

Graph Representation and Embedding for Semiconductor Manufacturing Fab States

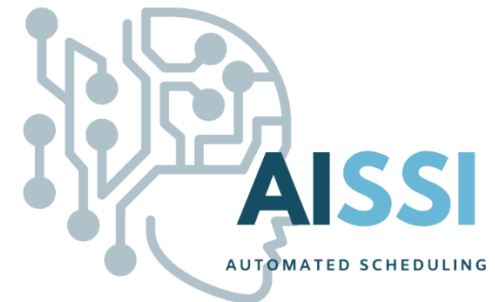
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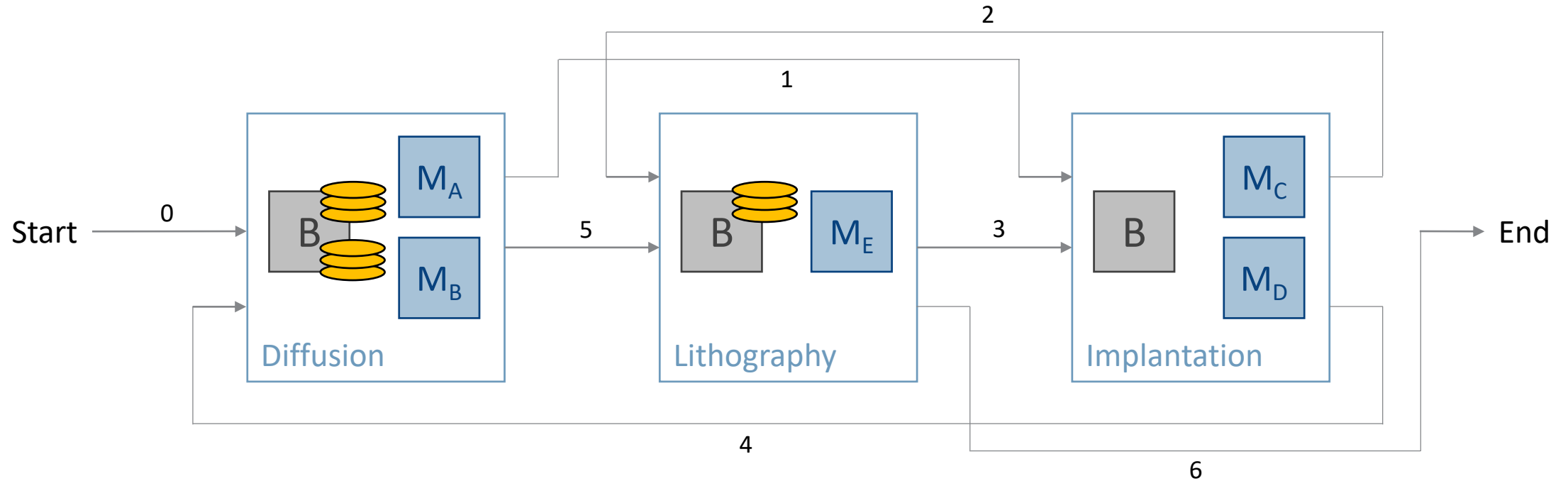


