

2013 IEEE Workshop on Automatic Speech Recognition and Understanding

(ASRU 2013)

**Olomouc, Czech Republic
8-12 December 2013**



**IEEE Catalog Number: CFP13SRW-POD
ISBN: 978-1-4799-2757-9**

TABLE OF CONTENTS

LM: LANGUAGE MODELING

LM.1: K-COMPONENT RECURRENT NEURAL NETWORK LANGUAGE MODELS1 USING CURRICULUM LEARNING

Yangyang Shi, Martha Larson, Catholijn M Jonker, Delft University of Technology, Netherlands

LM.2: LEARNING A SUBWORD VOCABULARY BASED ON UNIGRAM LIKELIHOOD7

Matti Varjokallio, Mikko Kurimo, Sami Virpioja, Aalto University, Finland

LM.3: EFFECTIVE PSEUDO-RELEVANCE FEEDBACK FOR LANGUAGE MODELING13 IN SPEECH RECOGNITION

Berlin Chen, Yi-Wen Chen, National Taiwan Normal University, Taiwan; Kuan-Yu Chen, Institute of Information Science, Academia Sinica, Taiwan; Ea-Ee Jan, IBM Thomas J. Watson Research Center, United States

LM.4: LEARNING BETTER LEXICAL PROPERTIES FOR RECURRENT OOV WORDS19

*Long Qin, M*Modal Inc, United States; Alexander I. Rudnicky, Carnegie Mellon University, United States*

LM.5: JOINT TRAINING OF INTERPOLATED EXPONENTIAL N-GRAM MODELS25

Abhinav Sethy, Stanley Chen, Ebru Arisoy, Bhuvana Ramabhadran, IBM, United States; Kartik Audkhasi, Shrikanth Narayanan, University of Southern California, United States; Paul Vozila, Nuance Communications, United States

LM.6: MIXTURE OF MIXTURE N-GRAM LANGUAGE MODELS31

Hasim Sak, Cyril Allauzen, Kaisuke Nakajima, Francoise Beaufays, Google, United States

AM: ACOUSTIC MODELING

AM.1: COMPACT ACOUSTIC MODELING BASED ON ACOUSTIC MANIFOLD USING A37 MIXTURE OF FACTOR ANALYZERS

Wen-Lin Zhang, Zhengzhou Information Science and Technology Institute, China; Wei-Qiang Zhang, Tsinghua University, China; Bi-Cheng Li, Zhengzhou Information Science and Technology Institute, China

AM.2: A GENERALIZED DISCRIMINATIVE TRAINING FRAMEWORK FOR SYSTEM43 COMBINATION

Yuuki Tachioka, Mitsubishi Electric, Japan; Shinji Watanabe, Jonathan Le Roux, John Hershey, Mitsubishi Electric Research Laboratories, United States

AM.3: ACOUSTIC MODELING USING TRANSFORM-BASED PHONE-CLUSTER49 ADAPTIVE TRAINING

Vimal Manohar, Bhargav Srinivas Ch., Umesh Srinivasan, Indian Institute of Technology Madras, India

AM.4: SPEAKER ADAPTATION OF NEURAL NETWORK ACOUSTIC MODELS USING55 I-VECTORS

George Saon, Hagen Soltau, David Nahamoo, Michael Picheny, IBM, United States

**AM.5: NEIGHBOUR SELECTION AND ADAPTATION FOR RAPID60
SPEAKER-DEPENDENT ASR**

*Udhyakumar Nallasamy, Carnegie Mellon University, United States; Mark Fuhs, Monika Woszczyna, M*Modal Inc, United States; Florian Metze, Carnegie Mellon University, United States; Tanja Schultz, Karlsruhe Institute of Technology, Germany*

Dec: DECODER SEARCH

**Dec.1: EFFICIENT NEARLY ERROR-LESS LVCSR DECODING BASED ON66
INCREMENTAL FORWARD AND BACKWARD PASSES**

David Nolden, Ralf Schlüter, Hermann Ney, RWTH Aachen University, Germany

SLU: SPOKEN LANGUAGE UNDERSTANDING

**SLU.1: QUERY UNDERSTANDING ENHANCED BY HIERARCHICAL PARSING72
STRUCTURES**

Jingjing Liu, Panupong Pasupat, Yining Wang, Scott Cyphers, Jim Glass, Massachusetts Institute of Technology, United States

