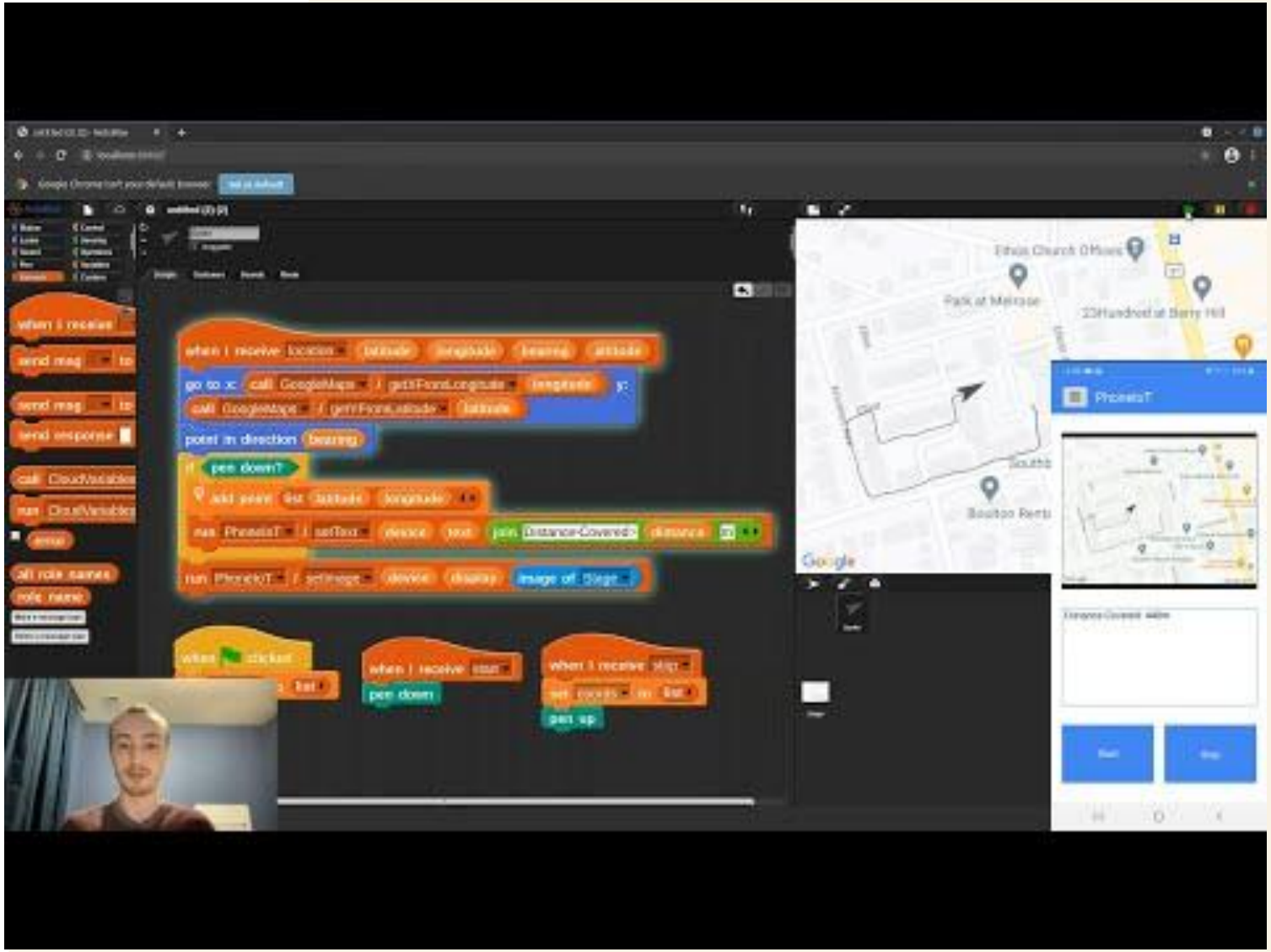
DEMOS



For the full video, check out https://tinyurl.com/phoneiot

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