EP2200 Queueing theory and teletraffic systems

Summary

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Reminders

- Registration for the exam (if question: stex@kth.se)
- Project (if question: respective contact person)

- Office hours before the exam

Course content

- Markov-processes – tool to analyze queuing systems
- Markovian queuing systems (M/M/*/*/*)
- Semi-Markovian queuing systems (M/*/1)
- Queuing networks

- Knowledge on different levels, e.g.,
  - M/M/1
    - derive the waiting time distribution
    - analyze similar systems
  - M/G/1
    - apply the P-K transform equations for different service time distributions

Markov-process

- Definition of continuous time Markov chain and the memoryless property
- Continuous time Markov-chains
  - state probability distribution in steady state – matrix equation
  - balance equations – derivation from the matrix equation
  - application for continuous time stochastic systems

- What "state probability in steady state" means (for ergodic systems) ?
  - statistical average: consider the process at arbitrary point of time, what is the probability that the process is in state *k*
  - time average: consider one process for a long time, what fraction of time the process is in state *k*

- Poisson process and B-D process as special cases

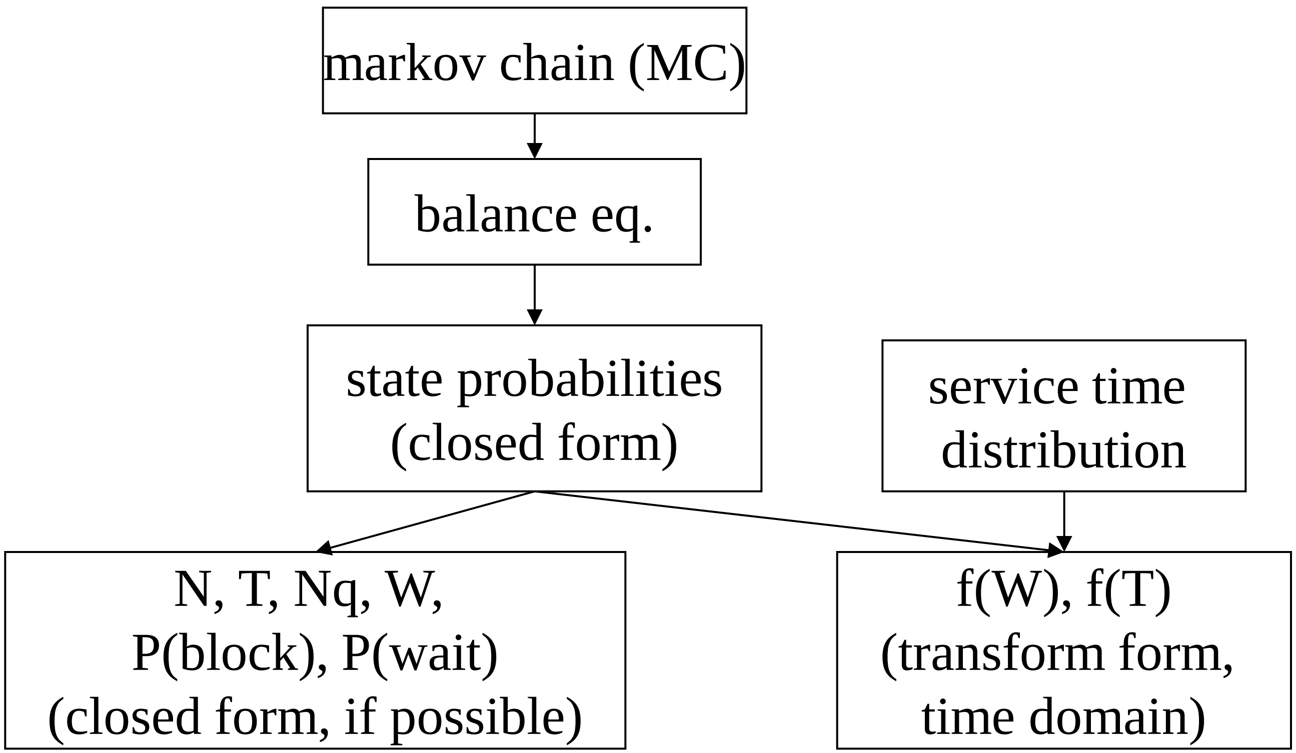
Queuing systems

- General results
  - Kendall notation – application
  - Little's result – no proof – but application
  - Definitions of offered load and utilization

- Markovian queuing systems
- Semi-markovian queuing systems
- Queuing networks

Markovian queuing systems – M/M/*/*/*

- Can be represented with continuous time MC
  - state: number of customers in the system
- Performance in steady state