**SLU.2: CONVOLUTIONAL NEURAL NETWORK BASED TRIANGULAR CRF FOR78
JOINT INTENT DETECTION AND SLOT FILLING**

Puyang Xu, Ruhi Sarikaya, Microsoft, United States

**SLU.3: SEMANTIC ENTITY DETECTION FROM MULTIPLE ASR HYPOTHESES84
WITHIN THE WFST FRAMEWORK**

Jan Svec, Pavel Ircing, Lubos Smidl, University of West Bohemia, Czech Republic

**SLU.4: ON-LINE ADAPTATION OF SEMANTIC MODELS FOR SPOKEN LANGUAGE90
UNDERSTANDING**

Ali Orkan Bayer, Giuseppe Riccardi, University of Trento, Italy

SLU.5: DYSFLUENT SPEECH DETECTION BY IMAGE FORENSICS TECHNIQUES96

Juraj Palfy, Sakhia Darjaa, Slovak Academy of Sciences, Slovakia; Jiri Pospichal, Slovak University of Technology, Slovakia

**SLU.6: BARGE-IN EFFECTS IN BAYESIAN DIALOGUE ACT RECOGNITION AND102
SIMULATION**

Heriberto Cuayahuitl, Nina Dethlefs, Helen Hastie, Oliver Lemon, Heriot-Watt University, United Kingdom

Dial: SPOKEN DIALOG SYSTEMS

**Dial.1: EXPERT-BASED REWARD SHAPING AND EXPLORATION SCHEME FOR108
BOOSTING POLICY LEARNING OF DIALOGUE MANAGEMENT**

Emmanuel Ferreira, Fabrice Lefèvre, Laboratoire Informatique d'Avignon, France

**Dial.2: DIALOGUE MANAGEMENT FOR LEADING THE CONVERSATION IN114
PERSUASIVE DIALOGUE SYSTEMS**

Takuya Hiraoka, Yuki Yamauchi, Graham Neubig, Sakriani Sakti, Tomoki Toda, Satoshi Nakamura, Nara Institute of Science and Technology, Japan

Dial.3: UNSUPERVISED INDUCTION AND FILLING OF SEMANTIC SLOTS FOR120
SPOKEN DIALOGUE SYSTEMS USING FRAME-SEMANTIC PARSING

Yun-Nung Chen, William Yang Wang, Alexander I. Rudnicky, Carnegie Mellon University, United States

Multi: MULTILINGUAL SPEECH & LANGUAGE PROCESSING

Multi.1: CROSS-LINGUAL CONTEXT SHARING AND PARAMETER-TYING FOR126
MULTI-LINGUAL SPEECH RECOGNITION

Aanchan Mohan, Richard Rose, McGill University, Canada

Multi.2: IMPROVED PUNCTUATION RECOVERY THROUGH COMBINATION OF132
MULTIPLE SPEECH STREAMS

João Miranda, Instituto Superior Técnico / Carnegie Mellon University, Portugal; João Neto, Instituto Superior Técnico, Portugal; Alan Black, Carnegie Mellon University, United States

Multi.3: INVESTIGATION OF MULTILINGUAL DEEP NEURAL NETWORKS FOR138
SPOKEN TERM DETECTION

Kate Knill, Mark Gales, Shakti Rath, Phil Woodland, Chao Zhang, Shi-Xiong Zhang, University of Cambridge,

Multi.4: LANGUAGE STYLE AND DOMAIN ADAPTATION FOR CROSS-LANGUAGE SLU144
PORTING

Evgeny Stepanov, Ilya Kashkarev, Orkan Bayer, Giuseppe Riccardi, Arindam Ghosh, University of Trento, Italy

Robust: ROBUSTNESS IN ASR

Robust.1: AUTOMATIC MODEL COMPLEXITY CONTROL FOR GENERALIZED150
VARIABLE PARAMETER HMMS

Rongfeng Su, Shenzhen Institutes of Advanced Technology, China; Xunying Liu, Cambridge University, United Kingdom; Lan Wang, Shenzhen Institutes of Advanced Technology, China

Robust.2: IMPROVED CEPSTRAL MEAN AND VARIANCE NORMALIZATION USING156
BAYESIAN FRAMEWORK

Vishnu Prasad N, Umesh S, Indian Institute of Technology Madras, India

Robust.3: THE SECOND ‘CHIME’ SPEECH SEPARATION AND RECOGNITION162
CHALLENGE: AN OVERVIEW OF CHALLENGE SYSTEMS AND OUTCOMES

