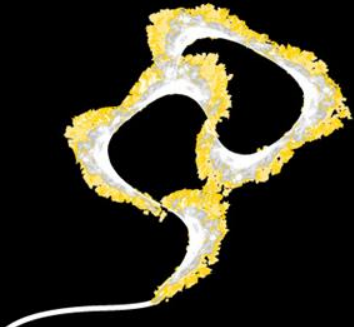# PREVENTING DELAYS IN RADIOTHERAPY BY ALLOCATING LINAC CAPACITY IN ADVANCE

Arturo E. Pérez Rivera

Monday 8th of July, 2013
ORAHS 2013, Istanbul, Turkey
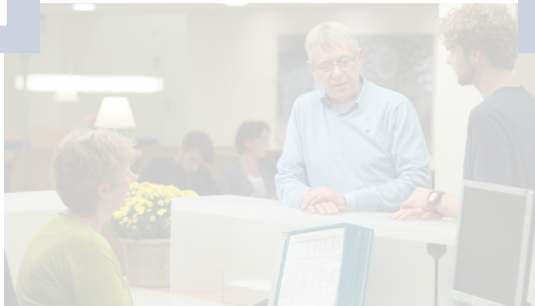
OUTLINE

- Radiotherapy at the Netherlands Cancer Institute
- •• Delays due to 'linac' constraints
- ••• Our heuristic approach
- •••• Preliminary results
- ▬ Conclusions

CHOI*R* NETHERLANDS CANCER INSTITUTE ANTONI VAN LEEUWENHOEK

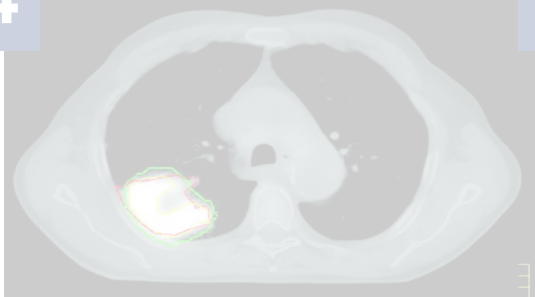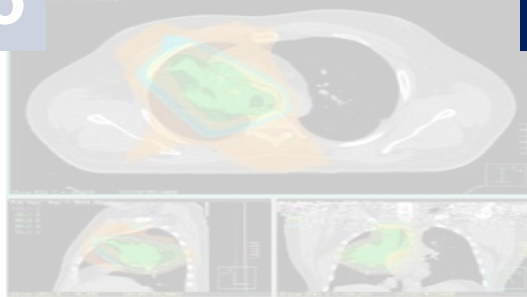# RADIOTHERAPY AT THE NETHERLANDS CANCER INSTITUTE

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2
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RADIOTHERAPY AT THE NETHERLANDS CANCER INSTITUTE
IRRADIATION USING LINEAR ACCELERATORS

- More than 5000 new treatments per year.

- More than 70 care plan types (patient groups).

- A care plan consists from 1 up to 35 daily irradiations.

- Total capacity of 8 linacs.

- Care plans have between 2 and 8 'feasible' linacs.

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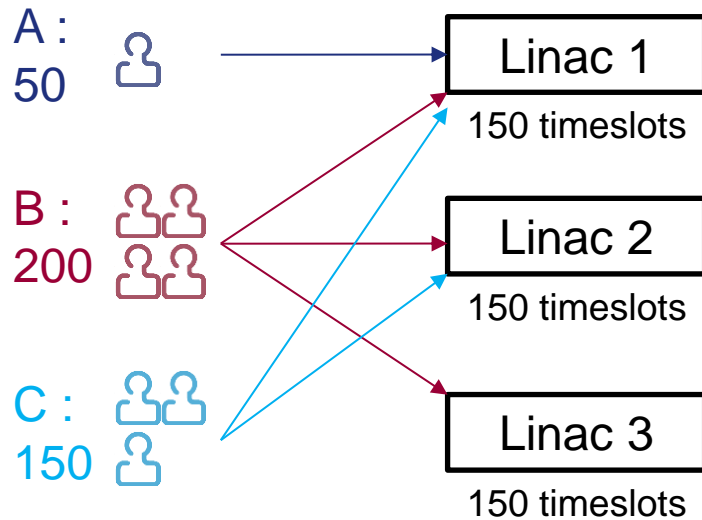*Arturo E. Pérez Rivera, ORAHS 2013*

