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# **Opt**imization and its **A**pplications in **L**earning and **I**ndustry (OptALI)

IRSES

## Ongoing Deliverable D1.2

## Description of Research Seminars

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| Participants: | UGOE<br>UNIKL<br>DTU<br>UOA<br>UC |
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# Research Seminar

offered by Samuel Ridler (ES-UOA)

in October 2015,

in Copenhagen, Denmark

Subject: Ambulance Move-up

Problem: Ambulance move-up, also known as ambulance redeployment or repositioning, is the practice of dynamically relocating idle ambulances between ambulance bases. This is done by some Emergency Medical Service (EMS) providers in order to reduce response times - the time between an emergency call being made, and an ambulance arriving at the site of the emergency. Move-up allows the behaviour of ambulances to be flexible, giving improved service levels that can be equivalent to having additional ambulance(s).

St John is the main EMS provider in New Zealand, and has a contract specifying a minimum level of service in terms of response times. E.g. 80% of high priority incidents in urban areas should have a response time within 10 minutes, 95% within 20 minutes. The growing population and increasing travel times are causing response times to worsen, making it difficult to reach the minimum level of service. St John has limited resources and so need to use their ambulances efficiently in order to improve their service, with move-up being a possible solution to this problem.

Main Results: No results to present, as the research had only just started recently. The seminar was an introduction to ambulance move-up and some models that others have developed.

Some move-up models developed by others that were presented:

- DDSM - the dynamic double standard model. One of the first models; it is an integer program for determining ambulance move-ups in real-time. The model requires that all points at which an emergency call could be generated are reachable within $x$ minutes from the nearest available ambulance, and some portion $\alpha$ are reachable within $y$ minutes ($y < x$). It also includes a cost function that reflects driving time and other aspects such as whether an ambulance has recently been moved-up, and avoiding 'round trips' between bases.
- Compliance table - a table of predetermined, optimised locations for each number of available ambulances. Whenever the number of available ambulances changes (e.g. an available ambulance becomes busy by responding to a new call, or a busy ambulance finishes servicing a call, becoming available), the entry in the table corresponding to the new number of available ambulances gives the locations for these ambulances.
- Zhang's IP model - a recent model that uses integer programming to determine move-ups in real-time. The model objective is to maximise the sum of marginal benefits from the arrangement of available ambulances, minus the cost based on the increased travel time that move-up causes. The marginal benefit values reflect the service improvement from adding an $m^{th}$ ambulance to a base. These benefit values are tuned through simulation iteratively, in order to maximise the number of calls reached within a given response time.

Some other modelling methods include stochastic programming, Markov models, and hypercube queueing models.

Zhang's IP model shows promise for improving service provision, but allows more driving than would be acceptable in practice. I aim to develop an improved move-up model and focus on the trade-off between reducing response times and limiting move-up driving distance.

Participants: Students and researchers from DTU.

Publication: -