



Global Energy Forecasting Competition

Past, Present and Future

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UNC Charlotte

Energy Production & Infrastructure Center

- The largest energy research center in the nation
- Sponsored by Duke Energy, Siemens, State of North Carolina, etc.
- Energy concentration in all engineering degrees and MBA

Systems Engineering & Engineering Management

- Online option for all graduate-level courses
- MS in Engineering Management w/ energy concentration
- Graduate certification program on energy

Global Energy Forecasting Competitions

- Motivation
- Organization
- Winning methods
- GEFCom2014
- Further readings



Motivation

Issues in energy forecasting

- Impractical research
- Lack of benchmarking data and process
- Hard-to-reproduce
- Limited educational programs and courses

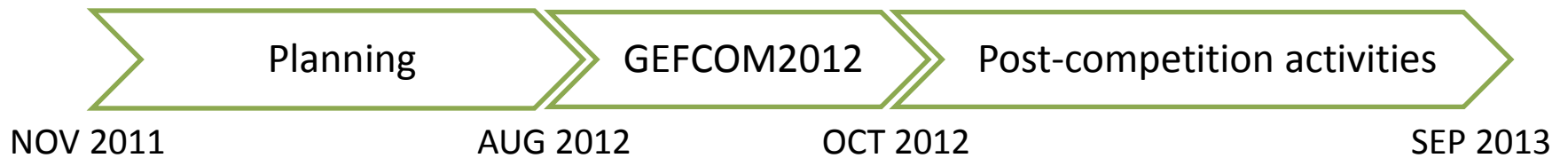
Motivation

Why GEFCom?

- Improve forecasting practices of the utility industry
- Bring together the state-of-the-art techniques
- Bridge the gap between academic research and industry practice
- Promote analytics in power & energy education
- Overcome quantitative challenges brought by smart grid

Organization

Timeline



IEEE PES ANNOUNCES THE EIGHT WINNING TEAMS FOR GEFCOM2012

Upcoming Events

Sort By

TECHNICALLY CO-SPONSORED

Wed, Oct 2 2013
2013 3rd International Conference on Electric Power and Energy Conversion Systems

SPONSORED

Sun, Oct 6 2013
2013 IEEE PES Innovative Smart Grid Technologies EUROPE (ISGT Europe 2013)

EDUCATION

Tue, Oct 8 2013
Plain Talk "Basics" Series in Santa

IEEE PES Announces the Eight Winning Teams for the Global Energy Forecasting Competition 2012

FOR IMMEDIATE RELEASE
30 September 2013

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IEEE POWER & ENERGY SOCIETY ANNOUNCES THE EIGHT WINNING TEAMS FOR THE GLOBAL ENERGY FORECASTING COMPETITION 2012

More than 200 teams submitted more than 2,000 entries focusing on hierarchical load forecasting and wind power forecasting

PISCATAWAY, N.J., USA, 30 September 2013 - IEEE, the world's largest professional organization advancing technology for humanity, today announced the results of the Global Energy Forecasting Competition 2012 (GEFCOM2012), which was organized and supported by the IEEE Power & Energy Society (IEEE PES) and the IEEE Working Group on Energy Forecasting (WGEF).

<http://www.ieee-pes.org/ieee-pes-announces-the-eight-winning-teams-for-gefcom2012>