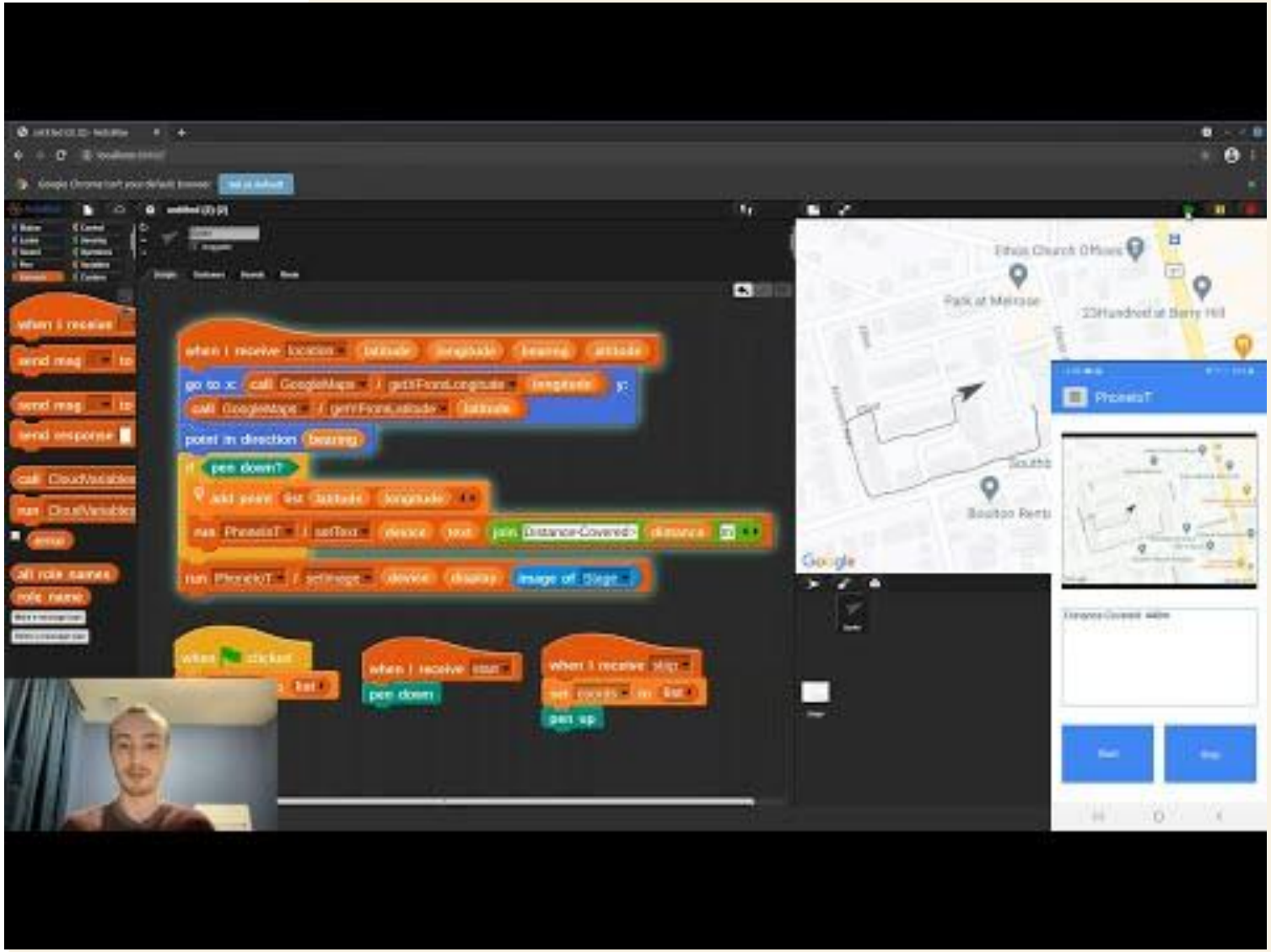
DEMOS



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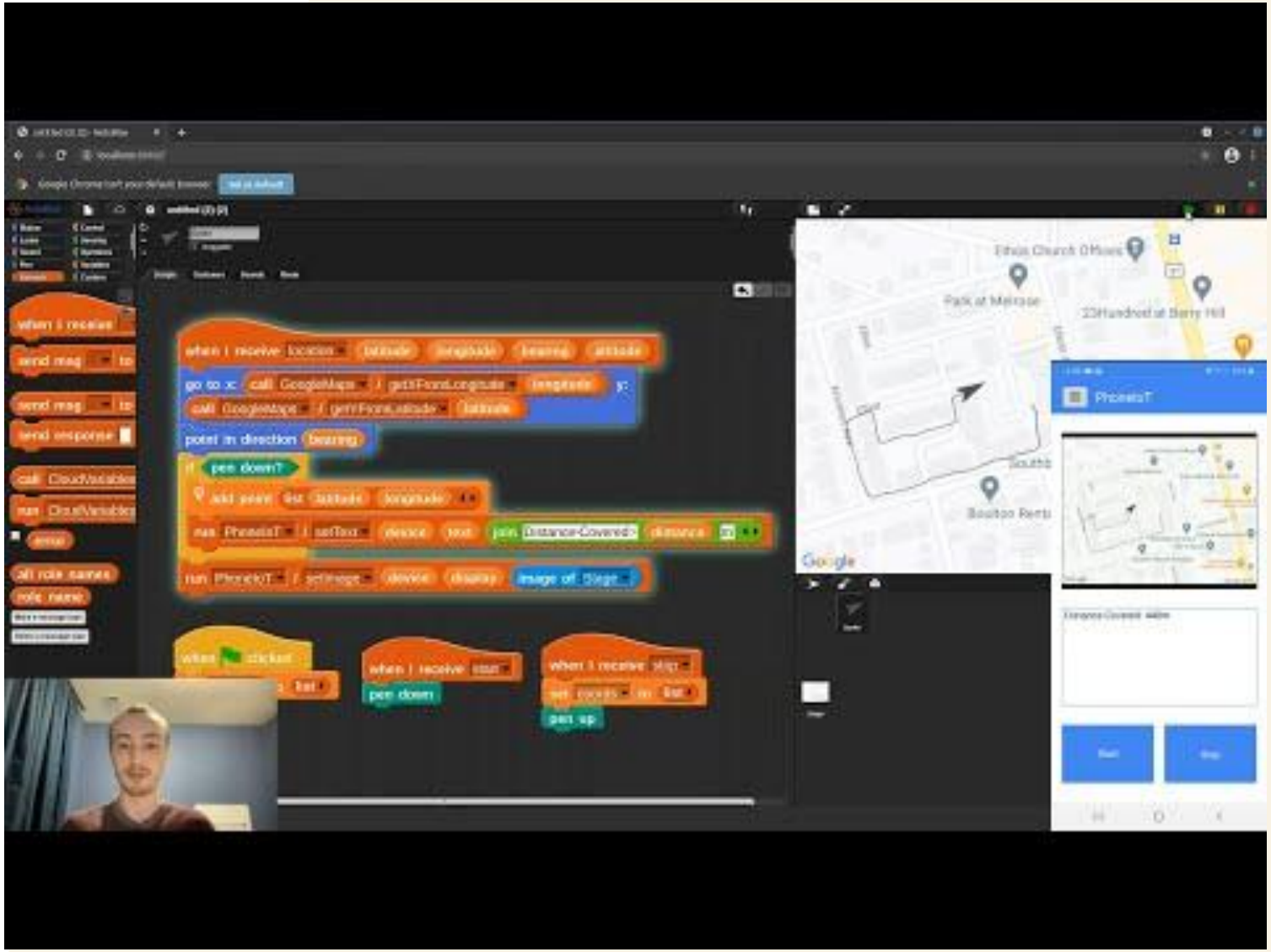

