Erasmus MC
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Health care process optimisation;

Mathematics is the easy part!

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Outline

- Framework for hospital planning and control
- Typology of hospitals

- Surgery planning in *practice; the Erasmus MC*
- Surgery planning in *theory*; creating an "*optimal*" OR program

Optimization of health care processes

Managers *learn by example*

JIT, Focused Factory, push vs. pull, zero inventory, Lean Manufacturing, OPT, MRP, Toyota, Wal-Mart, KLM, NASA,…

- These concepts were not all as successful as sometimes claimed
- Health care is an business like no other

Health care: a business like no other

- There are many types of hospitals
- Uncertainty is inherent to the *product* health care: emergencies, variability, or outcome of a treatment
- Professional organisation: Hippocratic oath, professional autonomy
- Conflicting objectives, incentives
- Financial system: budgets, DRGs (in Dutch: DBC's)

Managerial areas of health care P&C

- Resource capacity

  Scarce and “shared resources”

- Medical planning

  Research planning, development of new treatments, protocols, diagnosing

- Material coordination

  Transplants, blood, and disposables

- Financial coordination

  Budgets, contracts with insurance companies, DRG billing

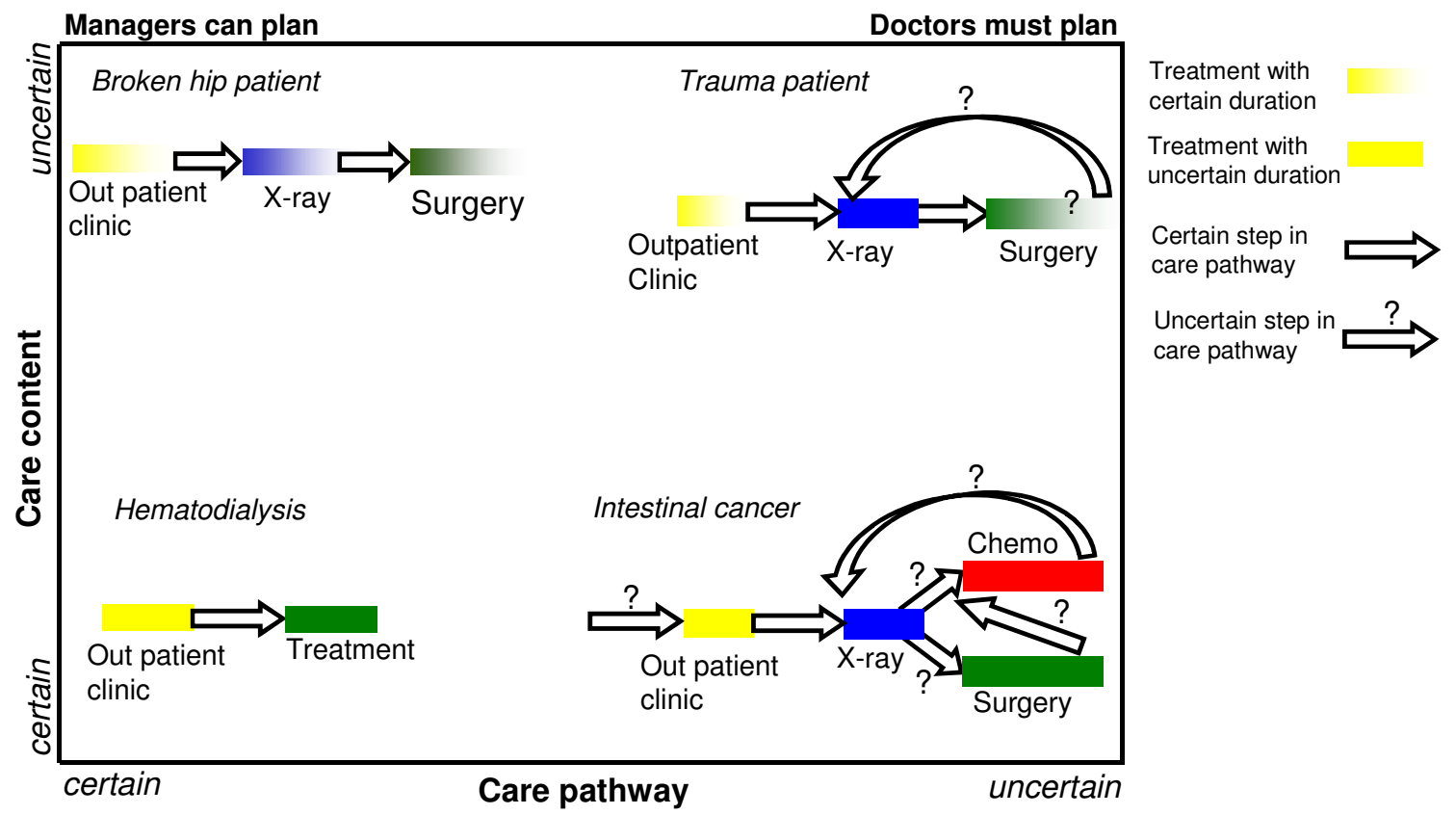
Framework for health care P&C

	Medical planning	*Resource capacity planning*	*Material coordination*	*Financial control*
Strategic	Research and treatment methods	Choice case mix, hospital layout, location planning	Supply chain and warehouse design	Agreements with insurance comp., investment plans
Tactical	Definition of medical protocols	Allocation of time and resources to specialties	Supplier selection, tendering	Determining and allocating budgets, annual plans
Operational offline	Diagnosis and planning of an individual treatment	Surgery planning Patient scheduling, workforce planning	Determining order sizes, purchasing	DRG billing
Operational online	Diagnosing emergencies and complications	Day-to-day and emergency coordination	Coordination of rush orders	Billing complications, changing bills

Hierarchical decomposition

Areas for hospital planning and control

Typology based on the case mix



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Surgery planning in practice