Media Coverage

CNBC



Yahoo Finance



Broadway World



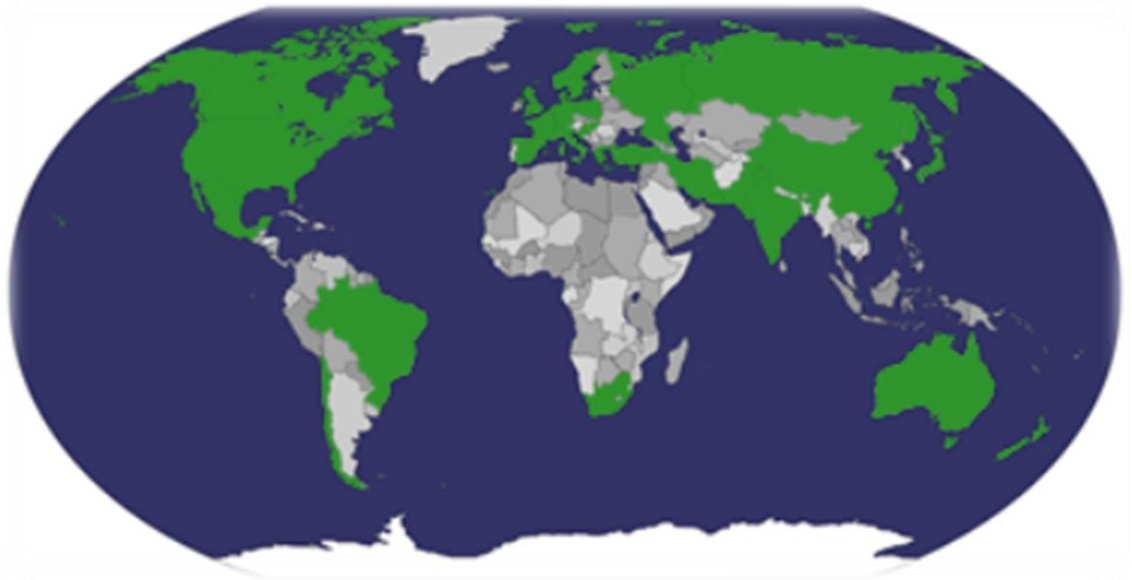
Business Wire



Organization

Participants

- 2000+ entries
- 200+ teams
- 30+ countries



Organization

Sponsors

- IEEE Power & Energy Society
- IEEE Power System Planning & Implementation Committee
- IEEE Power and Energy Education Committee
- IEEE Working Group on Energy Forecasting
- Kaggle
- International Journal of Forecasting
- IEEE Transactions on Smart Grid
- An anonymous Utility

Organization

Individuals

- General Chair – Dr. Tao Hong
- Vice Chair (load forecasting) – Dr. Shu Fan
- Vice Chair (wind forecasting) – Dr. Pierre Pinson
- Award Committee
 - Dr. Shu Fan, David Hamilton, Dr. Tao Hong, Dr. Pierre Pinson, Eric Wang, Dr. Hamidreza Zareipour
- Advisory Committee
 - Drs. ML Chan, Rob J Hyndman, Wei-Jen Lee, Fran Li, Shanshan Liu, Anil Pahwa, Mohammad Shahidehpour, Kumar Venayagamoorthy

The Two Tracks

Hierarchical Load Forecasting

- 20 delivery points
- 4.5 years of hourly history
- Backcast eight individual weeks
- Forecast one week ahead
- WRMSE

GEFCom2012
Load Forecasting

The Two Tracks

Wind Power Forecasting

- 7 wind farms
- 3 years of hourly history
- Wind forecasts issued twice a day
- 48 hours ahead forecasting
- RMSE

GEFCom2012
Wind Forecasting

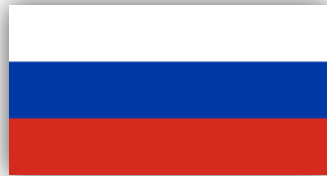
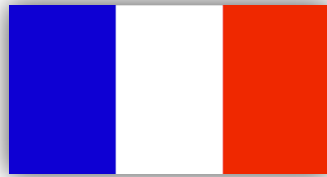
The Two Tracks

Six challenges

- Data cleansing
- Hierarchical forecasting
- Special days forecasting
- Temperature forecasting
- Ensemble forecasting
- Integration

GEFCom2012 Winning Teams

8 teams from 8 countries



Hierarchical Load Forecasting Track:

- #1. Colin Singleton and Nathaniel Charlton from Counting Lab (UK);
- #2. James Robert Lloyd from University of Cambridge (UK);
- #3. Raphael Nedellec from EDF R&D (France), Jairo Cugliari from INRIA (France) and Yannig Goude from EDF R&D (France);
- #4. Souhaib Ben Taieb from Université Libre de Bruxelles (Belgium) and Rob J Hyndman from Monash University (Australia).

Wind Power Forecasting Track:

- #1. Lucas Eustáquio Gomes da Silva from DTI Sistemas (Brazil);
- #2. Ekaterina Mangalova from Siberian State Aerospace University (Russia) and Evgeny Agafonov from Siberian Federal University (Russia);
- #3. Gabor I. Nagy from Budapest University of Technology and Economics (Hungary);
- #4. Duehee Lee from University of Texas at Austin (USA).

Winning Methods

Hierarchical Load Forecasting

- No ARIMA
- No Artificial Neural Networks
- Top 2 entries combined forecasts
- No. 1, 3, and 4 modeled holidays
- No. 1 and 4 performed data cleansing

GEFCom2012
Load Forecasting

To be improved

- Using the hierarchy
- Integration

Winning Methods

Techniques

1. Multiple linear regression, SVD
2. Multiple linear regression, gradient boosting, Gaussian process regression
3. Semi-parametric regression, splines
4. Non-parametric additive models, gradient boosting

GEFCom2012
Load Forecasting

REGRESSION is still an effective method for STLF.

