Price Normalization for Price-Responsive Devices—Algorithms and Issues

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Who We Are

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- William Cox
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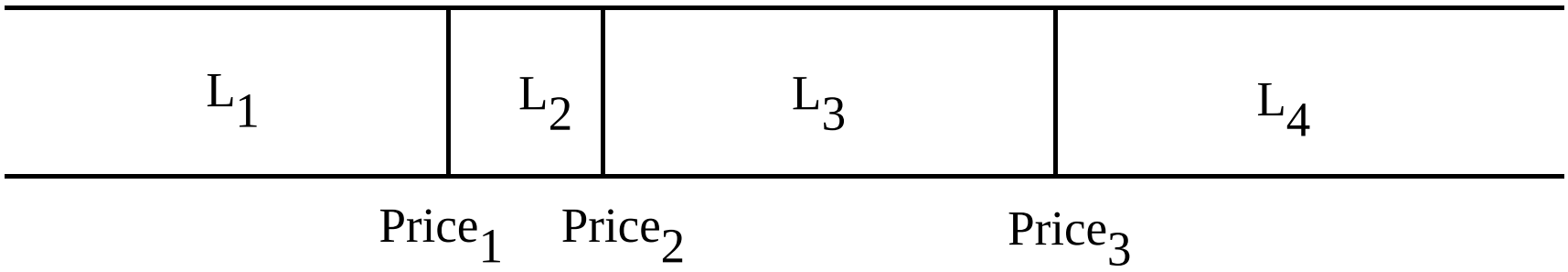
  - Co-Chair Energy Interoperation, EMIX
- Toby Considine
  - Chair WS-Calendar, Open Building Information Exchange (oBIX)
  - Member Smart Grid Architecture Committee

The Problem

- Price-responsive devices are in trial programs
- Simple levels abstract dynamic prices
- Processing is presumed to be best done prior to devices
- The general range of prices changes
  - Winter to summer
  - Day to night

Terminology

- Levels or Simple Levels
  - An abstraction of price
  - Levels are numbered from 1..numLevels
  - Higher levels abstract higher price
- Cut points
  - Separate price information into groups mapped to a single Level

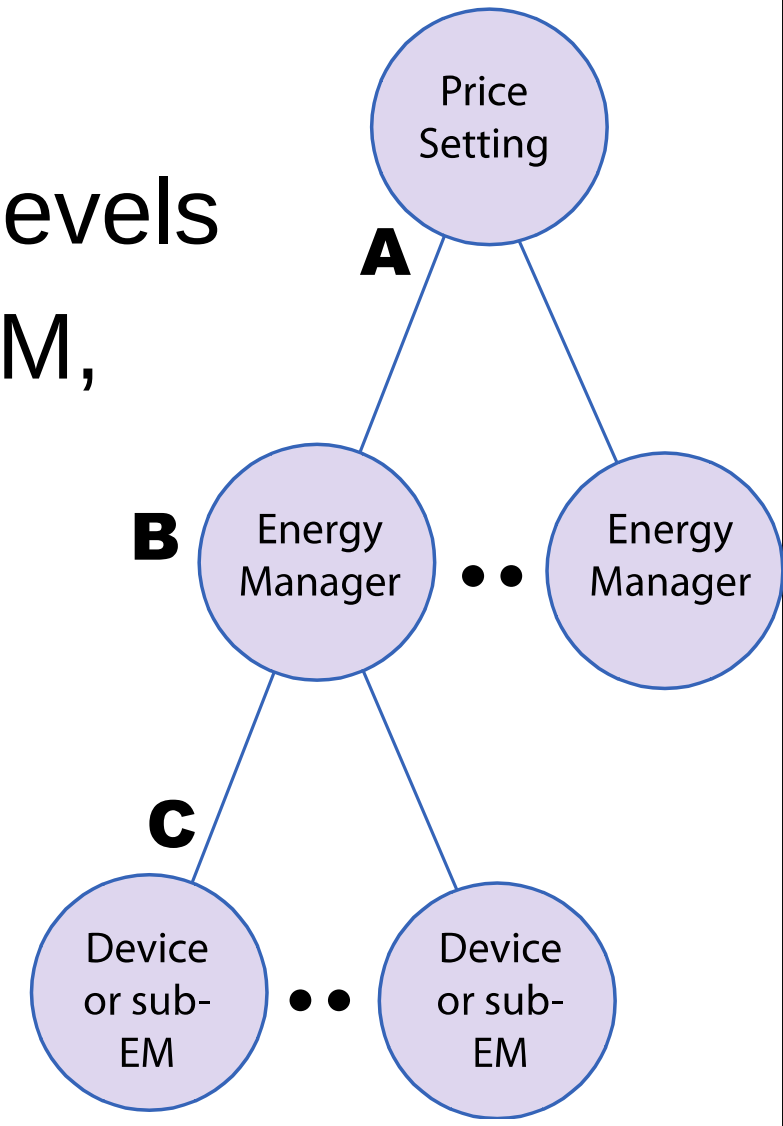


Quality of Solutions

- A normalization
  - Must allow response similar to that for real prices
  - Must show differentiation across time
- Given the changing nature of prices
  - Must evolve over time to reflect “current” prices
  - Quality of tracking is an important criterion

Where To Normalize?