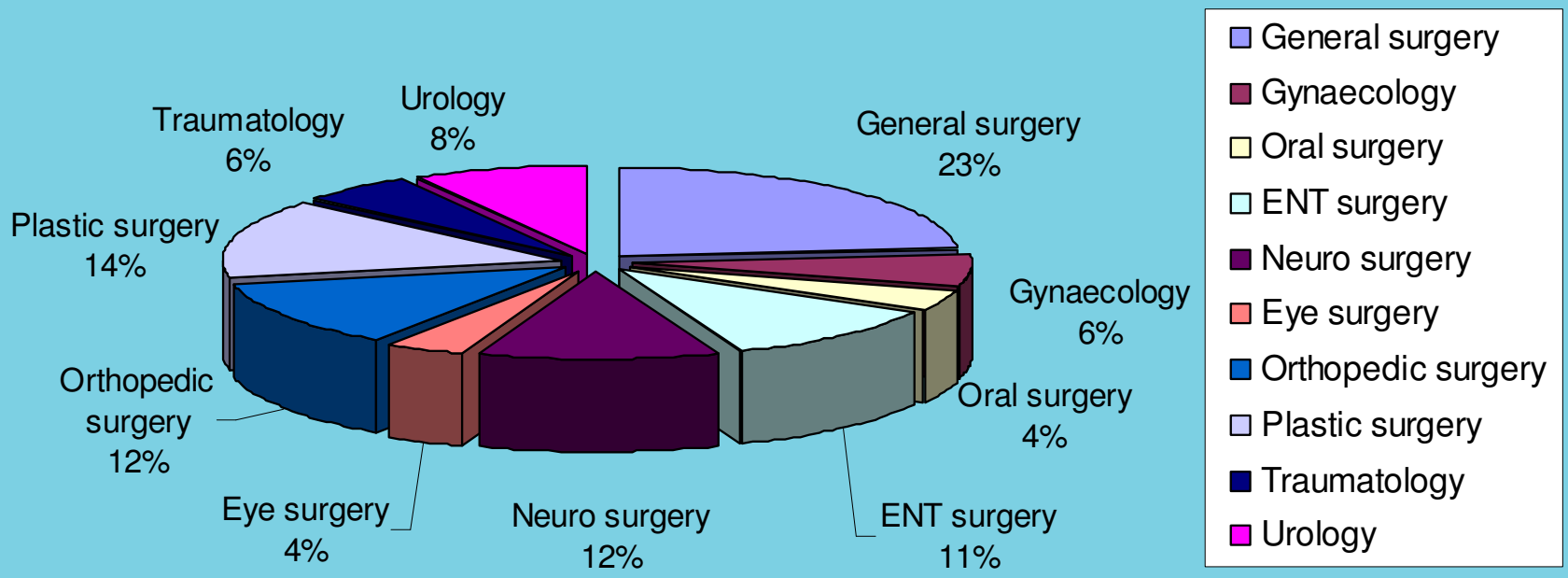
The Erasmus MC

Surgery planning in practice

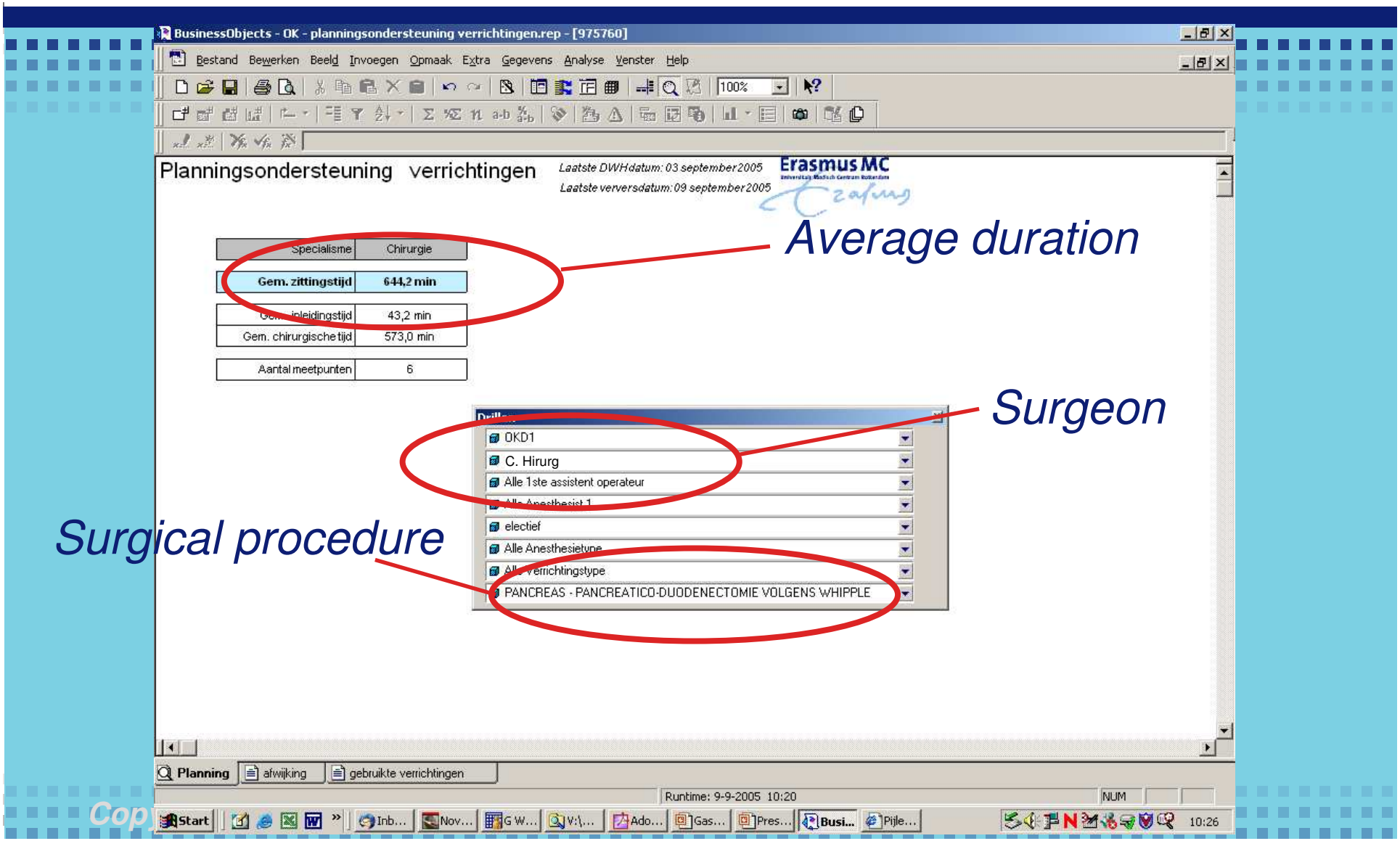
Structured approach to planning

- Each specialty plans its elective surgical procedures two weeks in their *own time slots*
- Use *historical* data
- Planned *slack* (in Dutch: “witte vlek”) to deal with uncertainties: emergencies and variability in duration