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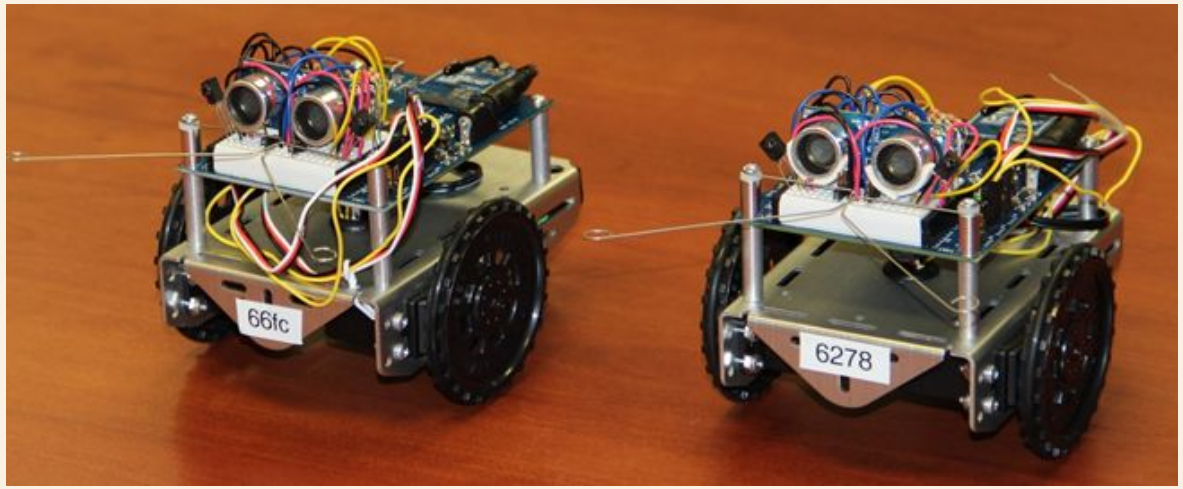
RoboScape

ROBOTICS WITH A TWIST

- RPCs and messages can be used to control WiFi-enabled robots
- Code runs in the browser (no wires, no downloads)
- Supports remote robotics out of the box



https://stemforall2019.videohall.com/presentations/1343

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ROBOTICS WITH A TWIST

- Wireless communication can be intercepted by other students, motivating cybersecurity
- Has been used to teach robotics and cybersecurity
- Encryption, secure key exchange, denial of service attacks, replay attacks, etc.
- Able to add security features without a firmware update
- Multiple summer camps

