Last but not least...

Matching Earliest-Deadline-First performance through deadline-oblivious policies

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Outline

Introduction

A crash course on measure valued processes

Partial service queues

Performance analysis

Simulations

Future work

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Motivation

A bit of history...

- Several queueing systems have service and timing requirements.
- Examples:
  - Computing tasks with real-time constraints.
  - Item delivery problems in logistics.
  - Emergency response.
  - etc. etc. etc.
- This has led to a long and rich history of research about queues with abandonments [Barrer, 1957; Stanford, 1979; Baccelli et al., 1984].

Motivation

Recent developments...

One of the most used policies is Earliest-Deadline-First (EDF)

- Serve the customers with more urgent deadlines in priority.

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Through fluid limits and diffusion approximations, establish performance:

- [Decreusefond and Moyal, 2008] establish EDF fluid limits in the single server case.
- [Kruk et al., 2011] provides diffusion approximations.
- [Moyal, 2013] establish some optimality properties of EDF.
- [Kang and Ramanan, 2010, 2012] analyze the many-server case.
- [Atar et al., 2018, 2023] establish asymptotic performance.

and many others...

Motivation

Common assumption

Customers renege *only* in the queue, and not during service.

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We call this the *call-center scenario*:

- Akin to waiting for the customer-help line to pick your call while you listen to annoying music.
- The underlying idea is that when a task reaches service, it will stay until completion.

Key performance metric: number of satisfied tasks (or reneging probability).

Motivation

Partial service queues

In several queueing systems:

- Tasks may abandon during service.
- More importantly, all service provided may be useful.

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Some examples:

- Electrical vehicle charging: customers leave the system with a *partial charge*.
- LLM inference: longer computation times lead to better answers, but these may be interrupted to deliver a quick response.
- File transfers over the Internet, that can be resumed later.

Key points of this talk

- Provide some suitable representation of the state space and dynamics of these partial service queues.
- Analyze several interesting policies under a suitable fluid model.
- Compute the main performance metric here: attained work.
- *Last but not least:* show that the simple LCFS policy exhibits the same performance than EDF in this setting, without using deadline information.

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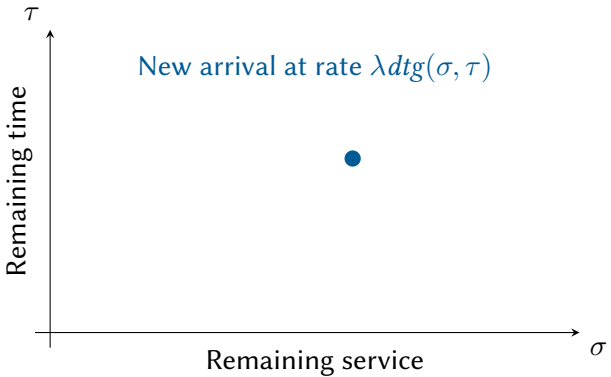
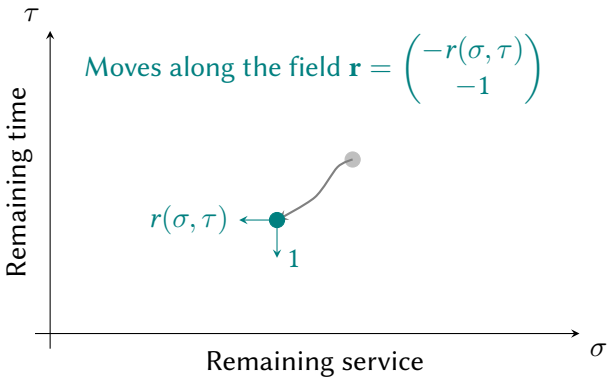
Remaining service state descriptor



Remaining service state descriptor



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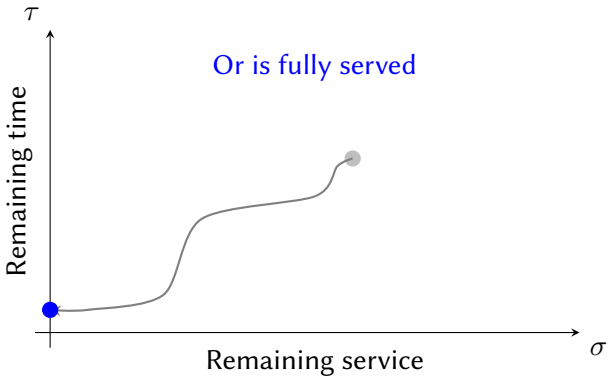
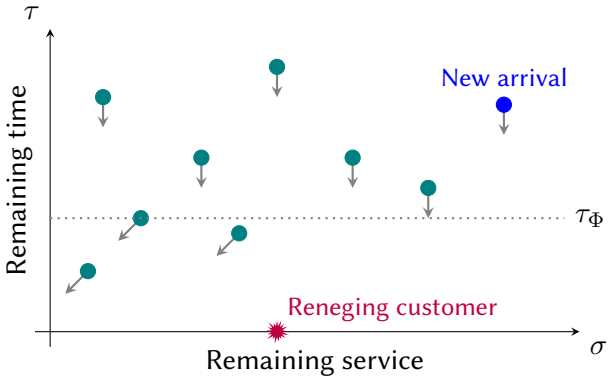
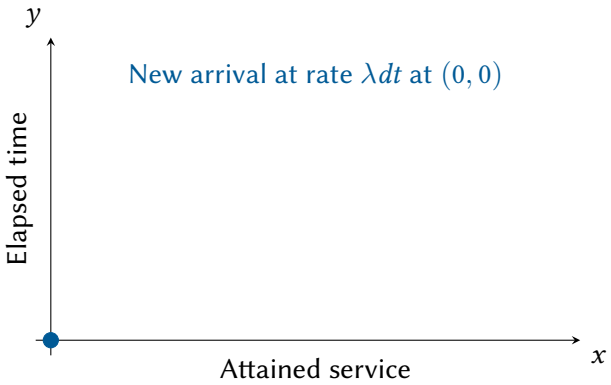


