Karlsruhe Institute of Technology

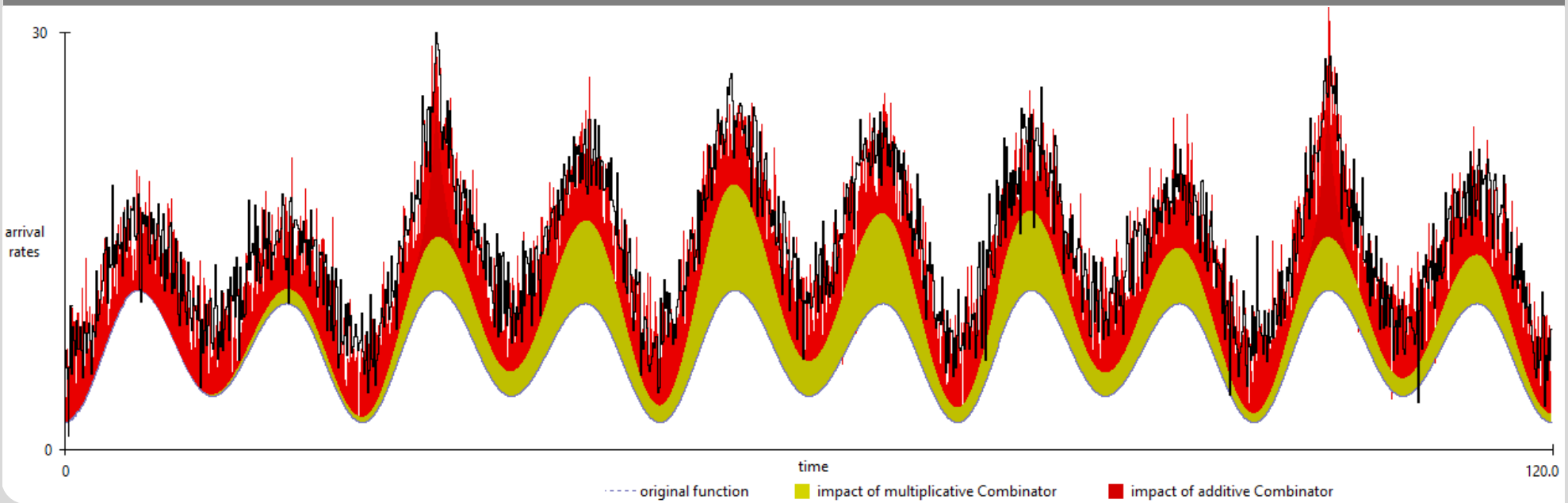
Descartes research

Modeling Variations in Load Intensity over Time

Third International Workshop on Large-Scale Testing (LT 2014), co-located with ICPE'14

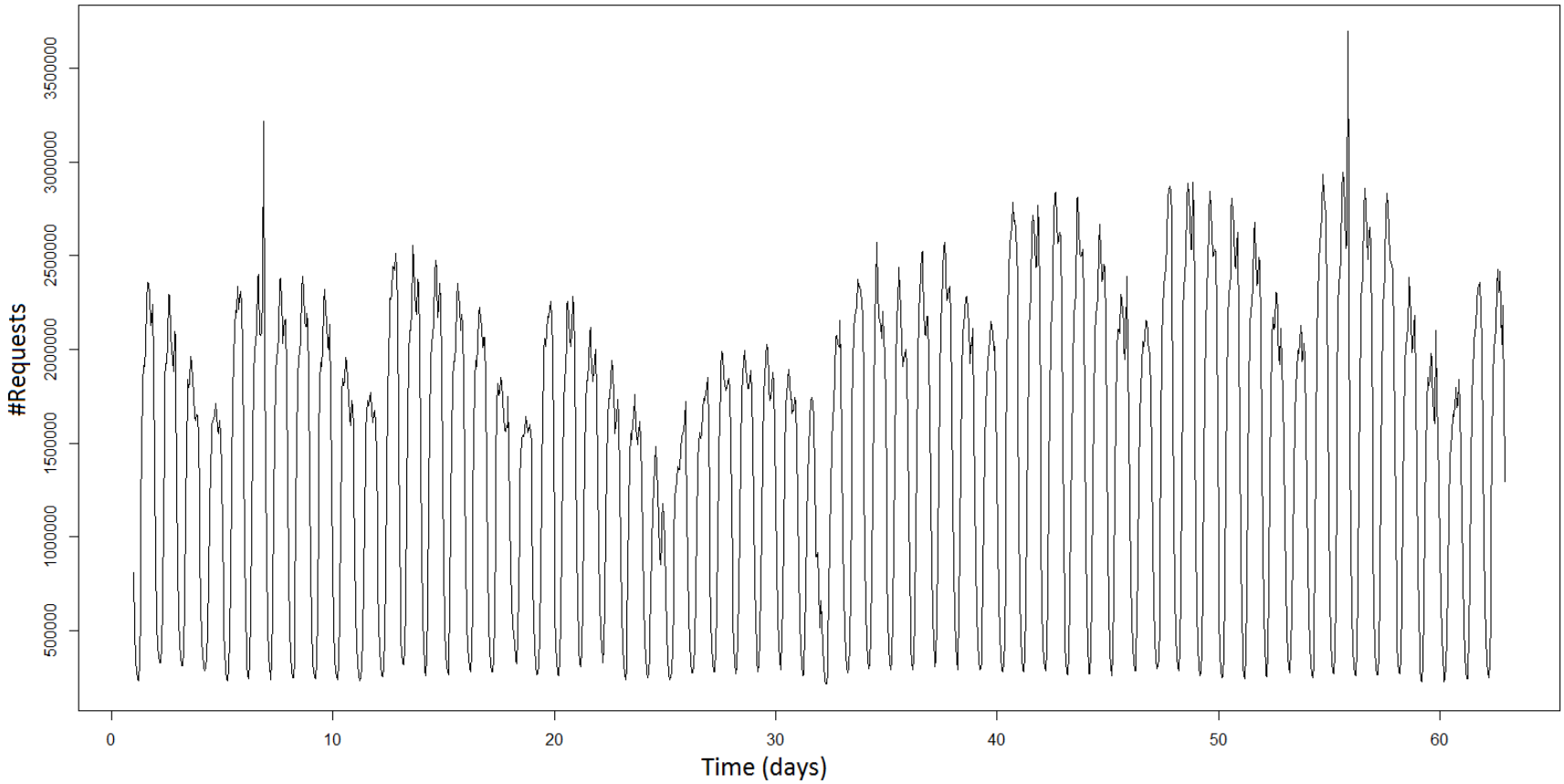
Jóakim v. Kistowski, Nikolas Herbst, Samuel Kounev | March 22nd, 2014