https://stemforall2019.videohall.com/presentations/1343

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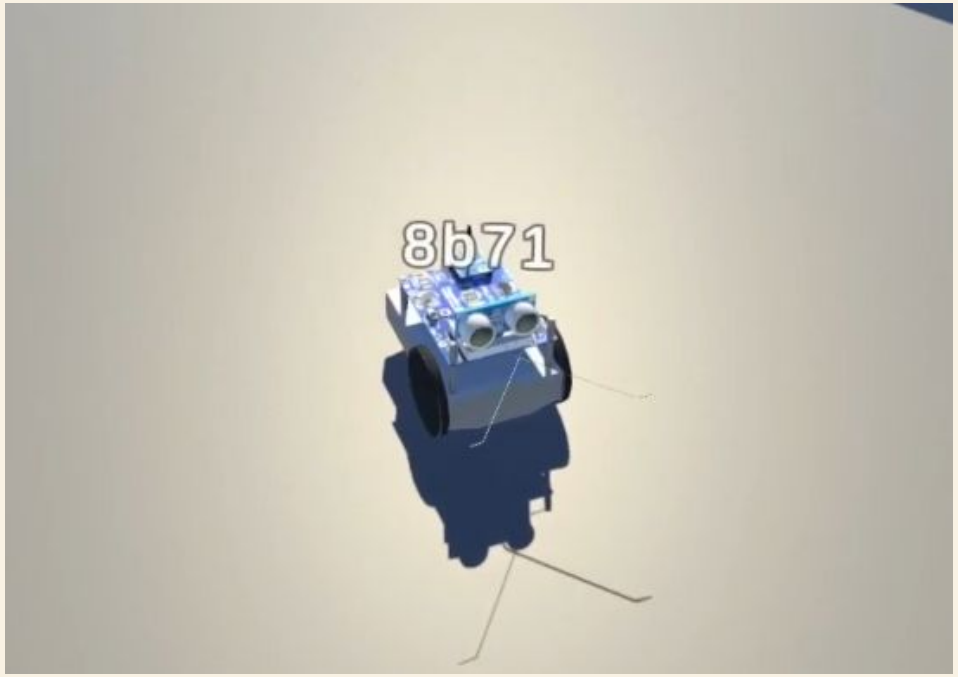
RoboScape Online

VIRTUAL ROBOTICS

- To enable remote learning, we have created a Unity-based 3D virtual robotics environment
- Same interface, same code as physical robots
- No hardware cost, no maintenance
- Students can remotely access shared space to collaborate or compete solving challenge problems