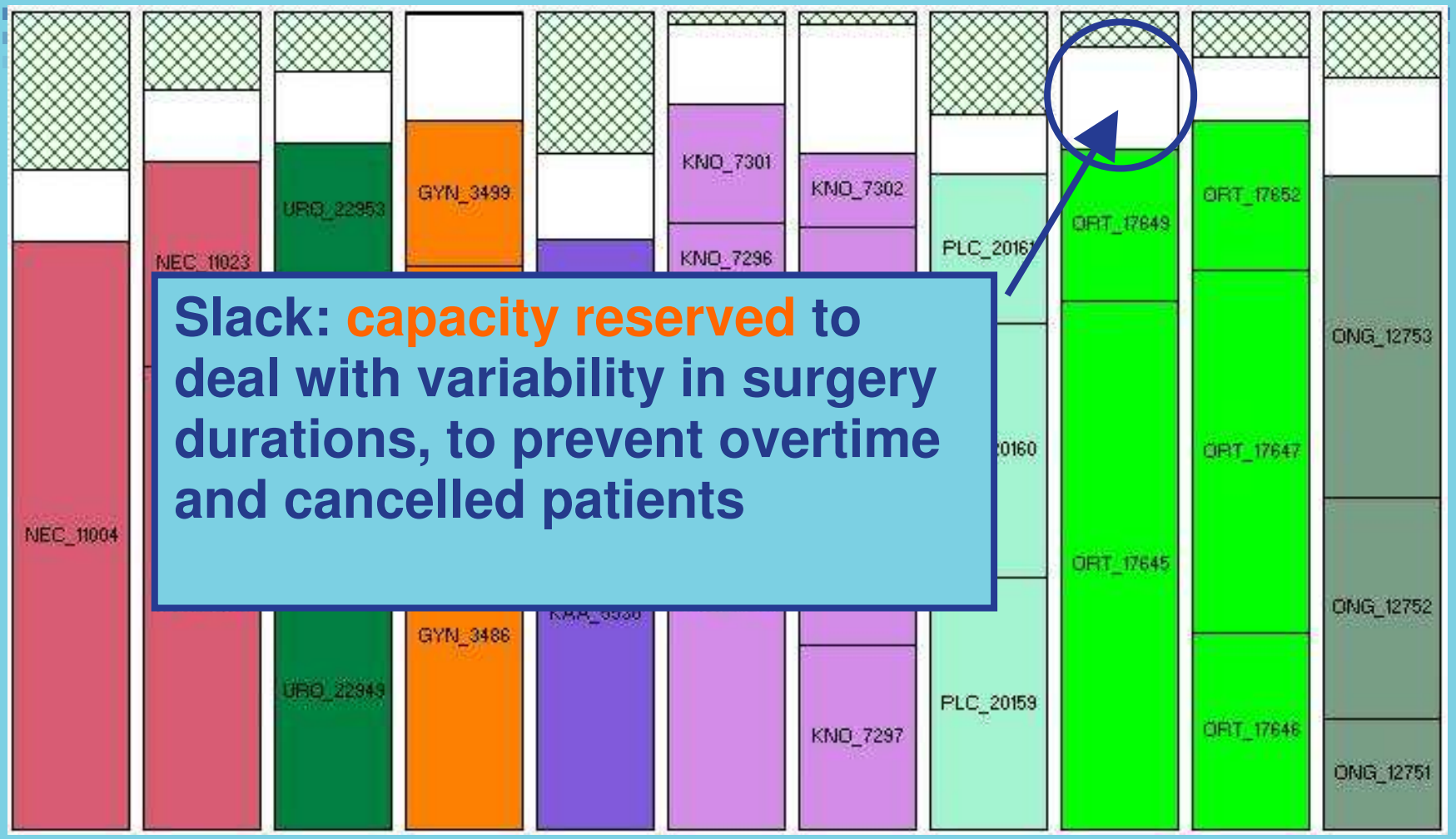
Allocation of OR capacity



Historical data



Planned slack