- A, B, or C?
- A: Prices emitted as simple levels
- B: Raw prices received by EM, which emits simple levels
- C: Raw prices received by device which uses simple levels



Assumptions

- Simple levels reflect cost
- Computing simple levels takes significant computing power
- Energy Managers want an abstraction of price
- Response to simple levels is “Good Enough”
- One computation fits all—receiving device should be able to use common levels
- Three or four levels are enough for effective and economic response

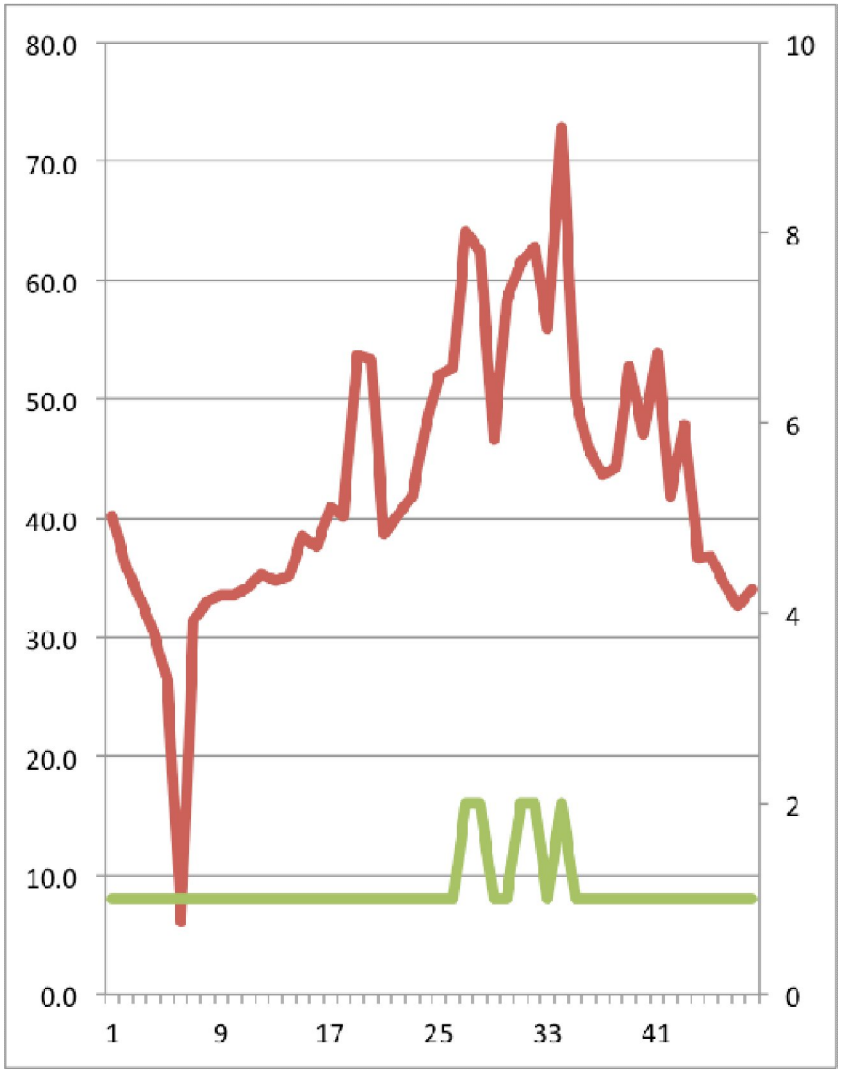
Historical and Future Knowledge

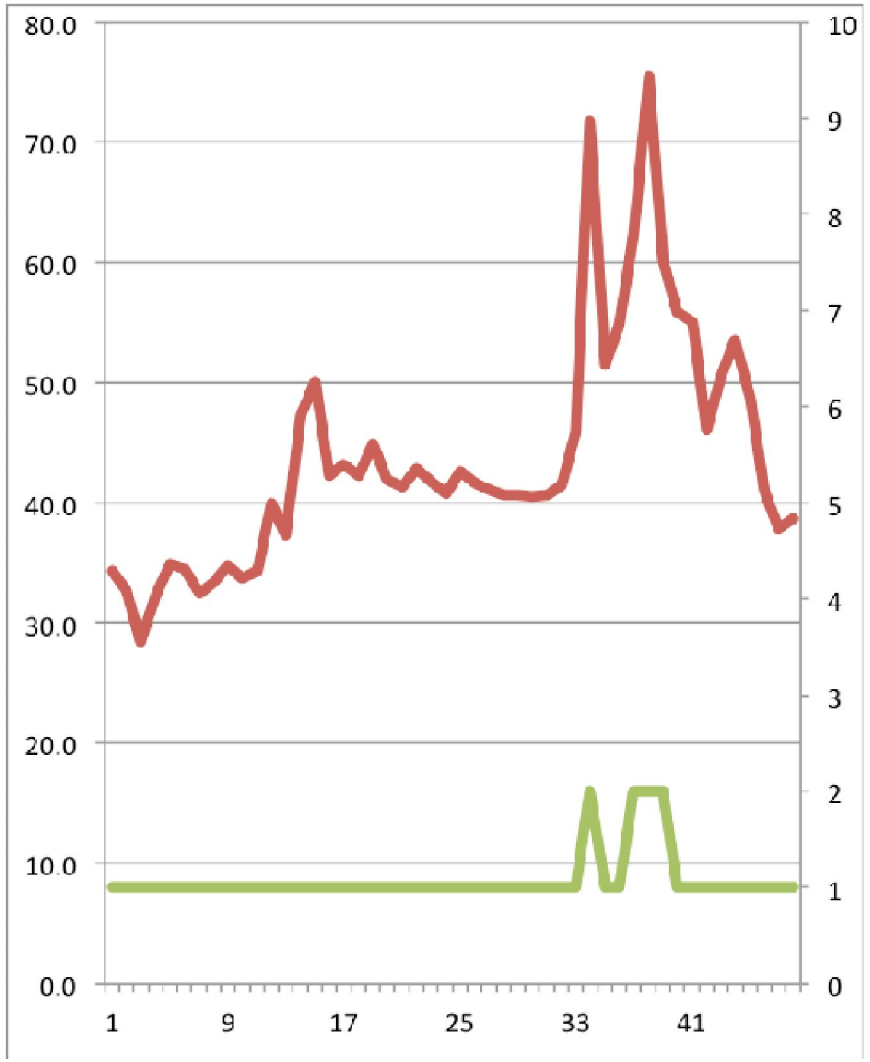
- Chance for better response with future price
- Algorithms typically look backward
- Too much history reduces variability
  - Long tail?
- Too little ignores price trends
  - Too much jitter?

Algorithms

- Describe and discuss several in the paper
- Pacific Northwest Project
- Vineyard Project

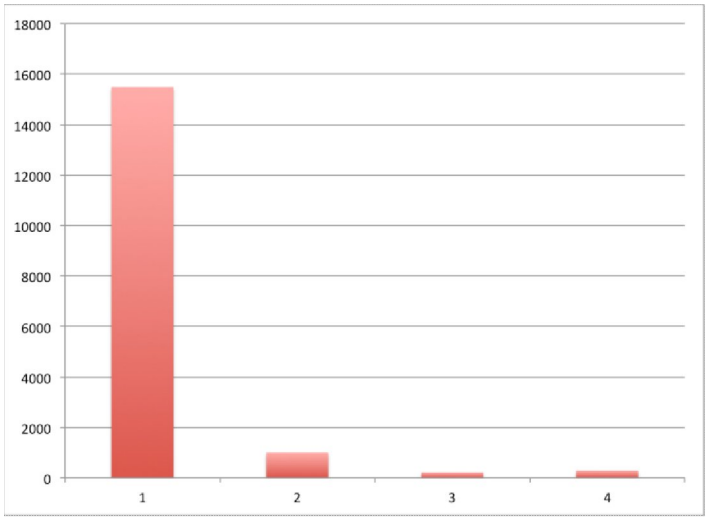
- Two days, one algorithm





Problem: Quality of Results

- "We either have all ones or all fours"
  - Vineyard Project data is pretty much "all ones"
  - Lots of variation of actual price
- High price variation in levels
  - If price is in level 1 or 4 no information on price
  - Suggests back-off to actual price, less simple
  - Mean 1.135, N=16993, one year of 30 minute data



Problem: Volatility

- Price volatility for dynamic pricing is significant
  - Studies on wholesale volatilities in 1500-3000% range
  - Need shorter term and longer term views
  - Dealing with volatility with limited levels is hard
- Moving averages are a useful smoothing tool
  - But every algorithm examined has issues

Problem: Asymmetry

- A change of $X is more important at high price levels
- If prevailing levels are low, probably shouldn't be worried about small variations

Problem: Actions or Prices

- Price abstraction is complex
- Levels of effort may be more useful
  - See e.g. OpenADR_1
  - Effort level 3 is “higher” or “more restrictive of energy use” than Effort level 2, and so forth
- Same issues of expression and approximation

Conclusions

- Defined a model for mapping of prices to Simple Levels
- Extracting value from simple levels is difficult
- Need to know price as well as level to determine or estimate cost
- Need model of device/virtual end node behavior to determine merit of algorithms
- Rethink small number of levels and behaviors

Conclusions (2)

Simple levels aren't

Questions

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