Debugging, Developing, Distributing and Demonstrating Complex Signal Processing Systems with MATLAB

November 3, 2016

Malcolm Slaney
Caveat

I’m currently a Research Scientist in Google’s Machine Hearing Group, but today’s work was done at:
• Apple Computer’s Advanced Technology Group
• Interval Research
• IBM’s Almaden Research
• Yahoo! Research

Not
• Google
Outline

Debugging
• CDROM
• Apple ASR via MEX

Developing
• Hadoop for Neural Network Grid Search

Documenting and Demonstrating
• Auditory Toolbox
• Telluride Decoding Toolbox
• Web API
• Snakes
• Support Vector Classifiers
Debugging – AT&T TrueVoice

Unknown (magical) processing

Spectral Estimation in MATLAB

https://www.youtube.com/watch?v=UFqX1Et-dWQ
James: Malcolm, you have to see this operator.
Malcolm: Yea, Jim.

James (next year): Malcolm, you have to see this operator.
Malcolm: Yea, Jim.
Debugging – CDROM Driver

**Dropped samples**
- Software engineers disagreed

---

**Test Audio**
- Correct

**Teager Output**
- Teager Energy Operator
Debugging – Automatic Speech Recognition

Debugging Acoustic Models
• Custom MEX
• Put() and Get() memory

MATLAB used to
• Assemble picture of ASR results
• Walk the graph
• (Not possible now due to memory management.)
Subplate Neurons
• Structural lattice for developing cortex
• Implicated in language learning
• Disappear post development

Question
• Develop tonotopic distribution?
• Frequency map

Hadoop Test
• Grid search for parameters
• Compiled MATLAB binary
• Command line arguments
• Distribute MSR everywhere
• 8000 CPUs one night
Distributing – Auditory Toolbox

Purpose
• Common models of auditory perception
• Cochlear models
• Reference implementations

Success
• Most popular toolkit for auditory modeling
• One of my highest cited references
• (a Tech Report!!!)

System ID and Modeling
• Audio <-> EEG
• Linear and non-linear models

Reason
• Reference implementation
• With data for debugging and testing

Telluride Decoding Toolbox

Sahar Akram (UMD), Alain de Cheveigné (ENS), Peter Udo Diehl (ETH), Emily Graber (Stanford), Carina Graversen (Oticon), Jens Hjortkjær (DTU), Nima Mesgarani (Columbia), Lucas Parra (NYU), Ulrich Pomper (UCL), Shihab Shamma (UMD), Jonathan Simon (UMD), Malcolm Slaney (Google), Daniel Wong (ENS)

http://www.ine-web.org/software/decoding/
Distributing – Web APIs

Want

Solution
Distributing - Snakes

http://www.slaney.org/malcolm/pubs.html#snakes
Demonstrating – Polynomial Support Vector Machine

http://www.slaney.org/malcolm/pubs.html#svc
Demonstration – SVM Polynomial Distances

http://www.slaney.org/malcolm/pubs.html#svc
Demonstration – SVM Polynomial Results

http://www.slaney.org/malcolm/pubs.html#svc
Demonstrating – Linear Support Vector Machine

**Matlab GUI**
- On top of support vector classifier

**Good**
- Exploring parameters
- Understanding performance

http://www.slaney.org/malcolm/pubs.html#svc
Demonstrating – SVM Linear Distance

http://www.slaney.org/malcolm/pubs.html#svc
Demonstrating – SVM Linear Results

http://www.slaney.org/malcolm/pubs.html#svc
Thank You

malcolm@ieee.org
Outline

Debugging
• CDROM
• Apple ASR via MEX
• Hadoop for NN Grid Search

Developing
• Neural network on Hadoop

Documenting and Demonstrating
• Auditory Toolbox
• Telluride Decoding Toolbox
• Web API
• Snakes
• Support Vector Classifiers