Emmanuel Vincent, Inria, France; Jon Barker, University of Sheffield, United Kingdom; Shinji Watanabe, Jonathan Le Roux, Mitsubishi Electric Research Laboratories, United States; Francesco Nesta, Conexant Systems, United States; Marco Matassoni, FBK-Irst, Italy

Robust.4: LEARNING STATE LABELS FOR SPARSE CLASSIFICATION OF SPEECH168
WITH MATRIX DECONVOLUTION

Antti Hurmalainen, Tuomas Virtanen, Tampere University of Technology, Finland

Robust.5: MODIFIED SPLICE AND ITS EXTENSION TO NON-STEREO DATA FOR174
NOISE ROBUST SPEECH RECOGNITION

Pavan Kumar D S, Vishnu Prasad N, Indian Institute of Technology Madras, India; Vikas Joshi, IBM India Research Labs, India; Umesh S, Indian Institute of Technology Madras, India

Robust.6: A PROPAGATION APPROACH TO MODELLING THE JOINT DISTRIBUTIONS180
OF CLEAN AND CORRUPTED SPEECH IN THE MEL-CEPSTRAL DOMAIN

Ramón Astudillo, INESC-ID Lisboa, Portugal

Robust.7: VECTOR TAYLOR SERIES BASED HMM ADAPTATION FOR GENERALIZED CEPSTRUM IN NOISY ENVIRONMENT	186
<i>Soonho Baek, Hong-Goo Kang, Yonsei University, Republic of Korea</i>	
SDRKWS: SPOKEN DOCUMENT RETRIEVAL AND KEYWORD SPOTTING	
SDRKWS.1: THE TAO OF ATWV: PROBING THE MYSTERIES OF KEYWORD SEARCH PERFORMANCE	192
<i>Steven Wegmann, Arlo Faria, Adam Janin, Korbinian Riedhammer, Nelson Morgan, ICSI, United States</i>	
SDRKWS.2: TOWARDS UNSUPERVISED SEMANTIC RETRIEVAL OF SPOKEN CONTENT WITH QUERY EXPANSION BASED ON AUTOMATICALLY DISCOVERED ACOUSTIC PATTERNS	198
<i>Yun-Chiao Li, National Taiwan University, Taiwan; Hung-yi Lee, Academia Sinica, Taiwan; Cheng-Tao Chung, Chun-an Chan, Lin-shan Lee, National Taiwan University, Taiwan</i>	
SDRKWS.3: THE IBM KEYWORD SEARCH SYSTEM FOR THE DARPA RATS PROGRAM	204
<i>Lidia Mangu, Hagen Soltau, Hong-Kwang Kuo, George Saon, IBM, United States</i>	
SDRKWS.4: SCORE NORMALIZATION AND SYSTEM COMBINATION FOR IMPROVED KEYWORD SPOTTING	210
<i>Damianos Karakos, Richard Schwartz, Stavros Tsakalidis, Le Zhang, Shivesh Ranjan, Tim Ng, Roger Hsiao, Guruprasad Saikumar, Ivan Bulyko, Long Nguyen, John Makhoul, Raytheon BBN Technologies, United States; Frantisek Grezl, Mirko Hannemann, Martin Karafiat, Igor Szoke, Karel Vesely, Brno University of Technology, Czech Republic; Lori Lamel, CNRS-LIMSI, France; Viet-Bac Le, Vocapia Research, France</i>	
NewApp: NEW APPLICATIONS OF ASR	
NewApp.1: EMOTION RECOGNITION FROM SPONTANEOUS SPEECH USING HIDDEN MARKOV MODELS WITH DEEP BELIEF NETWORKS	216
<i>Duc Le, Emily Mower Provost, University of Michigan, United States</i>	
NewApp.2: AUTOMATIC PRONUNCIATION CLUSTERING USING A WORLD ENGLISH ARCHIVE AND PRONUNCIATION STRUCTURE ANALYSIS	222
<i>Han-Ping Shen, National Cheng Kung University, Taiwan; Nobuaki Minematsu, The University of Tokyo, Japan; Takehiko Makino, Chuo University, Japan; Steven H. Weinberger, George Mason University, United States; Teeraphon Pongkittiphan, The University of Tokyo, Japan; Chung-Hsien Wu, National Cheng Kung University, Taiwan</i>	
NewApp.3: PHONETIC AND ANTHROPOMETRIC CONDITIONING OF MSA-KST COGNITIVE IMPAIRMENT CHARACTERIZATION SYSTEM	228
<i>Alexei Ivanov, Shahab Jalalvand, Roberto Gretter, Daniele Falavigna, Fondazione Bruno Kessler, Italy</i>	
NewApp.4: ASR FOR ELECTRO-LARYNGEAL SPEECH	234
<i>Anna Katharina Fuchs, Juan Andres Morales-Cordovilla, Martin Hagmüller, Graz University of Technology, Austria</i>	
NewApp.5: AUTOMATIC SENTIMENT EXTRACTION FROM YOUTUBE VIDEOS	239
<i>Lakshmish Kaushik, Abhijeet Sangwan, John H. L. Hansen, University of Texas at Dallas, United States</i>	