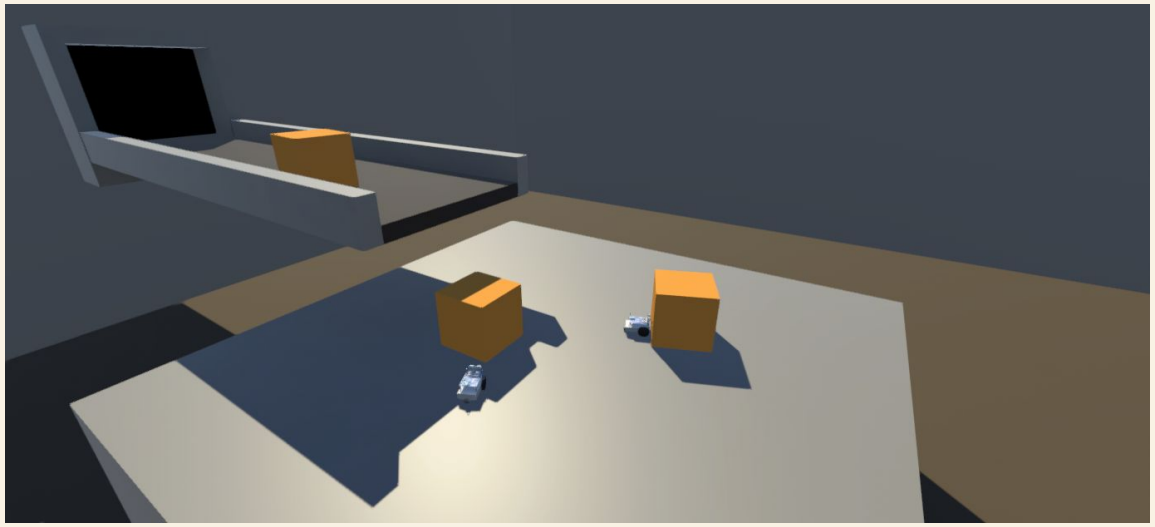


https://tinyurl.com/bhkz2ed9

VIRTUAL ROBOTICS

- Can support a wide range of robots and environments
- Extends beyond robotics

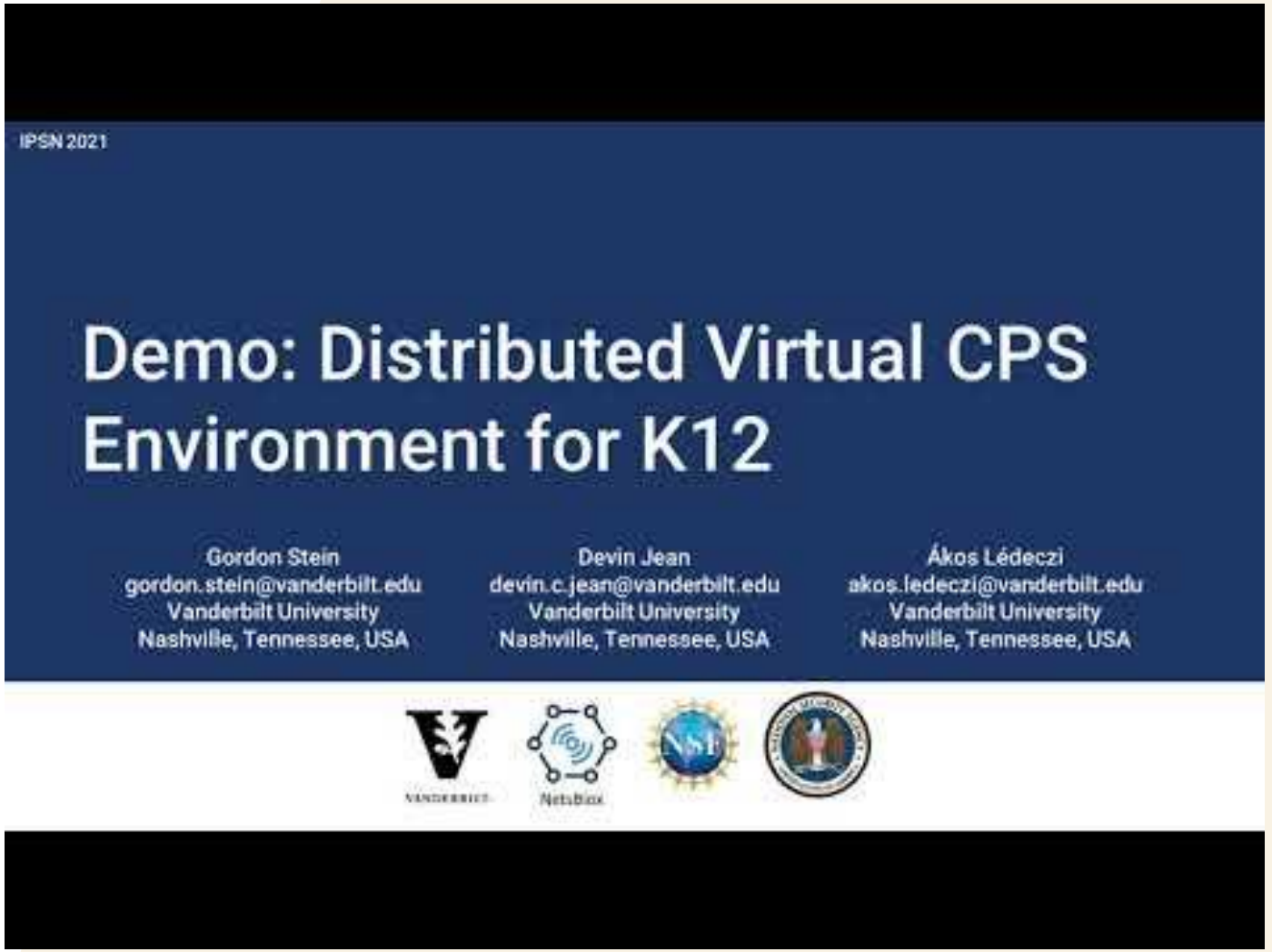
https://tinyurl.com/bhkz2ed9



Clear the table

Traffic light control

DEMOS



Traffic light control

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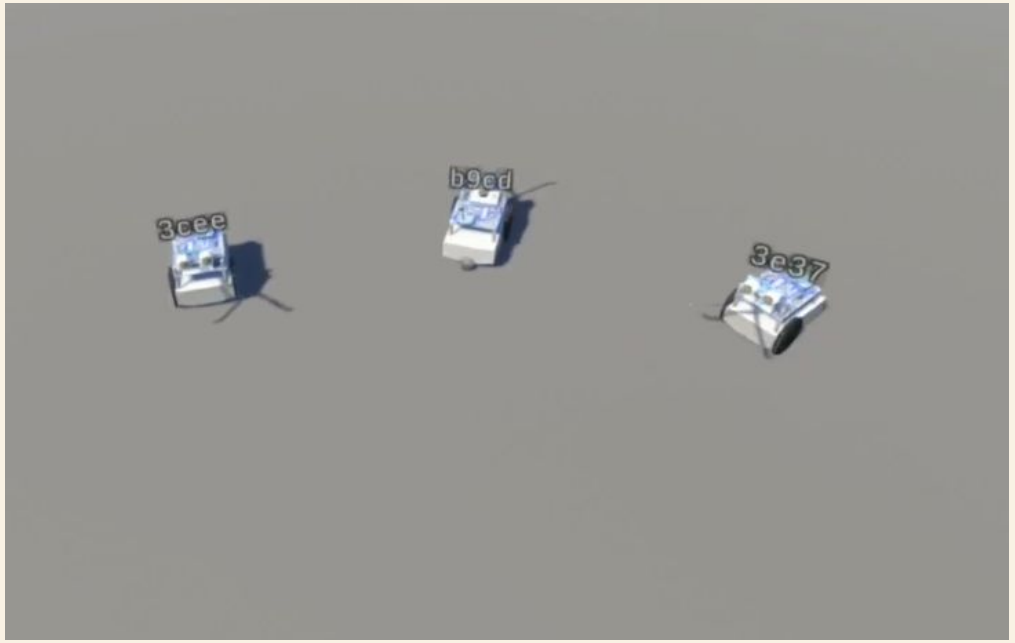
VIRTUAL ROBOTICS