Markovian queuing systems – M/M/*/*/*

server = m (m=1 spec. case)	System capacity		
	infinite	S	= servers
Infinite population	M/M/m •MC, p_k •P(wait) -Erlang-C –Erlang table •$L(f_w(t))$ - derive •$F_w(t)$ - apply	M/M/m/S (M/M/1/S) •MC, p_k •P(blocking)	M/M/m/m •MC, p_k •P(block) -Erlang-B –Erlang table –general result!
Finite population	Not covered, you have to be able to do it on your own.	Not covered, you have to be able to do it on your own.	M/M/m/m/C Engset loss system •MC, p_k •time blocking and call blocking •effective load

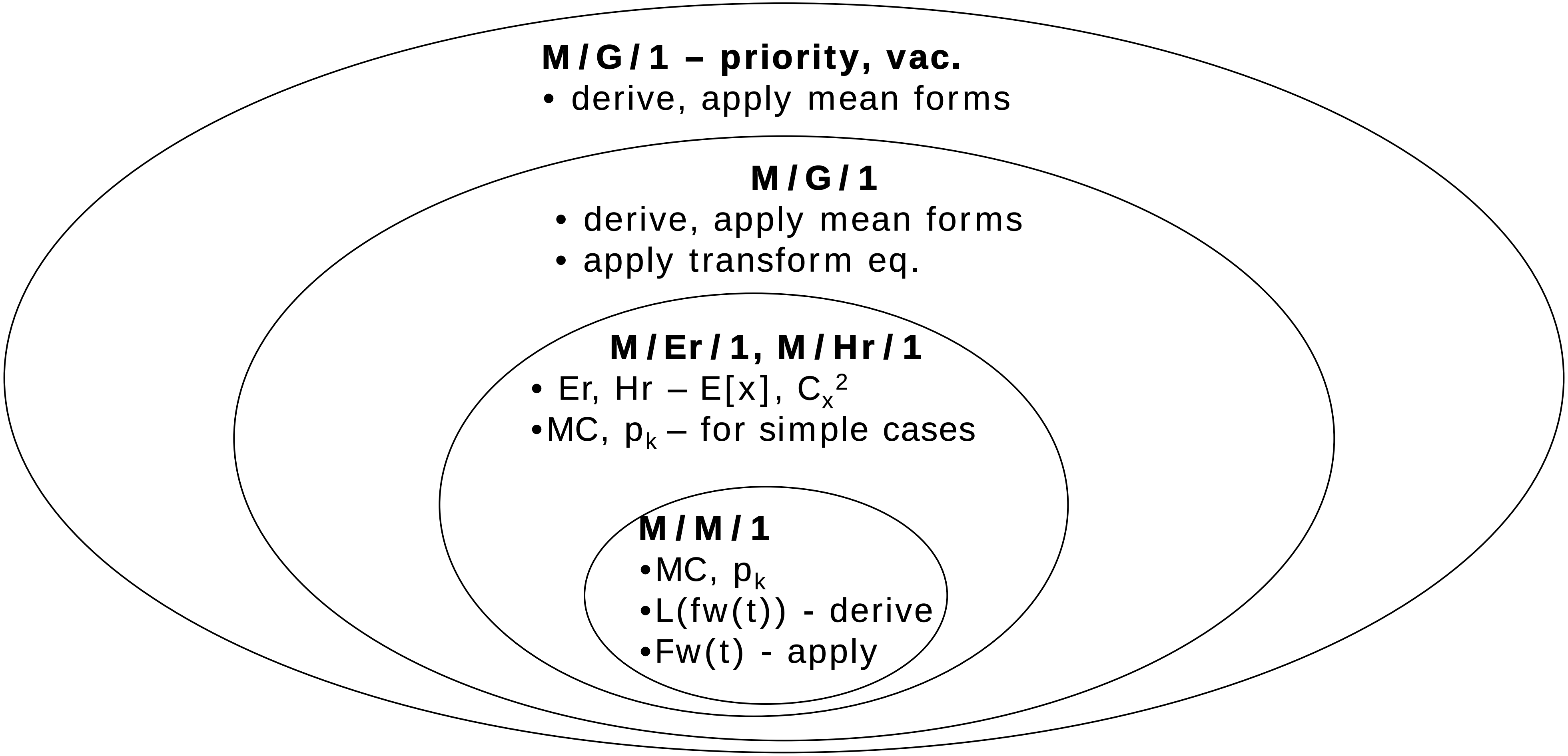
Time blocking ≠ call blocking

Markovian queuing systems – M/M/*/*/*

- Time blocking: fraction of time the system spends in blocking state = P(the system is in blocking state)

- Call blocking: ratio of calls arriving when the system is in blocking state
  - Equal to time blocking for Poisson arrivals with state independent intensity – due to the PASTA property
  - Not equal to time blocking in other cases – e.g., in the case of finite population, when the arrival intensity is state dependent.

Semi-Markovian queuing systems M/Er/1, M/Hr/1, M/G/1, vacation, priority



Markovian queuing networks

- Tandem queues
  - output process of M/M/1 - proof
  - product form solution – reasoning

- Open queuing networks
  - independence of queues - reasoning
  - application