SPFea: SPEECH SIGNAL PROCESSING AND FEATURE EXTRACTION

SPFea.1: ACOUSTIC CHARACTERISTICS RELATED TO THE PERCEPTUAL PITCH IN245 WHISPERED VOWELS

Hideaki Konno, Hideo Kanemitsu, Nobuyuki Takahashi, Hokkaido University of Education, Japan; Mineichi Kudo, Hokkaido University, Japan

SPFea.2: AN SVD-BASED SCHEME FOR MFCC COMPRESSION IN DISTRIBUTED250 SPEECH RECOGNITION SYSTEM

Azzedine Touazi, Mohamed Debyeche, University of Science and Technology Houari Boumediene, Algeria

SPFea.3: A STUDY OF SUPERVISED INTRINSIC SPECTRAL ANALYSIS FOR TIMIT256 PHONE CLASSIFICATION

Reza Sahraeian, Dirk Van Compernelle, Katholieke Universiteit Leuven, Belgium

SPFea.4: MODELS OF TONE FOR TONAL AND NON-TONAL LANGUAGES261

Florian Metze, Zaid A. W. Sheikh, Carnegie Mellon University, United States; Alex Waibel, Karlsruhe Institute of Technology / Carnegie Mellon University, Germany; Jonas Gehring, Kevin Kilgour, Quoc Bao Nguyen, Van Huy Nguyen, Karlsruhe Institute of Technology, Germany

NN: NEURAL NETWORKS IN ASR

NN.1: SEMI-SUPERVISED TRAINING OF DEEP NEURAL NETWORKS267

Karel Vesely, Mirko Hannemann, Lukas Burget, Brno University of Technology, Czech Republic

NN.2: HYBRID SPEECH RECOGNITION WITH DEEP BIDIRECTIONAL LSTM.....273

Alex Graves, Navdeep Jaitly, Abdel-rahman Mohamed, University of Toronto, Canada

NN.3: IMPROVING ROBUSTNESS OF DEEP NEURAL NETWORKS VIA SPECTRAL279 MASKING FOR AUTOMATIC SPEECH RECOGNITION

Bo Li, Khe Chai Sim, National University of Singapore, Singapore

NN.4: HYBRID ACOUSTIC MODELS FOR DISTANT AND MULTICHANNEL LARGE285 VOCABULARY SPEECH RECOGNITION

Pawel Swietojanski, Arnab Ghoshal, Steve Renals, University of Edinburgh, United Kingdom

NN.5: DEEP MAXOUT NEURAL NETWORKS FOR SPEECH RECOGNITION291

Meng Cai, Yongzhe Shi, Jia Liu, Tsinghua University, China

NN.6: LEARNING FILTER BANKS WITHIN A DEEP NEURAL NETWORK297 FRAMEWORK

Tara Sainath, Brian Kingsbury, IBM, United States; Abdel-Rahman Mohamed, University of Toronto, Canada; Bhuvana Ramabhadran, IBM, United States

NN.7: ACCELERATING HESSIAN-FREE OPTIMIZATION FOR DEEP NEURAL303 NETWORKS BY IMPLICIT PRECONDITIONING AND SAMPLING

Tara Sainath, Lior Horesh, Brian Kingsbury, Aleksandr Aravkin, Bhuvana Ramabhadran, IBM, United States