- 3 Summer Camps in June 2021
- Final project: drive your robot with your phone



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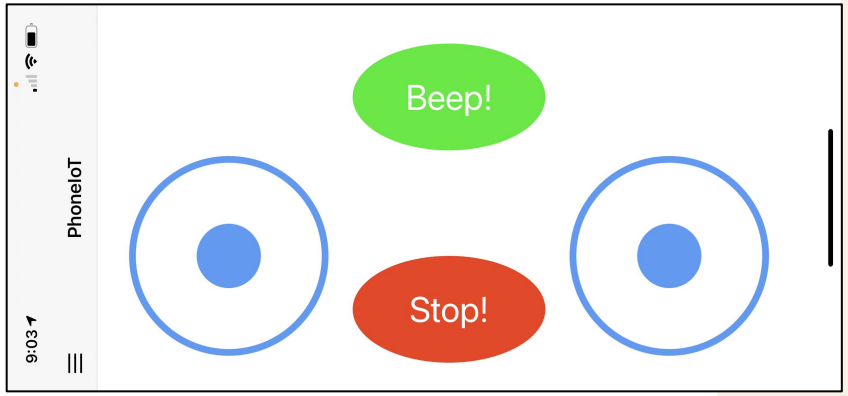
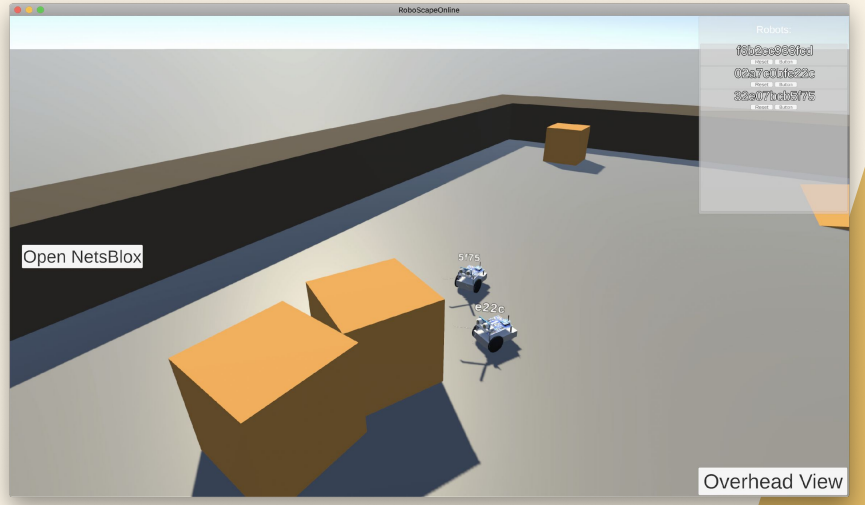
ROBOT CONTROL WITH PHONE

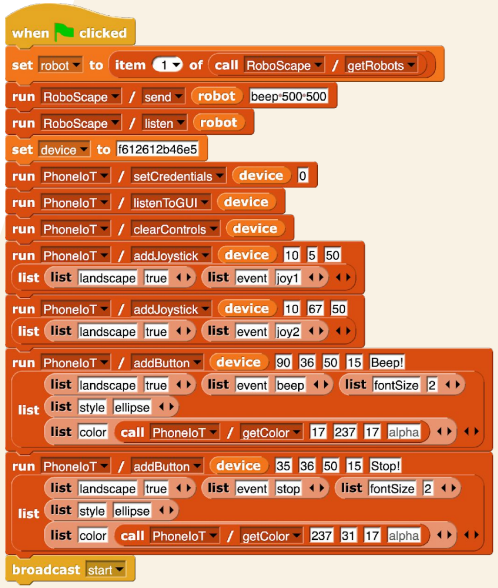
PhoneIoT on Mobile Device

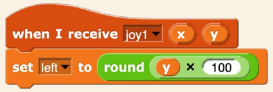


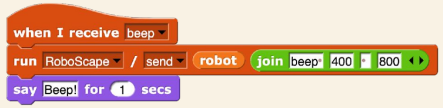
NetsBlox Server

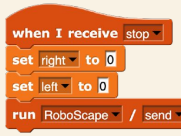


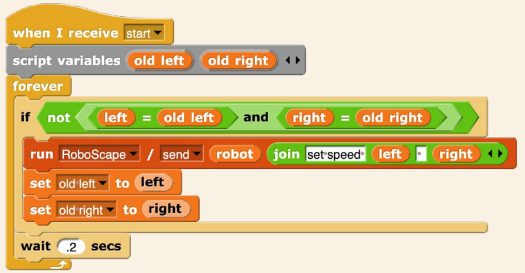
RoboScape Online
Unity VR Environment in the Cloud