DESCARTES RESEARCH GROUP



Motivation

- Page Requests for the German Wikipedia



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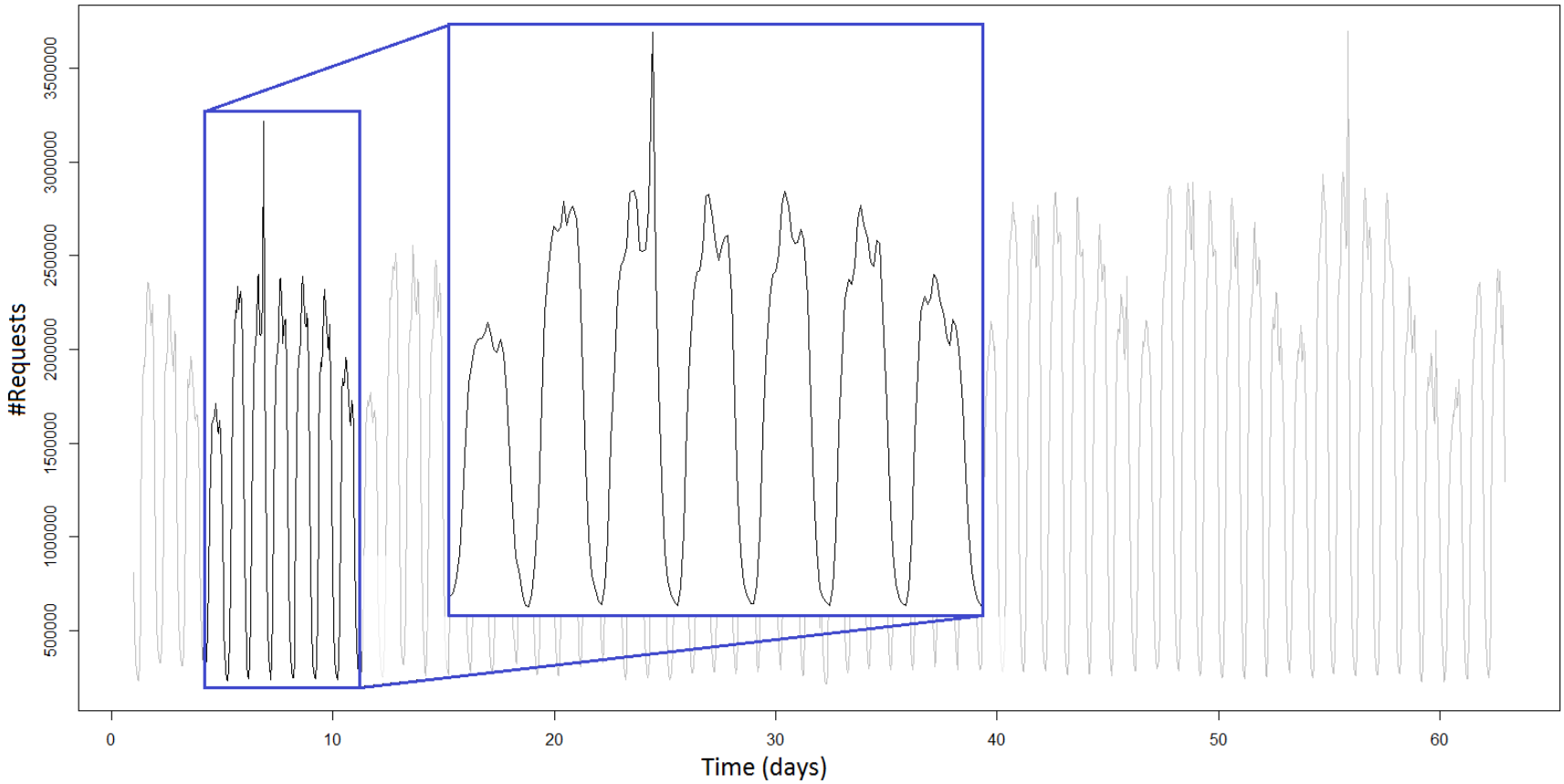