Winning Methods

Results

GEFCom2012
Load Forecasting

Kaggle ID	Backcast	1 day ahead	1 week ahead	Validation	Test	All	Submissions
CountingLab	61 890	72 504	73 900	70 700	67 215	68 160	33
James Lloyd	58 406	59 273	82 346	71 164	71 467	71 387	52
Tololo (EDF)	46 756	52 136	82 776	52 669	71 780	67 223	39
TinTin	50 926	1 12 410	86 590	64 352	73 307	71 033	42
Quadrivio	71 663	63 186	81 645	72 825	78 196	76 816	29
Chaotic Experiments	78 238	50 967	89 783	93 045	80 763	84 209	19
Andrew L.	68 638	1 33 005	1 06 272	1 01 069	84 850	89 456	3
NHH	65 360	1 21 818	1 09 850	93 641	89 174	90 385	18
TheJellyTeam	72 197	1 20 752	1 01 066	83 916	89 202	87 826	12
Tao's Vanilla Benchmark	69 557	1 48 352	1 23 758	1 12 547	95 588	1 00 385	1

Over 30% error reduction!

Winning Methods

Wind Power Forecasting

- No ARIMA
- No. 1 and 4 combined forecasts
- No. 2 and 3 performed data cleansing
- No. 1 and 2 smoothed the raw forecasts

GEFCom2012
Wind Forecasting

Winning Methods

Techniques

1. Gradient boosting, regression
2. K-Nearest Neighborhood, regression
3. Gradient boosting, regression
4. Neural networks, Gaussian process

GEFCom2012
Wind Forecasting

*The magic of
“Gradient Boosting + REGRESSION”*

Winning Methods

Results

GEFCom2012
Wind Forecasting

Kaggle ID	WF1	WF2	WF3	WF4	WF5	WF6	WF7	Validation	Test	All	Submissions
Leustagos	0.145	0.138	0.168	0.144	0.158	0.133	0.140	0.146	0.146	0.146	37
DuckTile	0.143	0.145	0.172	0.145	0.165	0.137	0.146	0.149	0.147	0.148	82
MZ	0.141	0.151	0.174	0.145	0.167	0.141	0.145	0.148	0.149	0.149	19
Propeller	0.144	0.153	0.177	0.147	0.175	0.141	0.147	0.148	0.153	0.152	64
Duehee Lee	0.157	0.144	0.176	0.160	0.169	0.154	0.148	0.155	0.155	0.155	10
MTU EE5260 forecast team	0.161	0.172	0.193	0.162	0.192	0.156	0.160	0.166	0.169	0.168	20
SunWind	0.174	0.177	0.193	0.176	0.179	0.157	0.162	0.173	0.171	0.172	26
ymzmsd	0.163	0.186	0.200	0.164	0.192	0.162	0.167	0.173	0.174	0.174	24
4138 Kalchas	0.180	0.179	0.197	0.175	0.200	0.160	0.165	0.179	0.176	0.177	3
Benchmark	0.302	0.338	0.373	0.364	0.388	0.341	0.361	0.361	0.353	0.355	1

Over 60% error reduction!

Winning Methods

Remarks

- The results may or may not be applicable to YOUR data
- There is not a technique dominantly better than the others
- Now you have more ideas to try
- Always try to improve your models

All forecasts are wrong. All forecasts can be improved.

GEFCom2014

Four tracks

WWW.GEFCOM.ORG

- Load Forecasting – Dr. Shu Fan, Australia
- Wind Forecasting – Dr. Pierre Pinson, Denmark
- Solar Forecasting – Dr. Alberto Troccoli, Australia
- Price Forecasting – Dr. Hamidreza Zareipour, Canada

Probabilistic forecasting

Pinball function scoring

Rolling forecasting

Prizes for students teams and for winning methods

Winning methods to be published in IJF

Further Readings

Blog posts

<http://blog.drhongtao.com/search/label/GEFCOM>

<http://robjhyndman.com/hyndsight/gefcom2014/>

Paper

Tao Hong, Pierre Pinson and Shu Fan, “Global Energy Forecasting Competition 2012”, International Journal of Forecasting (2014)

“GEFCom2012 is the largest known energy forecasting competition to date. Not only does it bring together many new ideas to the energy-forecasting field from data scientists in many different industries but the competition data has already been used by scholars for benchmarking purposes.”

-- IEEE Power and Energy Society, 9/30/2013