Winter Simulation Conference 2022



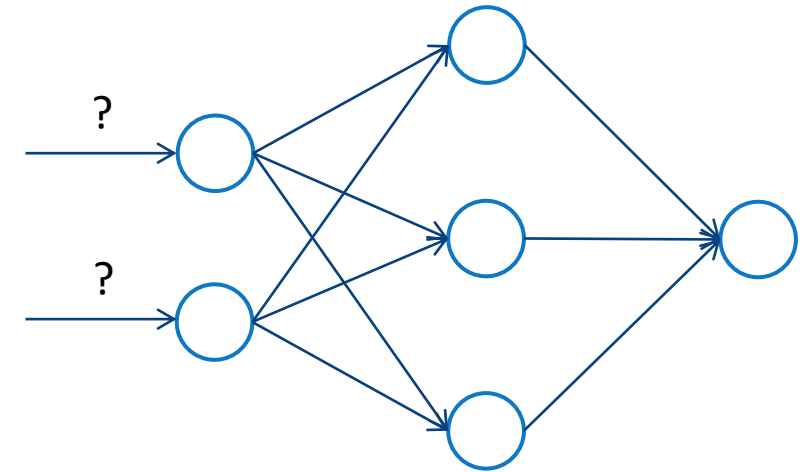
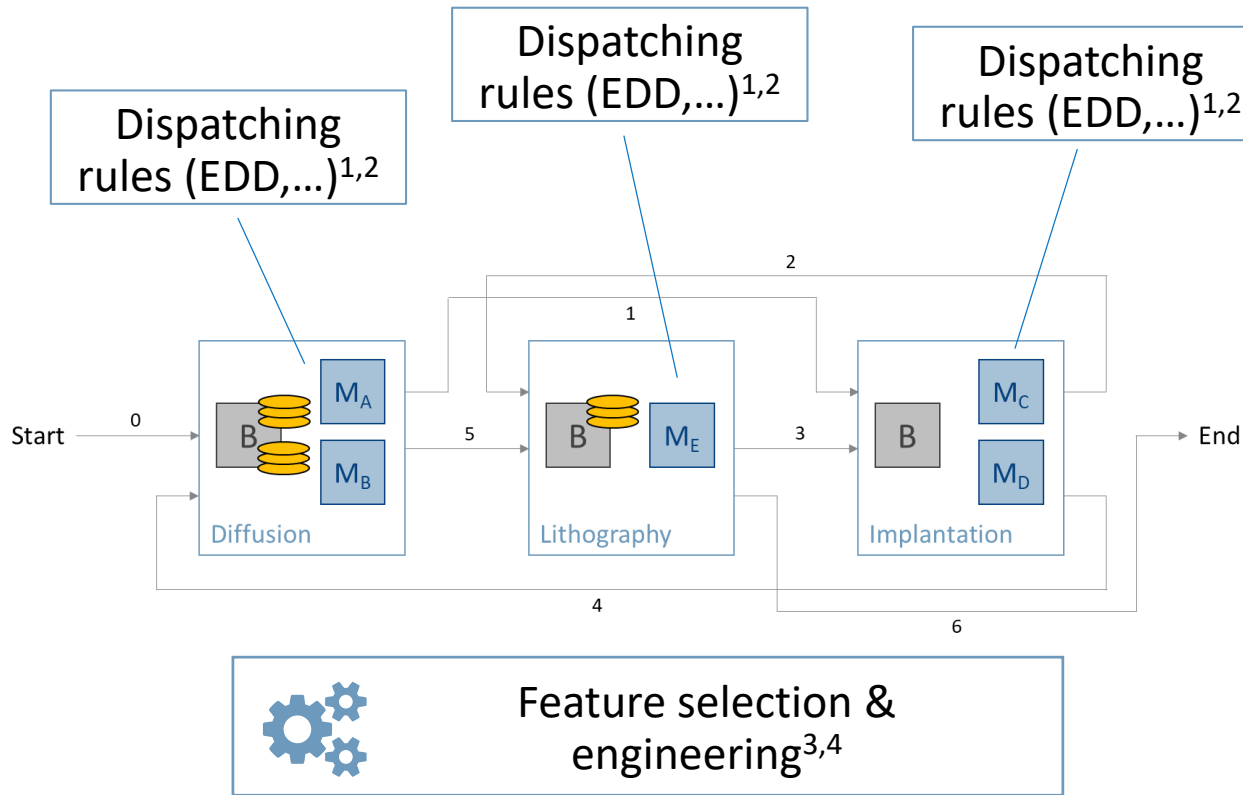
Semiconductor Manufacturing requires Planning Algorithms