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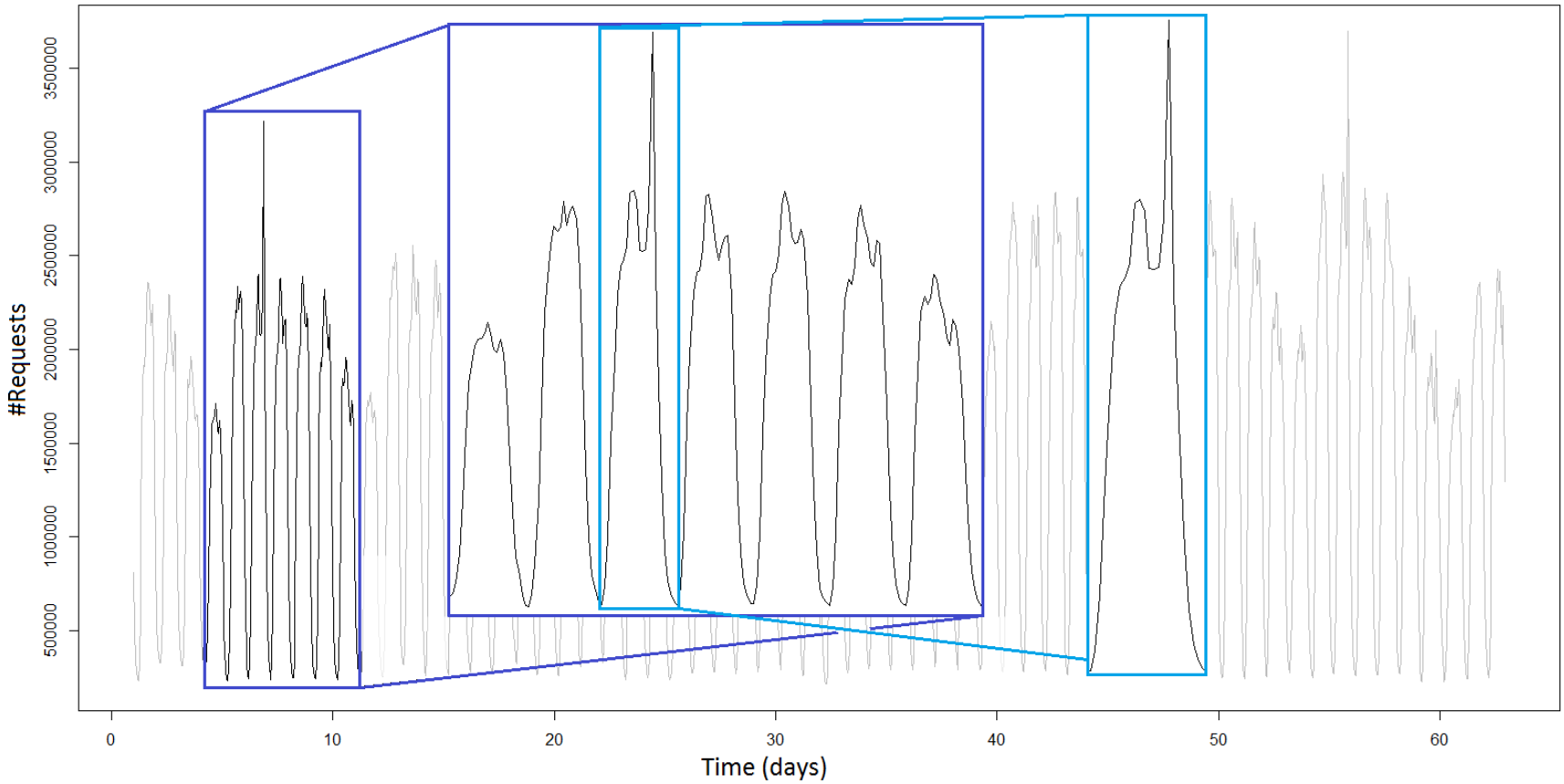

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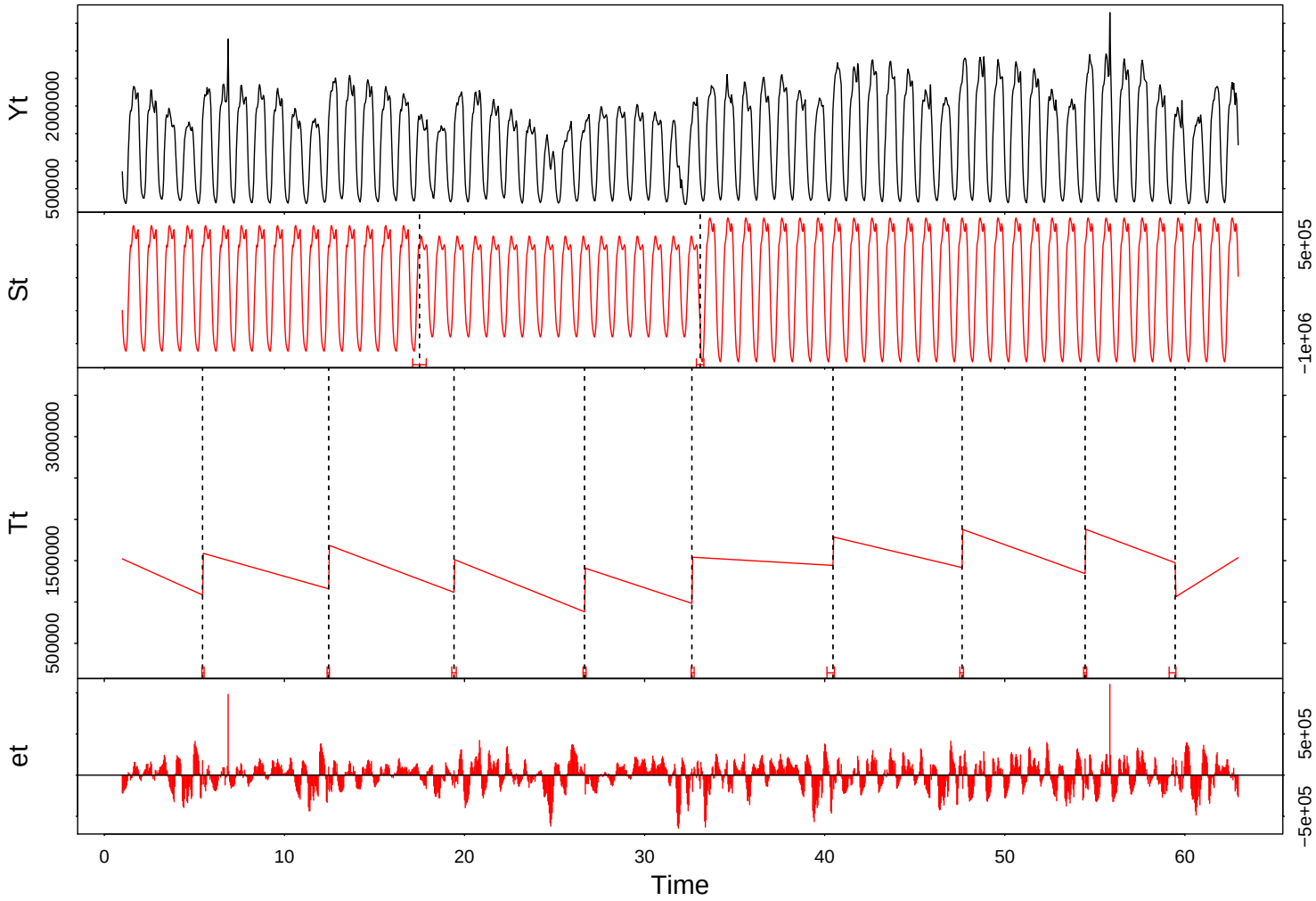

Additive decomposition into seasonal part, trend, and remainder. Created using *BFAST* [1].