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DELAYS DUE TO LINAC CONSTRAINTS
AND VARIATION IN ARRIVAL OF PATIENT GROUPS

A : 50

Linac 1
150 timeslots

B : 200

Linac 2
150 timeslots

C : 150

Linac 3
150 timeslots

Demand = 400 patients
Supply = 450 linac-timeslots
Demand/Supply Ratio = 89%

Care Plan →	A	B	C	Pat.	Capacity
Linac 1	50	100	-	**150**	**0**
Linac 2	-	-	150	**150**	**0**
Linac 3	-	100	-	**100**	*-50*
Started	50	200	150	400	-
Delayed	0	0	0	0	-

If all 'B' arrive 1st, 'A' 2nd and 'C' 3rd:

Care Plan →	A	B	C		Capacity
Linac 1	-	150	-	**150**	**0**
Linac 2	-	50	100	**150**	**0**
Linac 3	-	-	-	**100**	*-150*
Started	0	200	100	400	-
Delayed	*-50*	0	*-50*	*-100*	-

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OUR HEURISTIC APPROACH [1/3]
## TACTICAL PLANNING

- Allocation is in the form of a ***threshold on the number of patients*** from a given care plan that can be treated on a given linac on any day.

- Important assumptions:
  - A planner schedules the patient's irradiation immediately upon 'arrival' on the earliest available machine.
  - A patient has to receive all daily irradiation from the same linac.

Care plan	Linac 1	Linac 2	Linac 3
Prostate	16	25	7
Breast	12	0	10
Bone Met.	15	3	17
Lung	12	0	18