Example

Earliest-deadline-first



Attained service state descriptor



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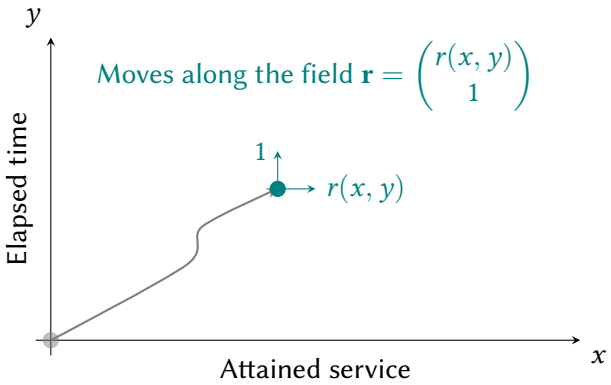

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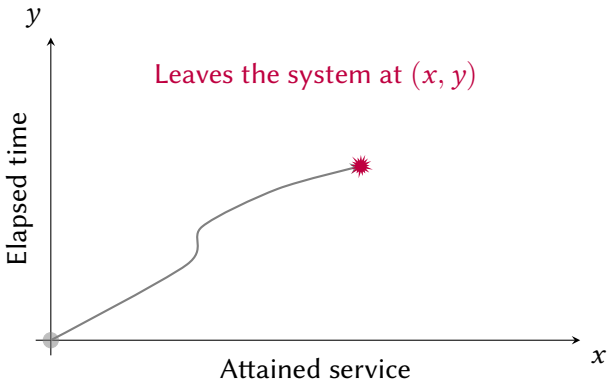
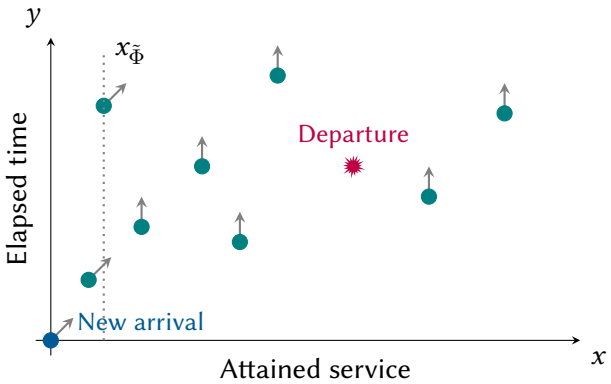


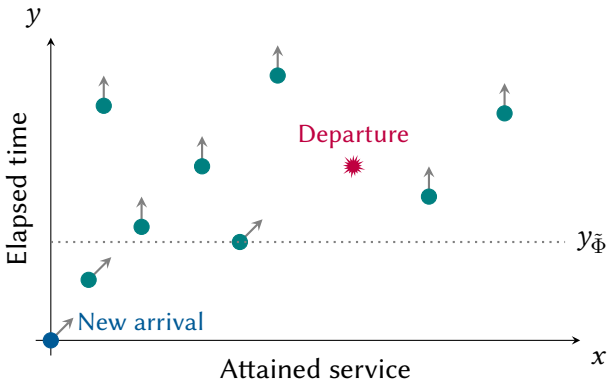
Example

Least-Attained-Service policy



Example

Last-Come-First-Served policy



The hazard rate field

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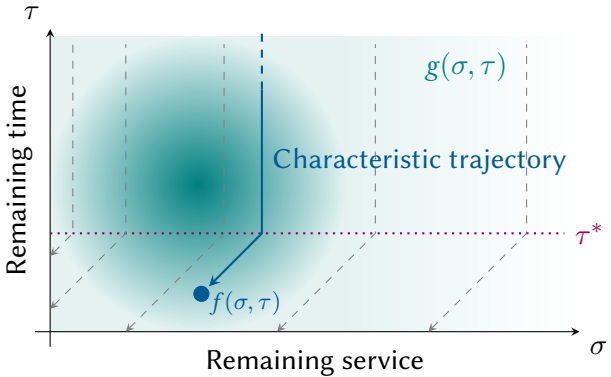
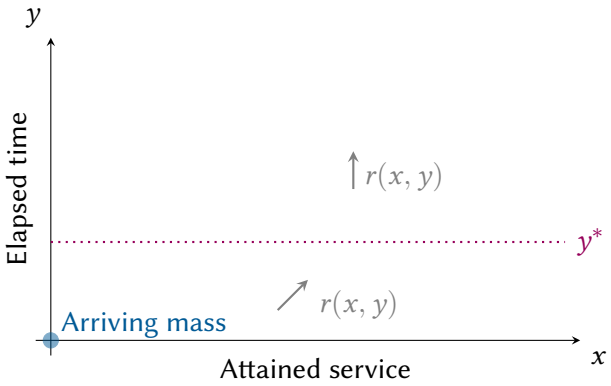
Solving the transport equation