Outline

- **Problem:** No means to effectively capture and reproduce the varying load intensity of real-world cloud systems
- **Idea:** Close this gap by creating a meta-model for load intensity variations
- **Benefits:** Enable more precise communication and creation of realistic load scenarios for benchmarking
- **Actions:** Creation of the Descartes Load Intensity Model (DLIM) and High-Level DLIM

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Related Work

User Behavior Models (Markov Chains)

- van Hoorn et al. (2008) [2]: probabilistic and intensity-varying workloads
- Roy et al. (2013) [3]: workload volatility of a VoD system

Workload Models

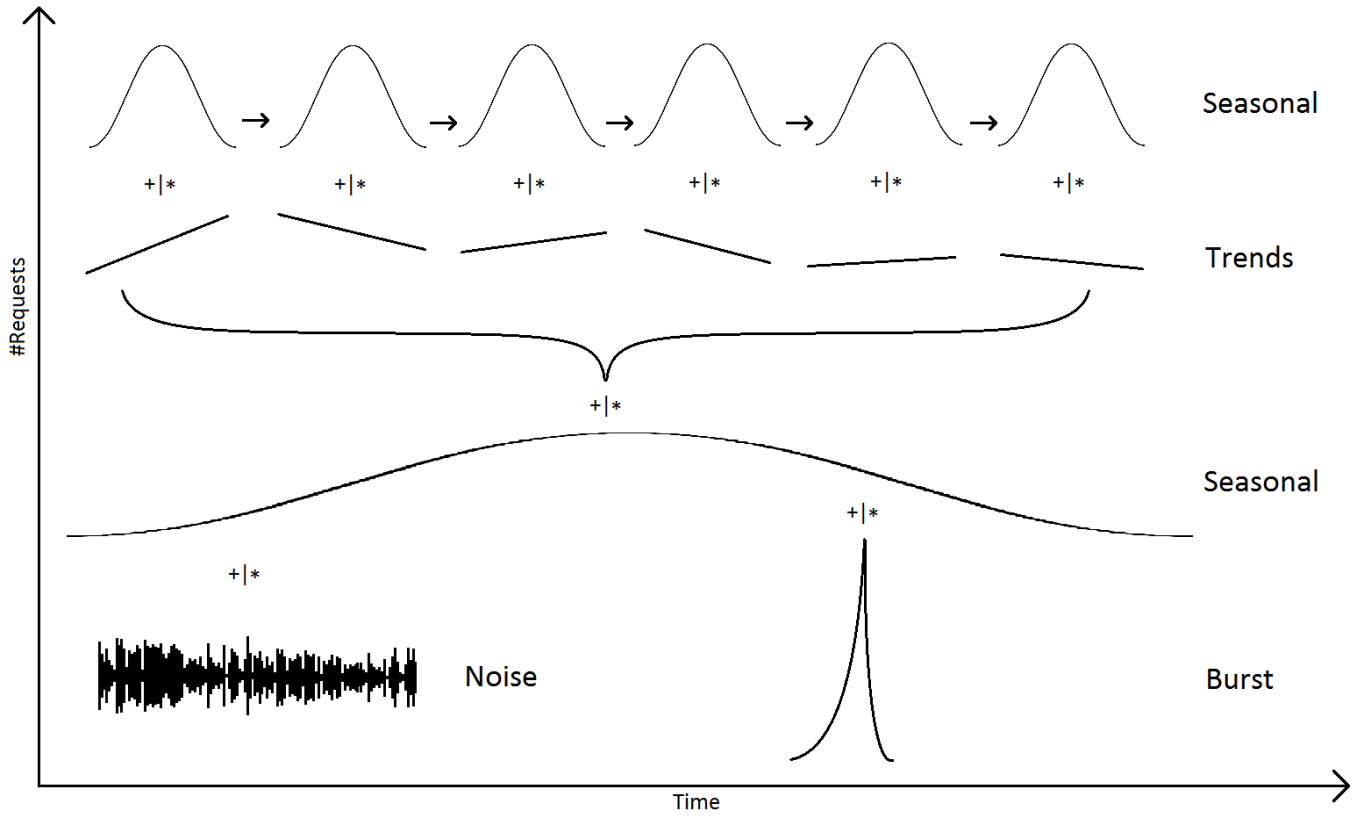
- Barford et al. (1998) [4]: file popularity and distribution (Web)
- Casale et al. (2012) [5]: bursts
- Beich et al. (2010) [6]: data popularity and user separation (Cloud)