Example threshold table

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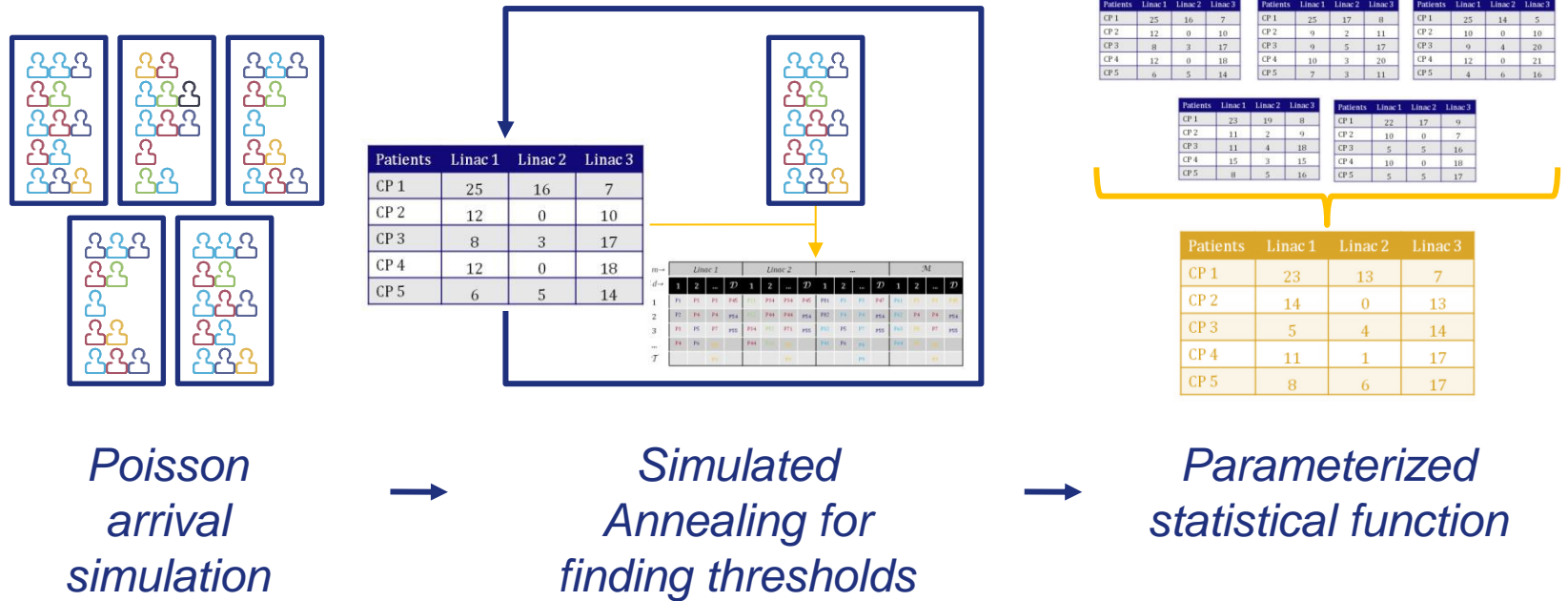# OUR HEURISTIC APPROACH [2/3]
INPUT AND OUTPUT
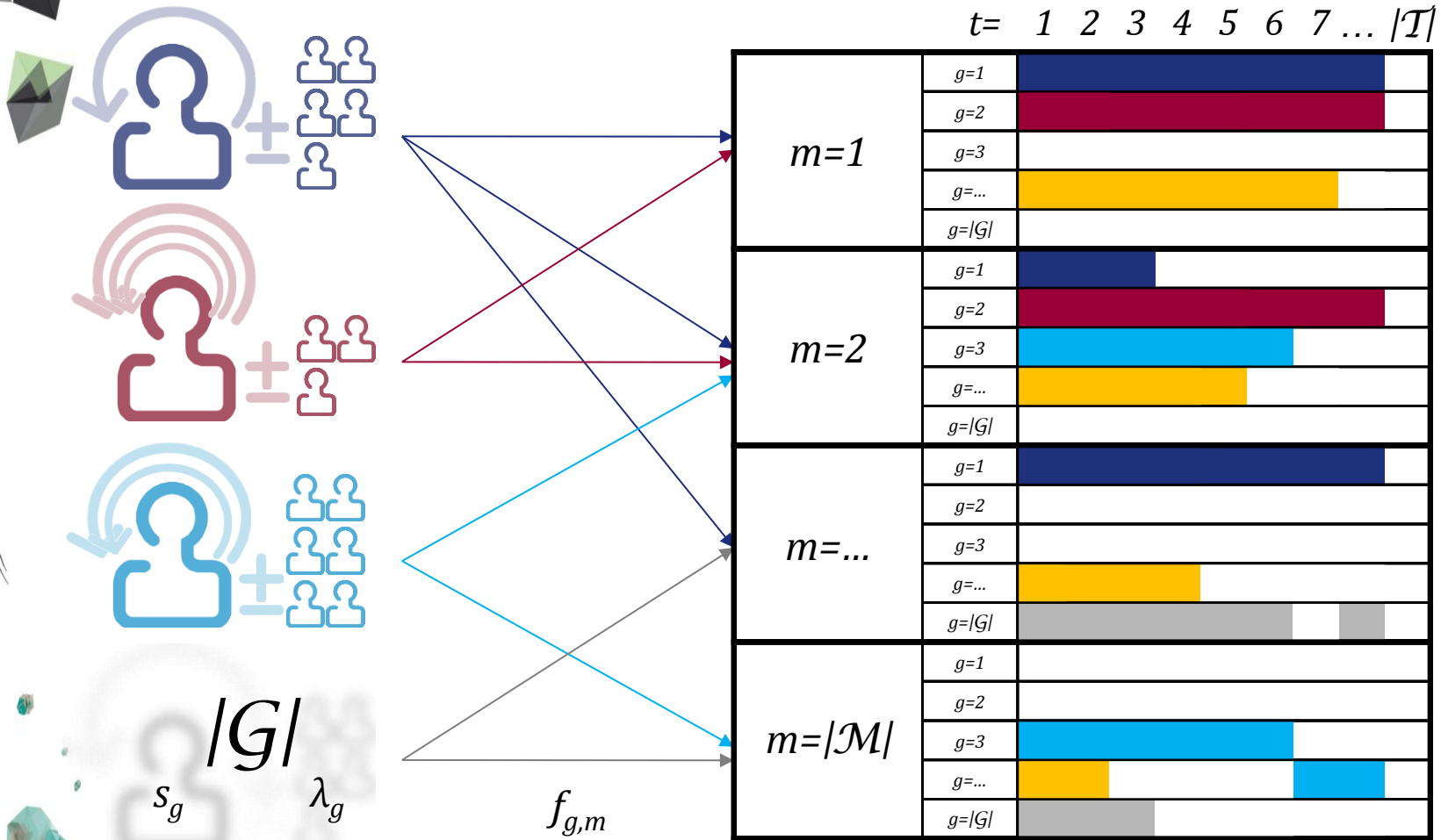
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OUR HEURISTIC APPROACH [3/3]
ARRIVAL SIMULATION + LOCAL SEARCH + OUTPUT FUNCTION