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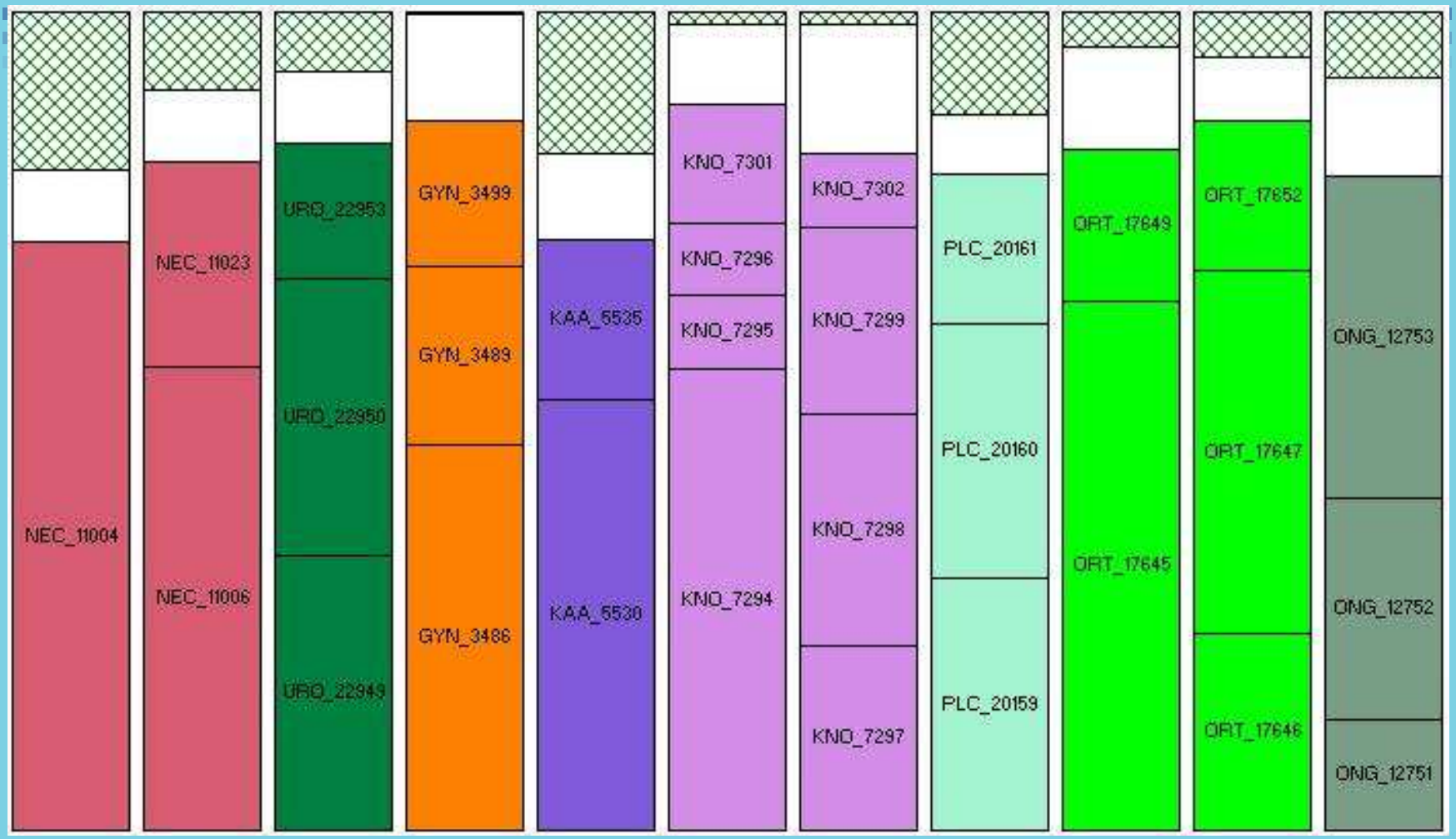
Surgery planning in theory