Statistical Model

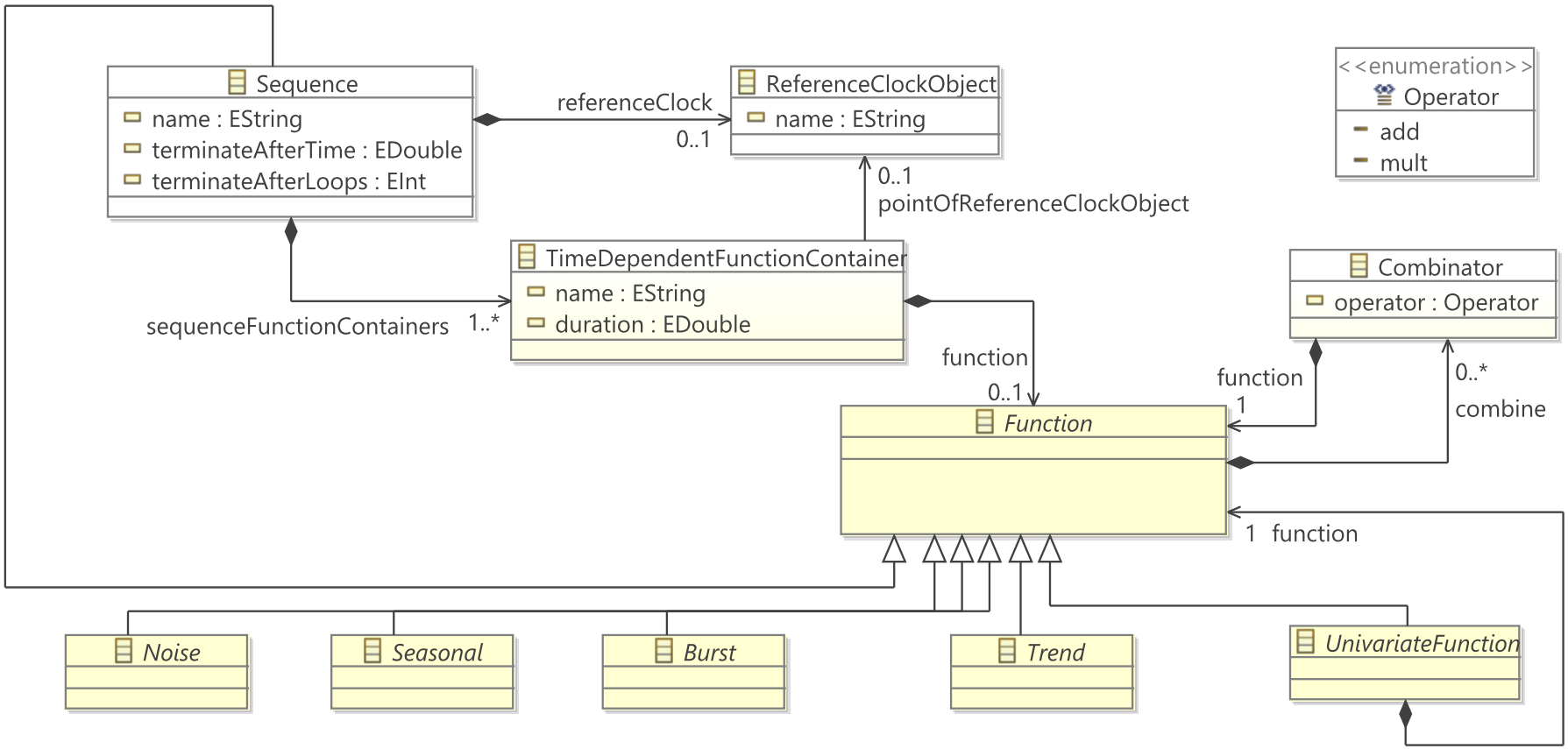
- Feitelson (2002) [7]: workload representativity through statistical characteristics

Descartes Load Intensity Meta-Model

- Describe arrival rate variations over time
- Provides structure for piece-wise mathematical functions
- Independent of work/request type

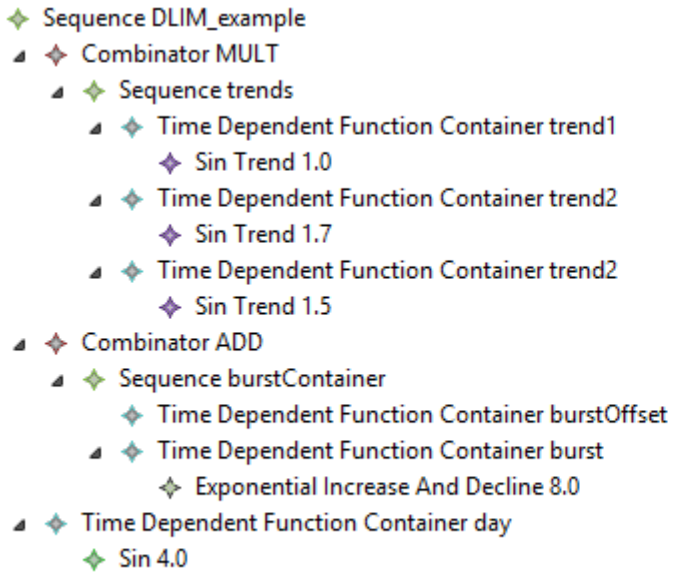


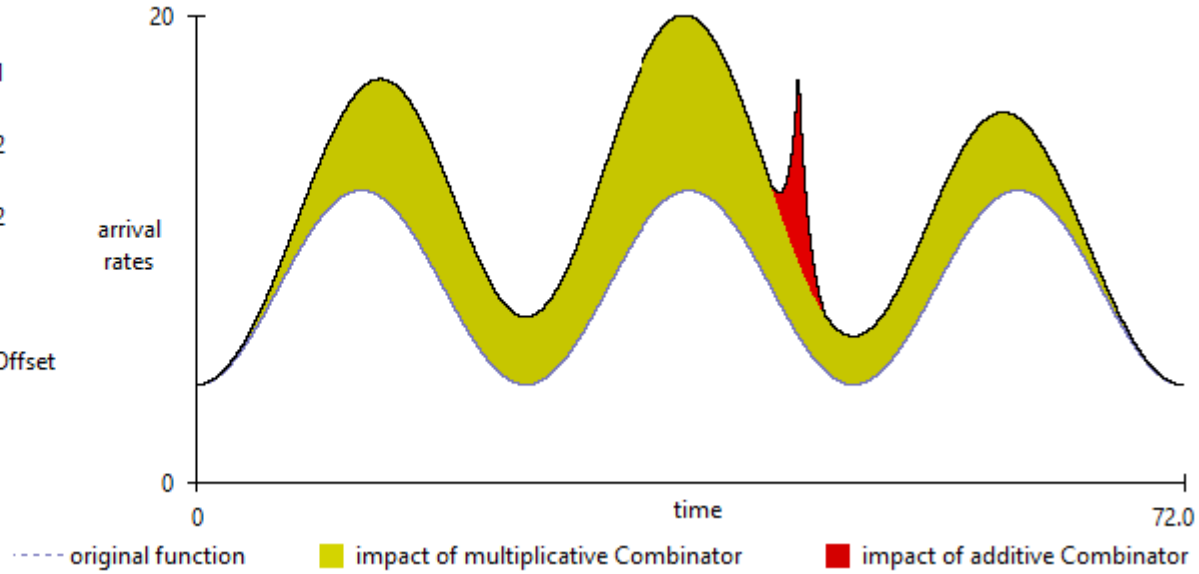
Descartes Load Intensity Meta-Model (DLIM)



