Bringing Intelligence to IoT Devices
Challenges Faced and Soletta Approach

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What is Soletta?

- IoT Framework
- Open Source
- Easy access:
  - Sensors
  - Actuators
  - Communication
- Portable code
- Different platforms, including small OSs
## Bringing intelligence to IoT devices

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**Hardware and Operating System Abstraction Layer**

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I have a problem
How can IoT help me?
Bringing intelligence to IoT devices
Bringing intelligence to IoT devices

**How can IoT help me?**

- Sensors monitoring the soil moisture
- Light Sensors monitoring the light incidence in the plants
- The device can send me a message to my smartphone when the plants need to be watered
- I could water my plants remotely
- The device could water the plants for me
- Use a simple timer
Simple Watering Sample
Bringing intelligence to IoT devices

Simple Watering Sample
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Simple Watering Sample

SoilMoistureSensor
gpio/reader

GardenController
GardenController

© MOISTURE
© IRRIGATE

Button
gpio/reader

Irrigator
gpio/writer

OUT
OUT
OUT
IN
When should we water the plants?
How much water should we use?
Why not learning from users
Bringing intelligence to IoT devices

Simple Watering Sample

Diagram:
- Garden Controller
  - Irrigator Network Resource
  - SML
  - Button (gpio/reader)
  - Sensor Network Resource
  - Timeblock
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Simple Watering Sample

SoilMoistureSensor
  gpio/reader
  OUT

Timeblock
  wallclock/timeblock
  OUT

GardenController
  GardenController
  MOISTURE
  TIMEBLOCK
  IRRIGATE
  IN_PREDICT
  OUT
  OUT_PREDICT

SmlANN
  machine-learning/neural-network-sync
  IN
  OUT

Button
  gpio/reader
  OUT

Irrigator
  gpio/writer
  IN
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Soletta Garden

- 2 plants for 2 backends
- Parrot Flower Power to monitor soil moisture
- Both backends learned how to water the plants :)

[Image of two potted plants with blue tubing]
What else could we do?

- Car air conditioning and stereo system
  - Changing configurations according to who is in the car.
- Shower temperature and water volume
  - Based on body temperature, weather and who is in the shower
- TV channel selection
  - Based on mood and number of people in the house
- Delivery food suggestion
  - Based on mood and number of people in the house
- Controlling house lights
  - Turn on and off lights when needed (security, comfort, economy)
Soletta Machine Learning

- Machine Learning module for Soletta framework
- Learns from user’s behavior
- 2 different backends:
  - Fuzzy Logic algorithm
  - Artificial Neural Network
- Extensible
- It is not necessary to have deep knowledge in ML to use it
- Runs locally

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Why not running in the cloud?

- Privacy
- Security
- Connectivity issues
Soletta Machine Learning

- Developer defines sensors (INPUTS) and actuators (OUTPUTS)
- SML learns from reading sensors and actuators status
  - Training (learning)
  - Trying to figure out how value read from sensors affects actuators
- SML predicts actuator values based on current sensor values
  - We can act in actuators using predicted values
- We don’t need to keep all collected data to train SML
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**Fuzzy**
- Uses Fuzzylite library
- Adapts faster when user’s behavior changes
- Better results
- Only give predictions when current sensors state is similar to a state that has happened before

**ANN**
- Uses Fast Artificial Neural Network library (FANN)
- Learning is faster
- Always give predictions
- Lower memory consumption when using a large number of inputs/outputs
- Tends to forget old events
Challenges
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Challenges: Validating Results

- Simulations
- Prototypes
- Lamp prototype
  - First sample to gather real data
  - Change lamp color when a different user arrives near the lamp area
Challenges: Incorrect predictions

- What if SML prediction is not what user is expecting?
- Garden: What if we are over watering the plants?
- We need a way of sml knowing that users dislike the prediction
- Suggestions
Challenges: Party!

- How will a party or a vacation affect SML learning process?
- How fast are we going to learn a new user’s behavior?
What’s next?
What is next?

- Adding support for different backends
  - Why not a backend that runs on the cloud?
- Creating new prototypes and use SML in real world scenarios
  - Gather more real data to validate results
- Extra simulations
Community

- IRC: #soletta @freenode
- Mailing Lists: https://lists.solettaproject.org
- Code: https://github.com/solettaproject/soletta-machine-learning
Q&A

Thanks

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