NetsBlox Client on Computer/Browser

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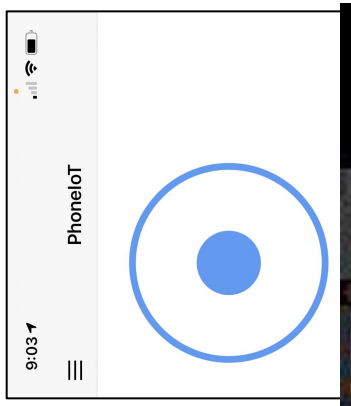
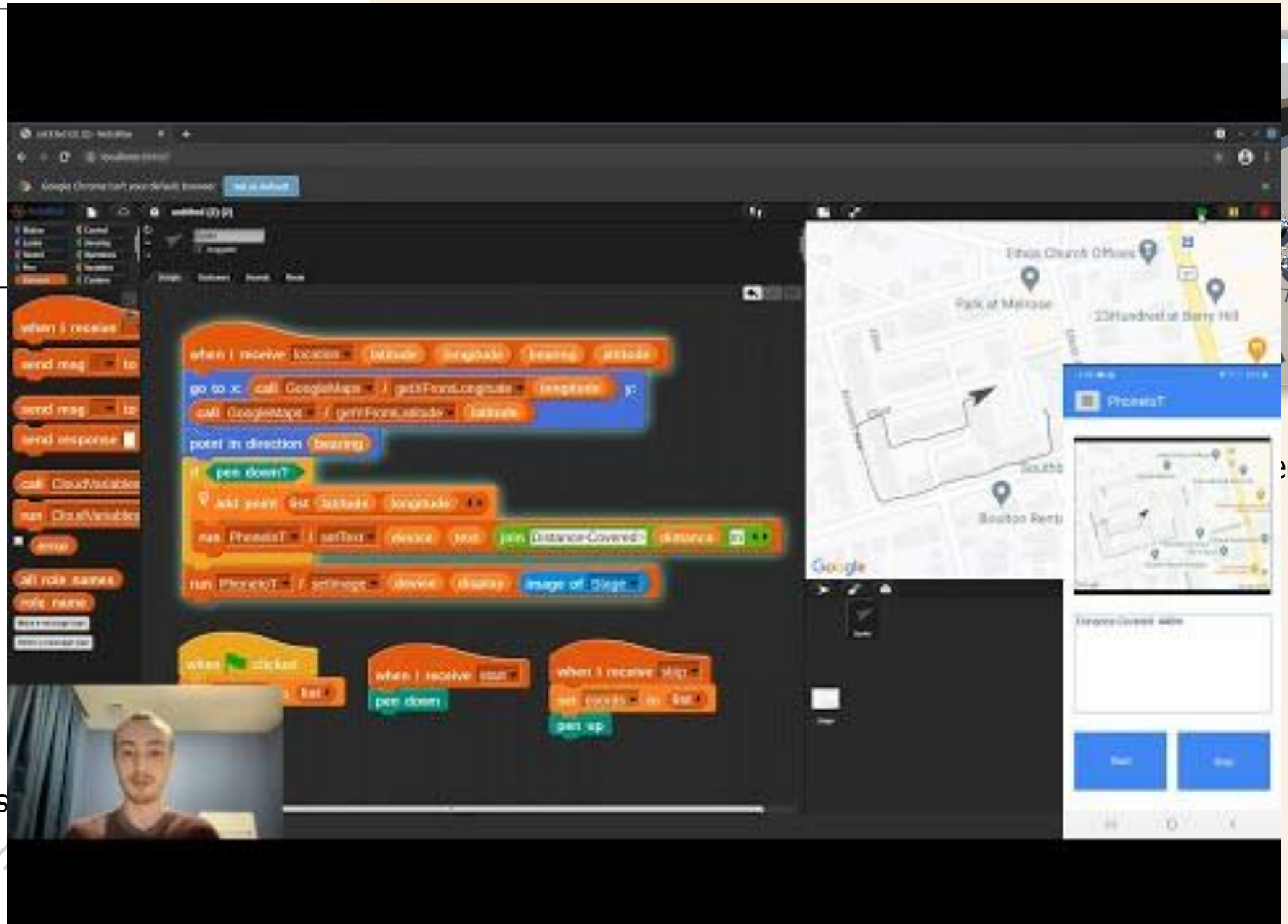
ROBOT CONTROL WITH PHONE