DLIM Example Instance

- Created using LIMBO [1]
- Contains *Seasonal* part, *Trends*, and *Burst*





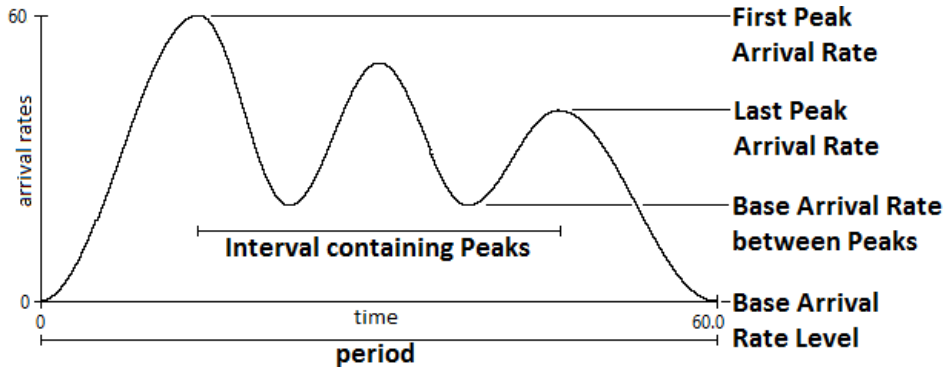
[1] LIMBO: `www.descartes-research.net/tools`

High-Level DLIM

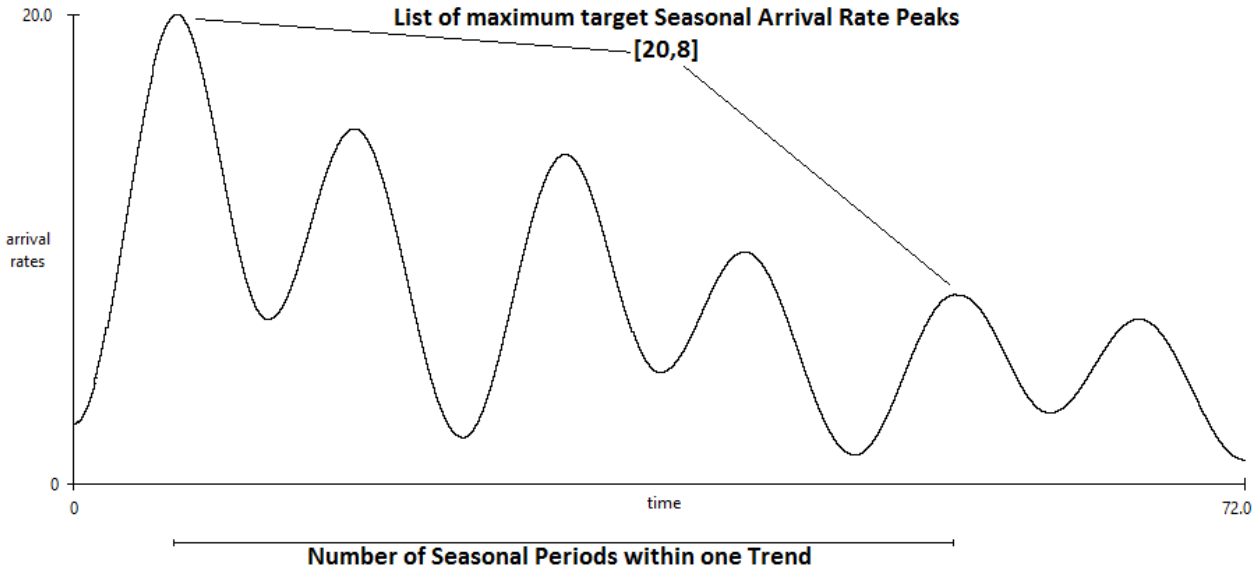
- DLIM Benefits:
  - Powerful
  - Expressive
  - Deriving arrival rates or request time-stamps is easy
- DLIM Drawbacks:
  - Instances can become complex
  - Large trees my be unintuitive
- Solution: **High-Level DLIM**
  - Few parameters for load intensity variation description
  - Easier to grasp
  - Strictly structured into one *Seasonal*, *Trend*, recurring *Burst*, and *Noise* parts

HLDLIM Seasonal and Trend parts

- HLDLIM *Seasonal* part:

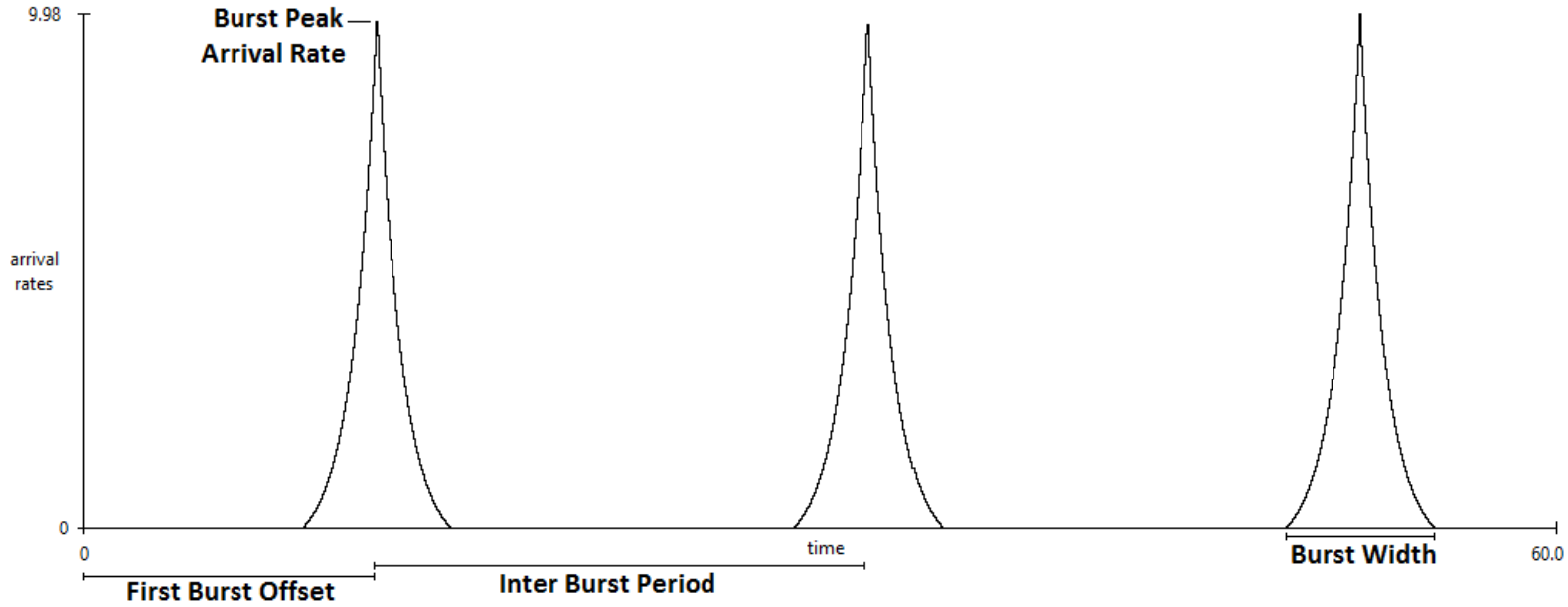


- HLDLIM *Trend* part:



HLDLIM Burst and Noise parts

- HLDLIM *Burst* part:



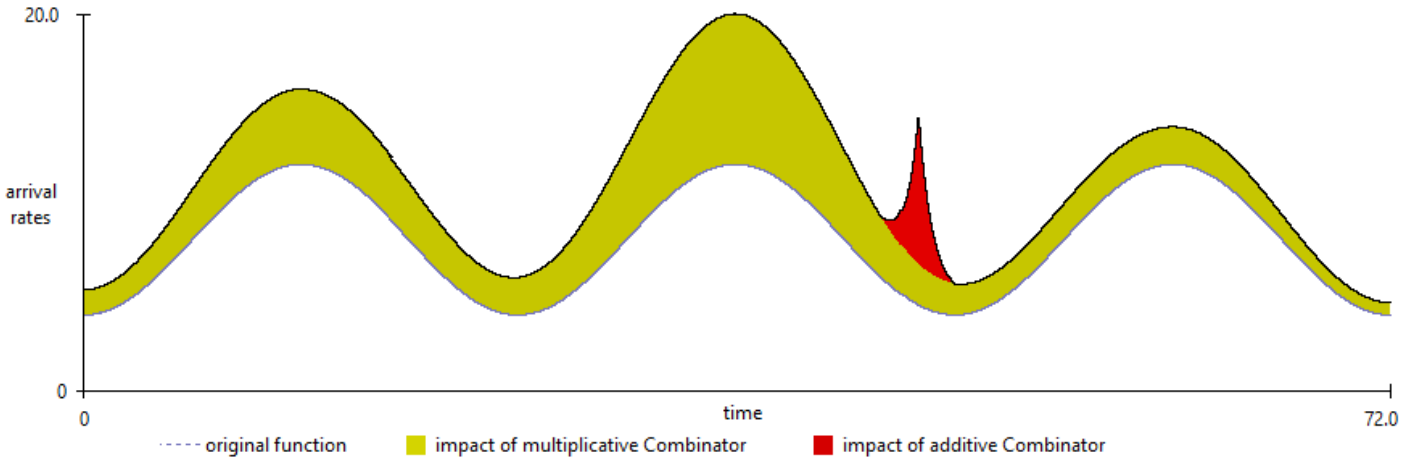
- HLDLIM *Noise* part:

Uniform Distribution

- Minimum Noise Rate
- Maximum Noise Rate

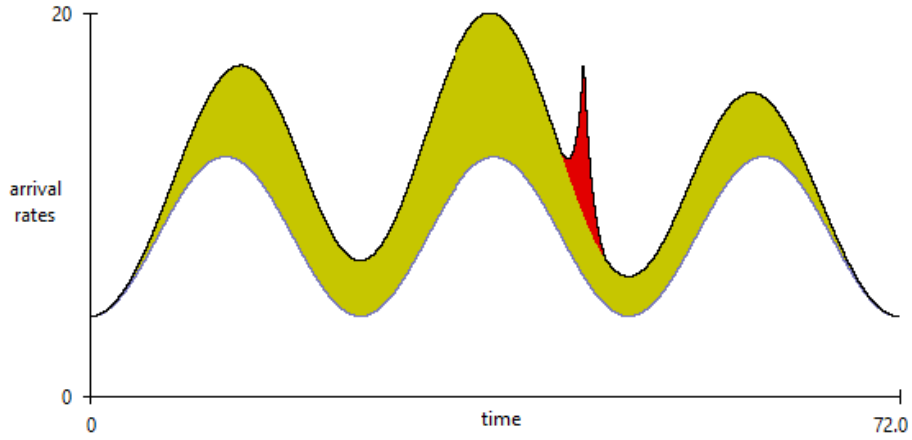
HLDLIM Example Instance

- *Seasonal* part:
  - Period: 24
  - Peaks per Seasonal: 1
  - Base Arrival Rate: 4
  - First Peak Arrival Rate: 12
- *Burst* part:
  - First Burst Offset: 46
  - Burst Peak Arrival Rate: 8
  - Burst Width: 4
- *Trend* part:
  - Number of Seasonal Periods within one Trend: 1
  - Trend List: 16, 20, 14