Robust surgery planning

To appear in: *European Journal of Operational Research, E.W. Hans et al.*

Idea of the approach



Idea of the approach

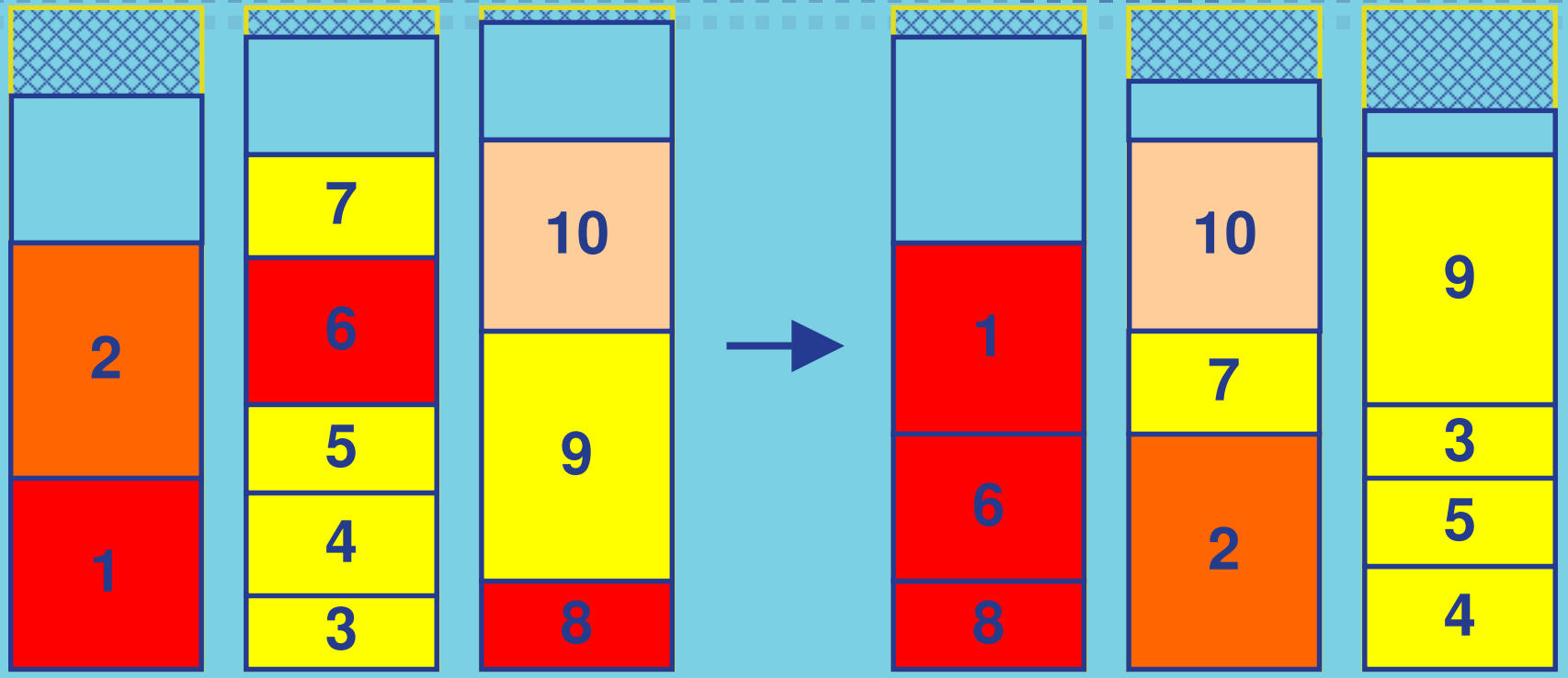
- Assume generic operating rooms; *reschedule surgical procedures* given *flexibility scenarios*
- Optimize the required amount of reserved capacity using the *portfolio effect*
- Use *optimization heuristics* to optimize an OR program

Flexibility scenarios

Reschedule:

1. within one day, within a specialty
2. within one week, within a specialty
3. within one year, within a specialty
4. within one week, over all specialties
5. within one day, over all specialties
6. within one week, over all specialties

