How to tell the difference between a tenured and an untended professor:

Walking speed

Year as a professor

Emeritus
Walking mate

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You have reached your steps goal

10341

8.15 km
Distance

695 kcal
Calories

Pause
Issues in Mobile Computing

- Energy, energy, energy or efficiency, efficiency, efficiency
- Many sensors
  - Camera (video)
  - Audio, Wi-Fi, GPS, temperature, health related sensors, accelerators
- Security, Privacy
Cellular Neuron Network Processors
- A neuron-network computing paradigm, used in variety of applications
- Proposed by Chua and Yang in 80s.

Very well suited for image processing applications
- Only local connections → short wire. Low energy consumption

Consume very little power
Global information is passed through cells

Other applications:
- More complicated image processing algorithms
- Optimal path finding
- Character recognition

Challenges of CNN
- Image size scalability
  - Scalable CNN [GT]
- Difficulty of programming
  - Learning templates
With Other Computing

Video sensor processors are used for front-end processors

Complex computations will be handled in multi-core CPUs
Computation can be further offloaded to Cloud
Performance and energy savings
Q. What to offload?
Q. Privacy, sensitive data

Key to have Wearable Computing
Another Opportunity to Save Energy

| Memory size |

- **2006**: iphone, iphone 3GS
- **2008**: Galaxy S4, LG Optimus G, Google Nexus 7
- **2010**: Galaxy S5
- **2012**:
- **2014**:

Memory Size (MB):

- 0 MB
- 500 MB
- 1000 MB
- 1500 MB
- 2000 MB
- 2500 MB
Energy Savings with NVM

Current Mobile Systems

Mobile system with NVM
Start-up Time of Android Applications

First launch takes several seconds.
Reducing Start-up Time

Dedicated Region for Start-up code
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Security and Performance

Tradeoff between security and performance

Example: Google’s Native Client Platform (NaCl)

- Run natively compiled applications in the browser
- Application execution is **secure**

Secure execution through:

- Elimination of unsafe instructions
- Safe branch jumps
- **Safe function calls and function returns**
To provide secure environment, all instructions are bundled.
Before jump, always check. Even for function calls!

```
0x...00 bundle_start:
   ...
0x...1B  nop
0x...1C  and $0xfffffffffffffffe0,%rcx
0x...1E  call *%rcx
0x...20 return_loc:
     <bundle aligned return>
     ...
0x...A0 nacl_function: <bundle aligned>
     ...
0x...A9  pop %rcx
0x...AA  and $0xfffffffffffffffe0,%rcx
0x...AC  jmp *%rcx
```
NaCl-RAS Mechanism

Solution: Simple! detect a pattern and store the return address in a stack

Lessons: Security solutions can create new branch prediction problems.
Still Lots of challenges/Issues in Mobile Platforms
- Energy, efficiency, security etc.

But that’s not the end!

Energy, Security, Reliability, and performance
Thank you

& Thank Yale!
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