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# Max-plus switching systems and long max-plus matrix products

*A Data Management Plan created using DMPonline*

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## **Project abstract:**

Switching max-plus linear (SMPL) systems are used to model the propagation of delays in a railway network.

Suppose that departure times of a network at a particular instant are given by a vector  $x(k)$ . The departure times at instant  $k$  are given by a recurrence relation based upon the departure times at a previous instant multiplied in the sense of max-plus arithmetic by matrix  $A(u(k))$  where  $u(k)$  is a control variable. At every instant, the network may slightly change, which is encapsulated in this control variable. This has a residual effect on the ultimate departure times, which one often seeks to optimize in some way: for instance, by minimizing the cumulative delay with respect to a given regular schedule.

The main idea of the proposed research is to study the switching max-plus linear systems as vector orbits of a finitely generated max-plus matrix semigroup: the set of all possible max-plus matrix products of a given finite set of matrices.

In this research we will be particularly interested in the long max-plus matrix products and developing for them an analogue of the CSR representation of max-plus matrix powers suggested by Sergeev and Schneider. We then aim to apply the new theoretical results which we obtain to switching max-plus systems and the above mentioned optimization problems over them.

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## **Copyright information:**

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## Data Collection

The research I will be working with is purely theoretical and it does not require any data to be collected or created. The closest type of data I will use will be fabricated examples required to illustrate or to confirm the correctness of the mathematical research I will be doing.

I have no intention to collect data but I may fabricate a worked example for the research. This will be done by myself and the lead supervisor.

## Documentation and Metadata

Any fabricated examples of note will either be given in publication or will be disregarded entirely.

## Ethics and Legal Compliance

Not applicable

In terms of data this is not applicable. In terms of actual research I will ensure to properly cite any work that I use in my own research where necessary.

## Storage and Backup

Not applicable

Not applicable

## Selection and Preservation

Not applicable

Not applicable

## Data Sharing

The examples will mainly be of use for myself but I will freely share them upon request.

Not applicable

## **Responsibilities and Resources**

Not applicable

Not applicable