Remaining service case



Solving the transport equation

Attained service case



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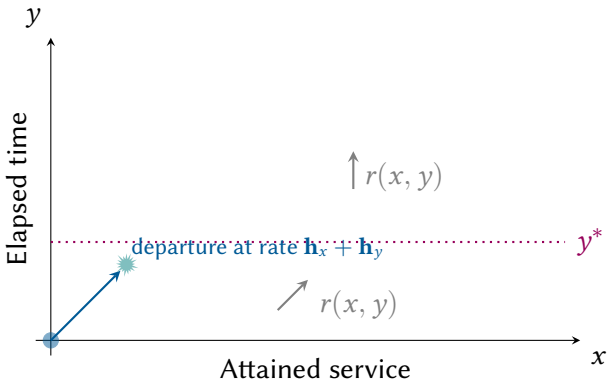

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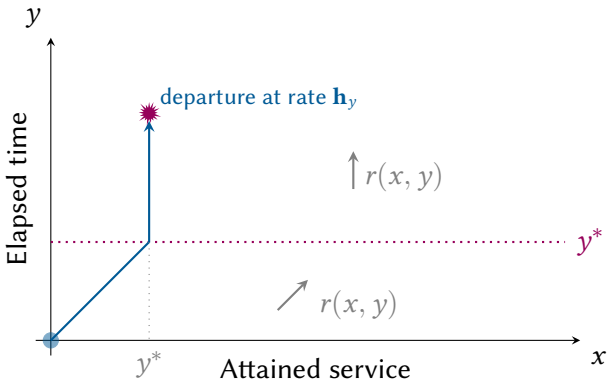
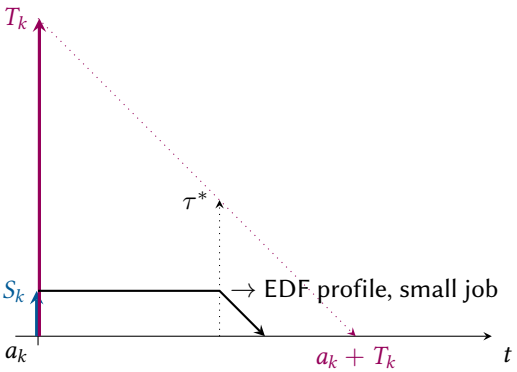


Perceived performance in EDF



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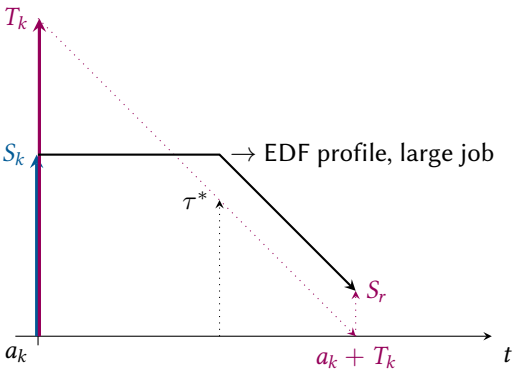
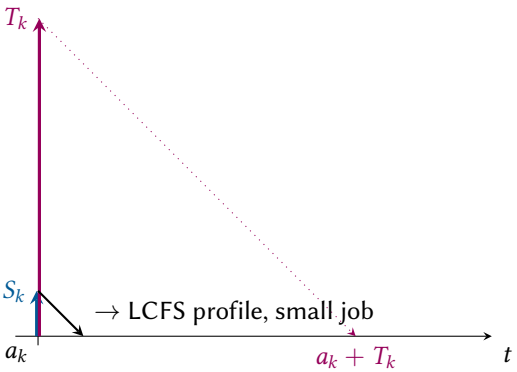


Perceived performance in LAS and LCFS



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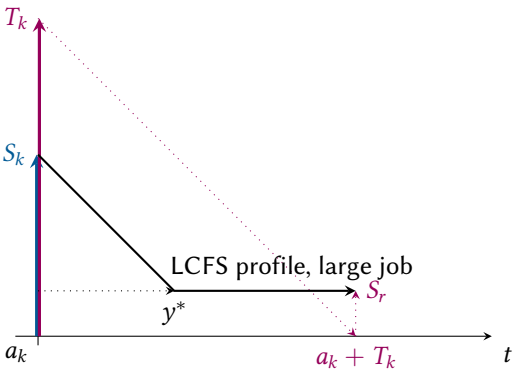

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Final remarks

Merci beaucoup!

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References I

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