NN.8: ELASTIC SPECTRAL DISTORTION FOR LOW RESOURCE SPEECH309 RECOGNITION WITH DEEP NEURAL NETWORKS

Naoyuki Kanda, Ryu Takeda, Yasunari Obuchi, Hitachi Ltd., Japan

NN.9: IMPROVEMENTS TO DEEP CONVOLUTIONAL NEURAL NETWORKS FOR LVCSR	315
<i>Tara Sainath, Brian Kingsbury, IBM, United States; Abdel-Rahman Mohamed, George Dahl, University of Toronto, United States; George Saon, Hagen Soltau, Tomas Beran, Aleksandr Aravkin, Bhuvana Ramabhadran, IBM, United States</i>	
NN.10: COMBINING STOCHASTIC AVERAGE GRADIENT AND HESSIAN-FREE OPTIMIZATION FOR SEQUENCE TRAINING OF DEEP NEURAL NETWORKS	321
<i>Pierre Dognin, Vaibhava Goel, IBM Research, United States</i>	
NN.11: ACCELERATING RECURRENT NEURAL NETWORK TRAINING VIA TWO STAGE CLASSES AND PARALLELIZATION	326
<i>Zhiheng Huang, Geoffrey Zweig, Michael Levit, Benoit Dumoulin, Barlas Oguz, Shawn Chang, Microsoft, United States</i>	
NN.12: IMPACT OF DEEP MLP ARCHITECTURE ON DIFFERENT ACOUSTIC MODELING TECHNIQUES FOR UNDER-RESOURCED SPEECH RECOGNITION	332
<i>David Imseng, Petr Motlicek, Philip N. Garner, Hervé Bourlard, Idiap Research Institute, Switzerland</i>	
NN.13: CONTEXT-DEPENDENT MODELLING OF DEEP NEURAL NETWORK USING LOGISTIC REGRESSION	338
<i>Guangsen Wang, Khe Chai Sim, National University of Singapore, Singapore</i>	
NN.14: DNN ACOUSTIC MODELING WITH MODULAR MULTI-LINGUAL FEATURE EXTRACTION NETWORKS	344
<i>Jonas Gehring, Quoc Bao Nguyen, Karlsruhe Institute of Technology, Germany; Florian Metze, Carnegie Mellon University, United States; Alex Waibel, Karlsruhe Institute of Technology, Germany</i>	
NN.15: DISCRIMINATIVE PIECEWISE LINEAR TRANSFORMATION BASED ON DEEP LEARNING FOR NOISE ROBUST AUTOMATIC SPEECH RECOGNITION	350
<i>Yosuke Kashiwagi, Daisuke Saito, Nobuaki Minematsu, Keikichi Hirose, The University of Tokyo, Japan</i>	
NN.16: PORTING CONCEPTS FROM DNNS BACK TO GMMS	356
<i>Kris Demuynck, Fabian Triefenbach, Ghent University, Belgium</i>	
NN.17: HIERARCHICAL NEURAL NETWORKS AND ENHANCED CLASS POSTERiors FOR SOCIAL SIGNAL CLASSIFICATION	362
<i>Raymond Brueckner, Technische Universität München, Germany; Björn Schuller, Imperial College London, United Kingdom</i>	
NN.18: LARGE SCALE DEEP NEURAL NETWORK ACOUSTIC MODELING WITH SEMI-SUPERVISED TRAINING DATA FOR YOUTUBE VIDEO TRANSCRIPTION	368
<i>Hank Liao, Erik McDermott, Andrew Senior, Google, United States</i>	
LowZero: ASR/SPEECH SEARCH WITH LOW OR ZERO RESOURCES	
LowZero.1: ACOUSTIC DATA-DRIVEN PRONUNCIATION LEXICON FOR LARGE VOCABULARY SPEECH RECOGNITION	374
<i>Liang Lu, Arnab Ghoshal, Steve Renals, University of Edinburgh, United Kingdom</i>	
LowZero.2: ACOUSTIC UNIT DISCOVERY AND PRONUNCIATION GENERATION FROM A GRAPHEME-BASED LEXICON	380
<i>William Hartmann, Anindya Roy, Lori Lamel, Jean-Luc Gauvain, LIMSI-CNRS, France</i>	