PhoneIoT on Mobile Device





Online
ent in the Cloud

Nets

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Camps and Curriculum

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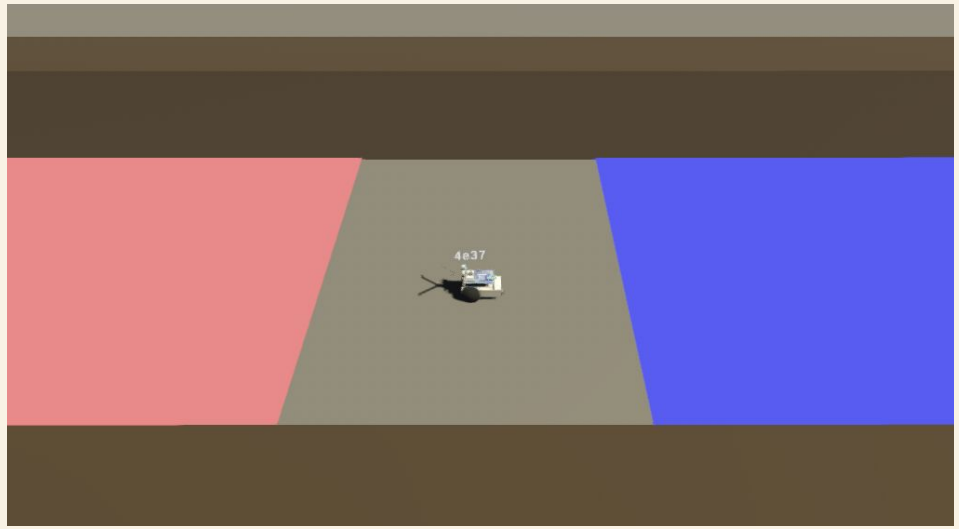
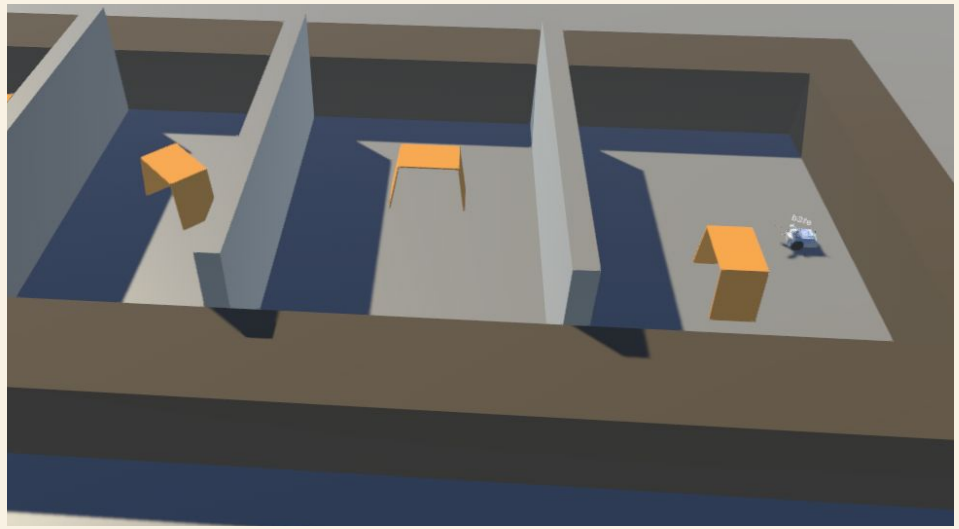
SUMMER CAMPS

- MLK High School Camp
  - 1 week long summer camp
  - Students learned basic programming concepts followed by robotics and cybersecurity activities
- Computer Science Frontiers
  - 1 week professional development with teachers followed by a 2 week summer camp with high school students
  - Teachers were learning the content in the first week and teaching it in the following 2 weeks
  - Students learned about distributed computing, cybersecurity, IoT, and robotics





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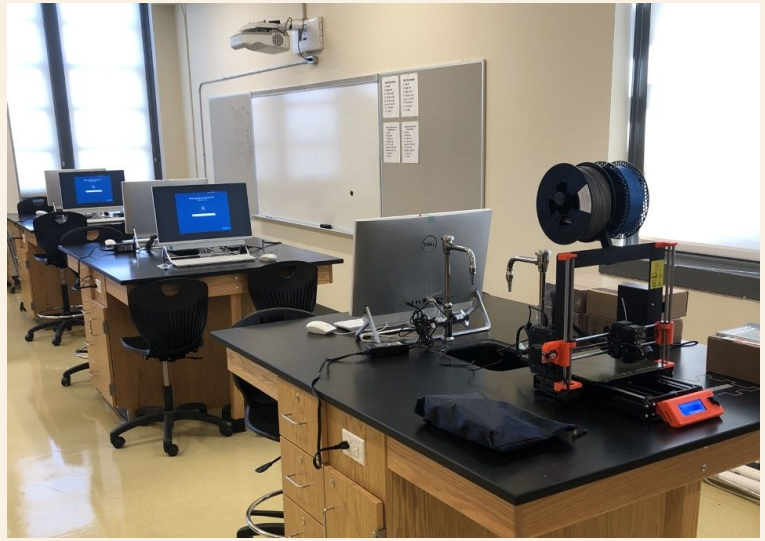
IN THE CLASSROOM

- Created a makerspace for MLK High School complete with laptops, VR headsets, and physical robots.
- Developing a course following AP CSP with a focus on:
  - Distributed Computing
  - Machine Learning
  - Internet of Things
  - Software Engineering
- We have begun the course approval for the state of Tennessee
- Planning to add the course for this coming Fall at MLK High School in Nashville



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CONCLUSIONS

- Opening the internet creates a rich set of possibilities:
  - Access to online data and services
  - Distributed programs: social apps, multiplayer games, etc.
  - Support for a wide variety of devices including robots, phones and voice assistants
  - Real-time collaboration, remote learning
  - User extendibility
- Students can create projects that interests them and are relevant to their lives promoting engagement
- A small set of powerful abstractions supported by a handful of simple blocks keeps the learning curve gentle:
  - Adding support for phones or robots required no changes on the client and no new blocks!

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Computational
Thinking and Learning

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- Collaborators:
  - **Shuchi Grover, Tiffany Barnes, Veronica Catete, Marnie Hill, Dan Garcia, Jens Moenig**
- Countless undergraduate students, summer interns, high school teachers and students

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