Poisson arrival simulation → *Simulated Annealing for finding thresholds* → *Parameterized statistical function*

PRELIMINARY RESULTS
SIMULATION STUDY OF THE NETHERLANDS CANCER INSTITUTE
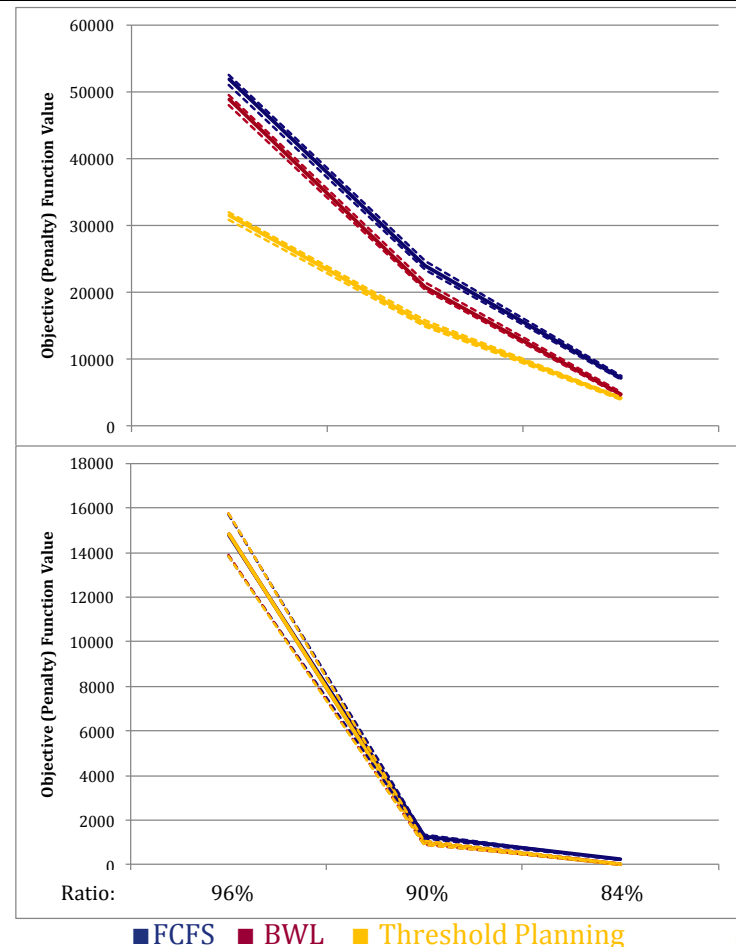
- Important factors:

- All levels:

- 16 categories

- 8 linacs

- On the normal level:

- Linac feasibility of 63%

- Demand/Supply ratio of 89%

- Patient-fraction distribution of 2x15%,4x10%,10x3%

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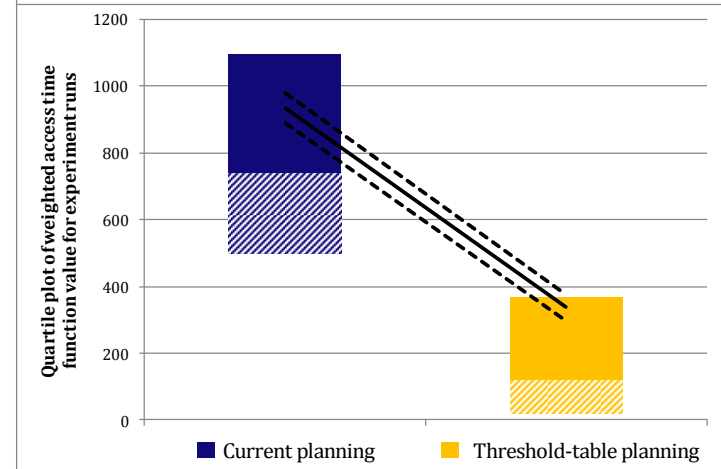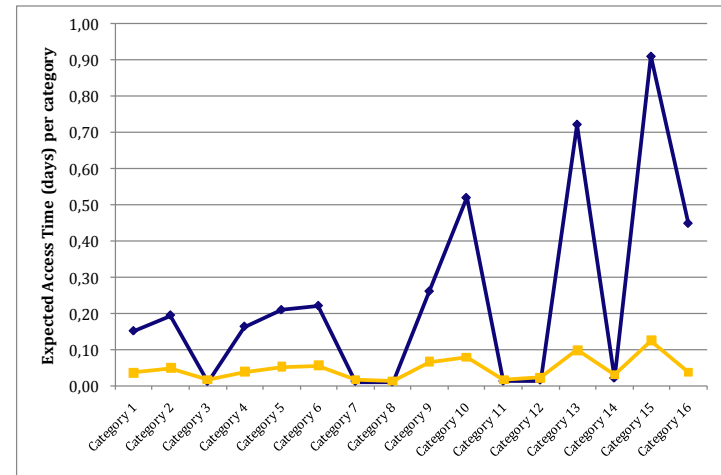
PRELIMINARY RESULTS
SIMULATION STUDY OF THEORETICAL HOSPITALS

- 'Critical' radiotherapy center:

  - Patients can be treated, on average, in 50% of the linacs.

  - 80% of the total fractions given are to 20% of the care plans.

- 'Relaxed' radiotherapy center:

  - Patients can be treated, on average, in 75% of the linacs.

  - All care plans have the same total fractions given.

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CONCLUSIONS

- For 'critical' and large radiotherapy departments, using our threshold planning reduces access time for critical patient groups.

- On average, linac-capacity is not the bottleneck in our hospital (access time is of 0,24 days). Nevertheless, allocating it in-advance can decrease access times (down to 0,05 days).

- Further logistical research in the entire chain of radiotherapy operations can is necessary for a faster start of treatment.

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UNIVERSITY OF TWENTE.
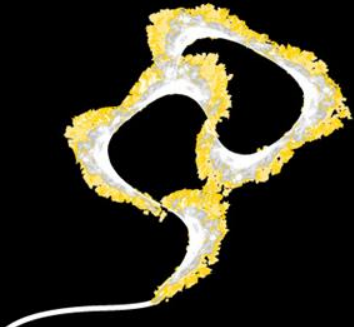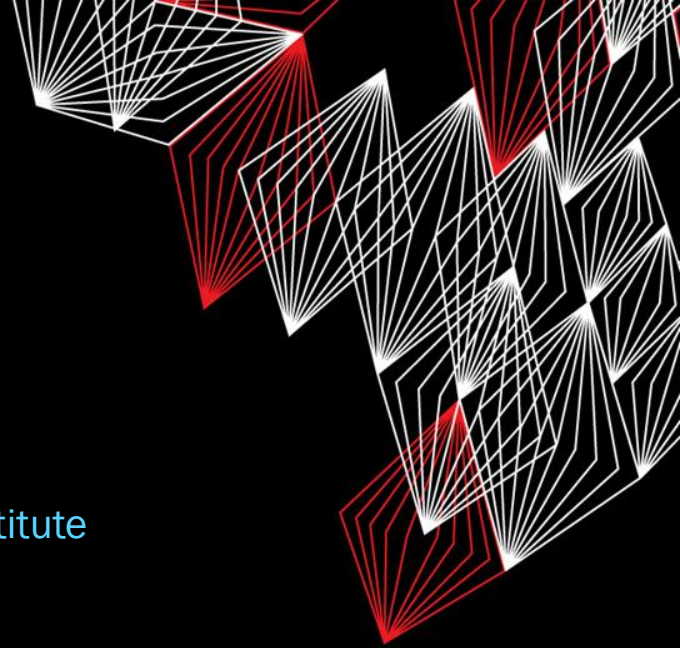
QUESTIONS?

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