LowZero.3: A HIERARCHICAL SYSTEM FOR WORD DISCOVERY EXPLOITING DTW-BASED INITIALIZATION	386
<i>Oliver Walter, Timo Korthals, Reinhold Haeb-Umbach, University of Paderborn, Germany; Bhiksha Raj, Carnegie Mellon University, United States</i>	
LowZero.4: NMF-BASED KEYWORD LEARNING FROM SCARCE DATA	392
<i>Bart Ons, Jort F. Gemmeke, Hugo Van hamme, Katholieke Universiteit Leuven, Belgium</i>	
LowZero.5: DEEP MAXOUT NETWORKS FOR LOW-RESOURCE SPEECH RECOGNITION	398
<i>Yajie Miao, Florian Metze, Shourabh Rawat, Language Technologies Institute, School of Computer Science, Carnegie Mellon University, United States</i>	
LowZero.6: COMBINATION OF DATA BORROWING STRATEGIES FOR LOW-RESOURCE LVCSR	404
<i>Yanmin Qian, Kai Yu, Shanghai Jiao Tong University, China; Jia Liu, Tsinghua University, China</i>	
LowZero.7: FIXED-DIMENSIONAL ACOUSTIC EMBEDDINGS OF VARIABLE-LENGTH SEGMENTS IN LOW-RESOURCE SETTINGS	410
<i>Keith Levin, Johns Hopkins University, United States; Katharine Henry, University of Chicago, United States; Aren Jansen, Johns Hopkins University, United States; Karen Livescu, Toyota Technological Institute at Chicago, United States</i>	
LowZero.8: USING PROXIES FOR OOV KEYWORDS IN THE KEYWORD SEARCH TASK	416
<i>Guoguo Chen, Oguz Yilmaz, Jan Trmal, Daniel Povey, Sanjeev Khudanpur, Johns Hopkins University, United States</i>	
LowZero.9: SEARCH RESULTS BASED N-BEST HYPOTHESIS RESCORING WITH MAXIMUM ENTROPY CLASSIFICATION	422
<i>Fuchun Peng, Scott Roy, Ben Shahshahani, Françoise Beaufays, Google, United States</i>	
LowZero.10: USING WEB TEXT TO IMPROVE KEYWORD SPOTTING IN SPEECH	428
<i>Ankur Gandhe, Long Qin, Florian Metze, Alexander I. Rudnicky, Ian Lane, Carnegie Mellon University, United States; Matthias Eck, Mobile Technologies, United States</i>	
LowZero.11: MULTI-STREAM TEMPORALLY VARYING WEIGHT REGRESSION FOR CROSS-LINGUAL SPEECH RECOGNITION	434
<i>Shilin Liu, Khe Chai Sim, National University of Singapore, Singapore</i>	
LowZero.12: DISCRIMINATIVE SEMI-SUPERVISED TRAINING FOR KEYWORD SEARCH IN LOW RESOURCE LANGUAGES	440
<i>Roger Hsiao, Tim Ng, Raytheon BBN Technologies, United States; Frantisek Grezl, Brno University of Technology, Czech Republic; Damianos Karakos, Stavros Tsakalidis, Long Nguyen, Richard Schwartz, Raytheon BBN Technologies, United States</i>	
LowZero.13: PROBABILISTIC LEXICAL MODELING AND UNSUPERVISED TRAINING FOR ZERO-RESOURCED ASR	446
<i>Ramya Rasipuram, Marzieh Razavi, Idiap Research Institute, École polytechnique fédérale de Lausanne, Switzerland; Mathew Magimai Doss, Idiap Research Institute, Switzerland</i>	

**LowZero.14: LIGHTLY SUPERVISED AUTOMATIC SUBTITLING OF WEATHER452
FORECASTS**

Joris Driesen, Steve Renals, University of Edinburgh, United Kingdom

LowZero.15: UNSUPERVISED WORD SEGMENTATION FROM NOISY INPUT458

Jahn Heymann, Oliver Walter, Reinhold Haeb-Umbach, University of Paderborn, Germany; Bhiksha Raj, Carnegie Mellon University, United States

**LowZero.16: AN EMPIRICAL STUDY OF CONFUSION MODELING IN KEYWORD464
SEARCH FOR LOW RESOURCE LANGUAGES**

Murat Saraclar, IBM / Bogazici University, United States; Abhinav Sethy, Bhuvana Ramabhadran, Lidia Mangu, Jia Cui, Xiaodong Cui, Brian Kingsbury, IBM, United States; Jonathan Mamou, IBM Haifa Research Labs, Israel

**LowZero.17: SEMI-SUPERVISED BOOTSTRAPPING APPROACH FOR NEURAL470
NETWORK FEATURE EXTRACTOR TRAINING**

Frantisek Grezl, Martin Karafiat, Brno University of Technology, Czech Republic