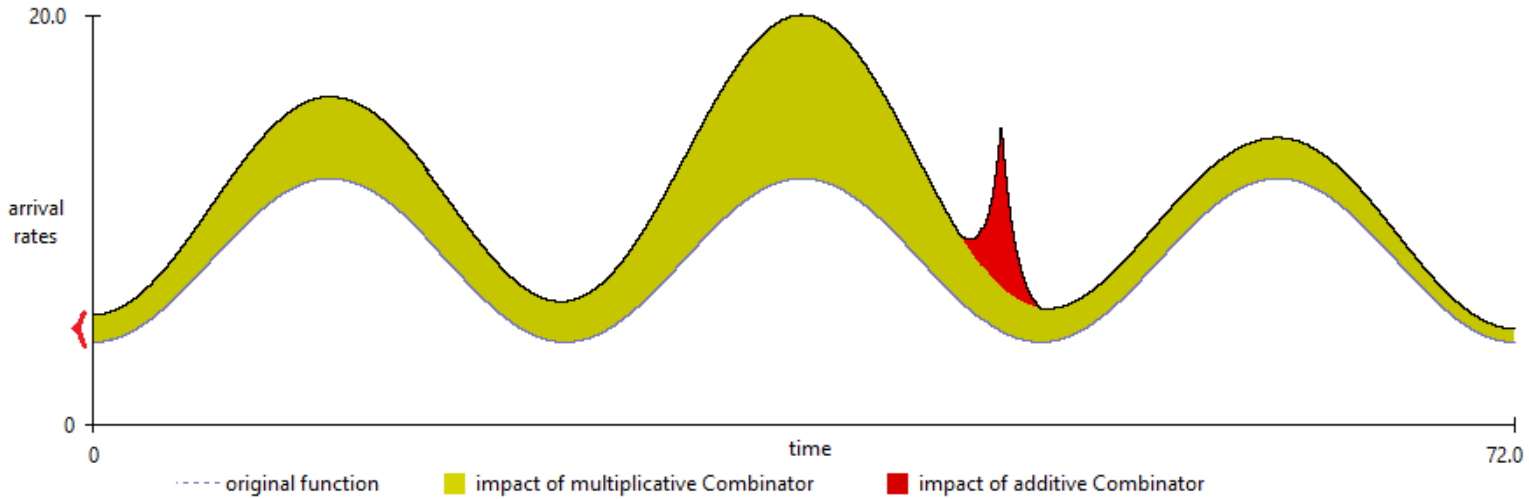


DLIM / HLDLIM Differences

- DLIM:



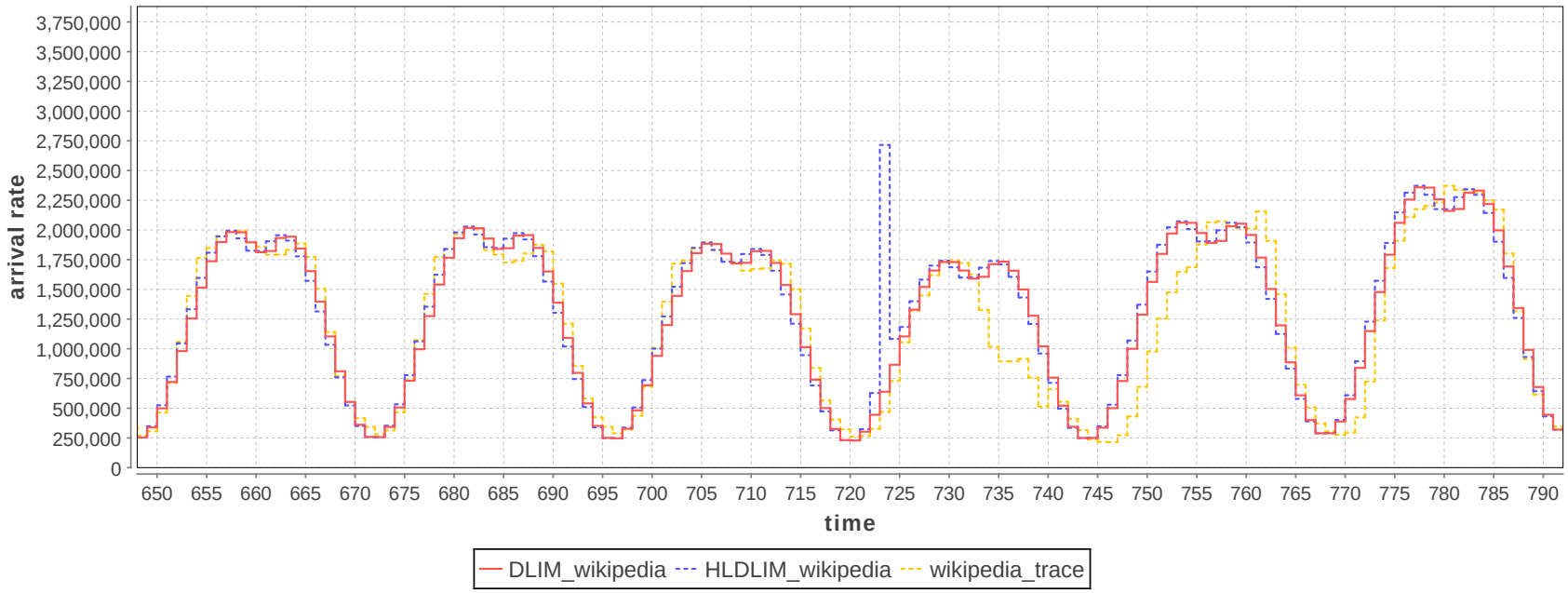
- HLDLIM:



Preliminary Evaluation

- Trace: German Wikipedia project-counts
- Fitted using best effort approach

	median error	mean error
DLIM	8.95%	16.08%
HLDLIM	9.64%	16.25%



Conclusions

- Two Meta-Models for load intensity variation description
  - **DLIM:** Powerful and expressive
  - **HLDLIM:** Abstract and concise
- Available as part of LIMBO [2]

- Enables creation of custom load intensity variations for open workload based benchmarking
- Capable of accurately capturing real-world load intensity variations

[2] LIMBO: `www.descartes-research.net/tools`

Thank you for your Interest!

- Which parameters are missing in HLDLIM, which are superfluous?
- How would you go about using DLIM for run-time resource managements? Which additional use cases do you envision for DLIM?
- LIMBO: `www.descartes-research.net/tools`

References

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