The portfolio effect

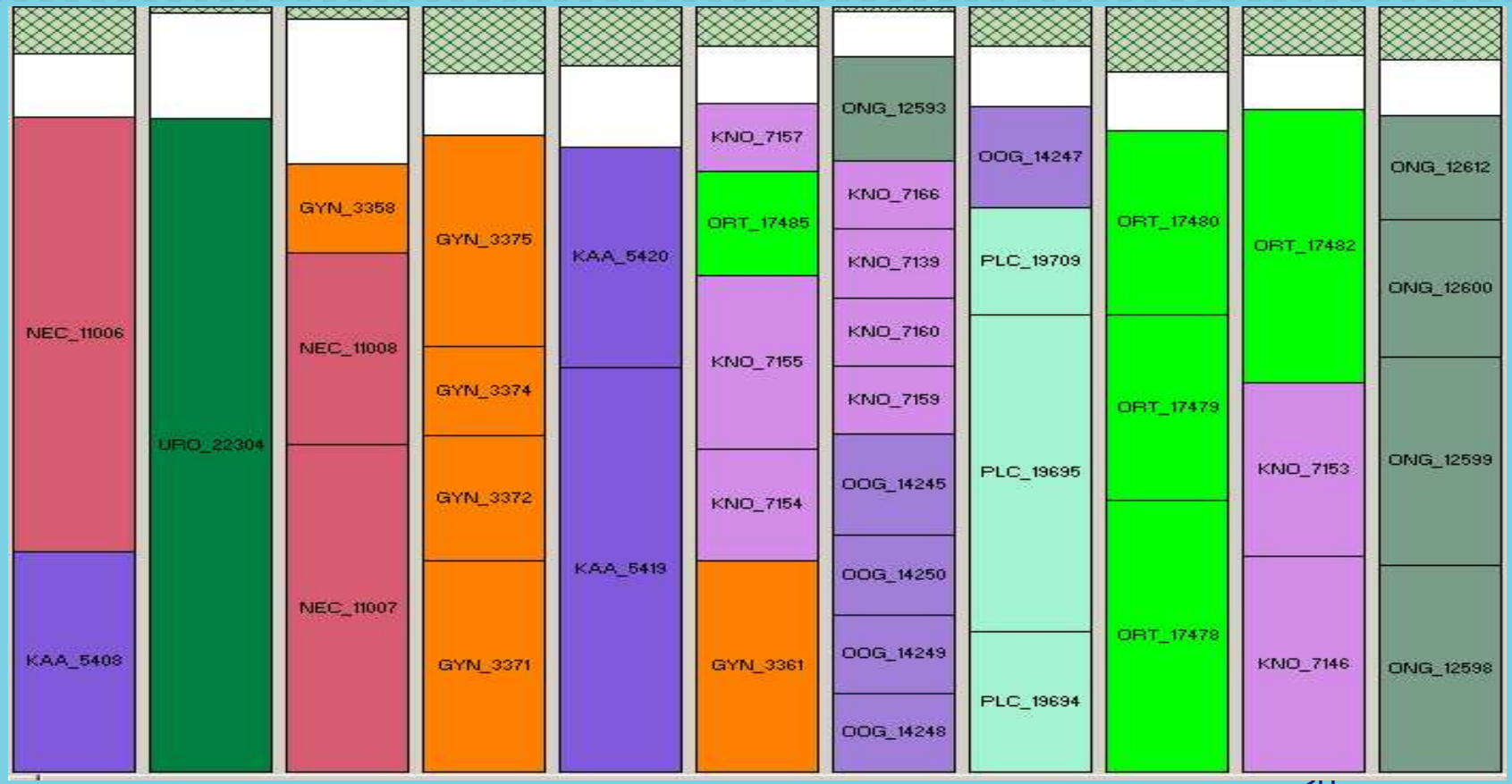


Capacity gain 2.3%, increase in unused capacity: 40%

Optimization heuristics

- First Fit: base solution as constructed by clinicians
- Sampling methods
  - Random sampling
  - Biased-random sampling
  - Regret-based random sampling
- Local search
  - Greedy
  - Simulated annealing

A ‘rescheduled’ OR program



Results for *maximum* flexibility

	Base solution	*Constructive heuristics*			*Local search*	
	First Fit	**Random Sampling**	**Biased Random Sampling**	**Regret based random sampling**	**Greedy**	**Simulated annealing**
Number of free OR days	*0.0*	343.2	344.5	348.3	336.0	352.5
Computation time	*0.0*	492.0	632.8	2226.7	1734.0	6315.6

Average over all scenarios

Discussion

- Less operating rooms required to operate same amount of patients
- Optimization of the amount of slack required to deal with uncertainty
- Similar surgical procedures are planned together (set-up times)

- Generic operating rooms
- Central planning approach

Conclusions

- Many interesting topics in a Hospital that can benefit from OR, but
- Position the problem in a framework
- Hospital type and case mix
- Sound historical data
- Willingness of management and especially clinicians; cooperation of mathematicians, clinicians, and managers

- Be aware: *mathematics is the easy part!*