Semiconductor Manufacturing in the MiniFab



Semiconductor Manufacturing requires Planning Algorithms

Planning algorithms require well-structured input data

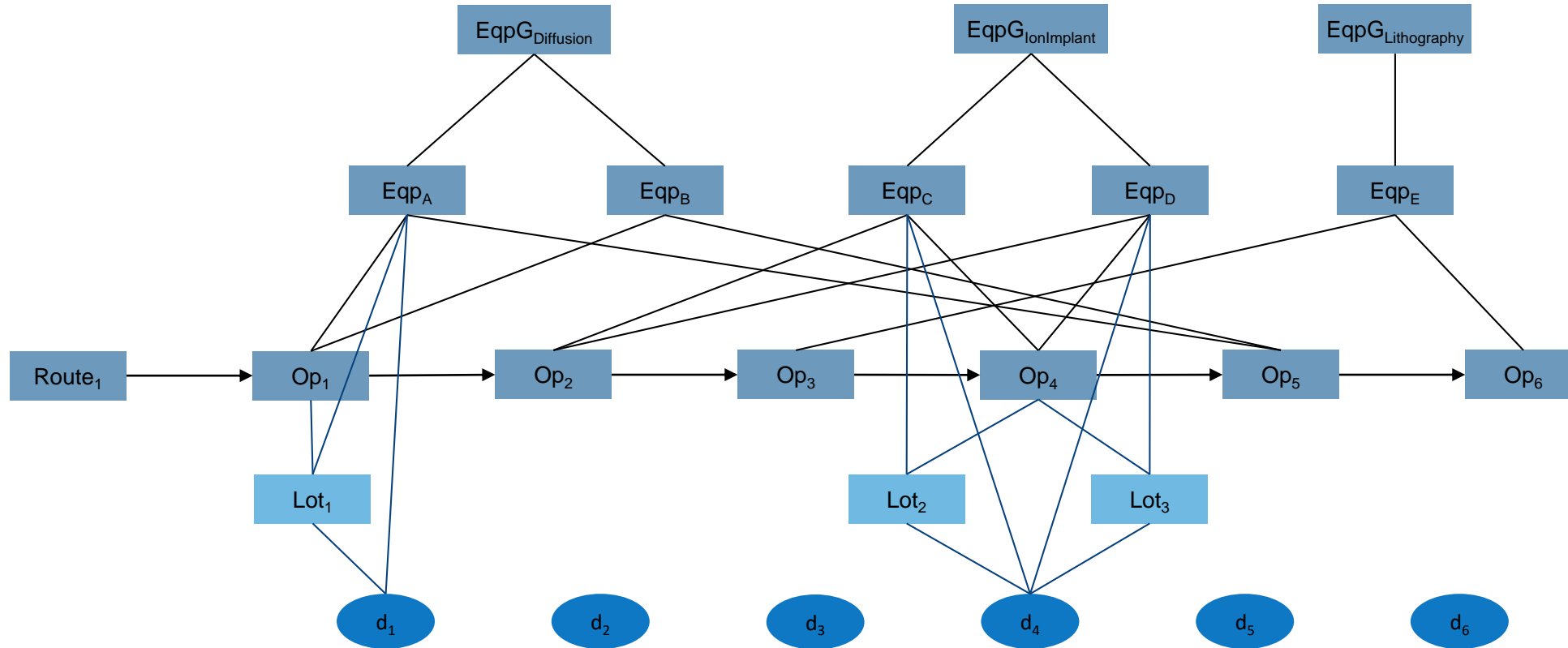


How to encode the state of a whole fab to provide it to a planning algorithm?

¹ (Sarin et al. 2011), ² (Li et al. 2013), ³ (Schelthoff et al. 2022), ⁴ (Qiao et al. 2013)

Modelling a Semiconductor Manufacturing Fab State as a Graph

Graph representation incorporates structure and parameters of the fab state



How does this graph representation approach help to encode fab states?

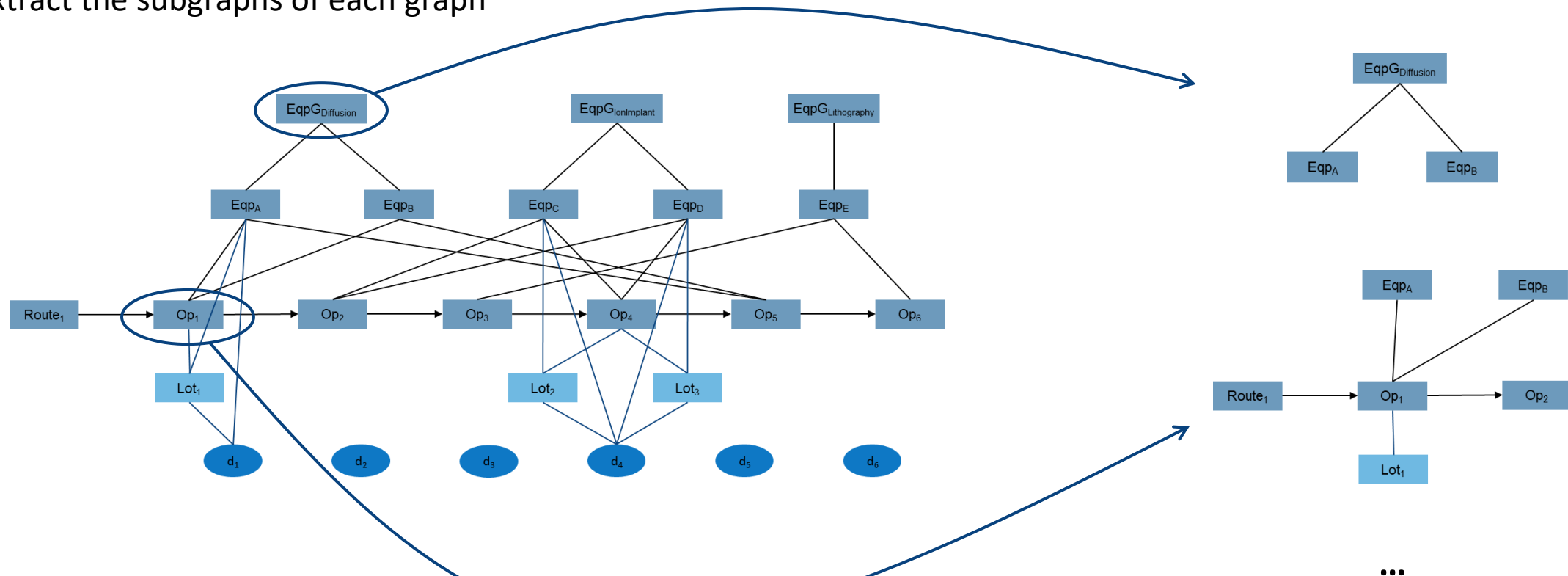
Using Representation Learning to Embed Fab State Graphs

Graph embedding allows to encode fab state graph with low-dimensional vector



graph2vec (Narayanan et al. (2017)): Map graphs to vectors

1 Extract the subgraphs of each graph

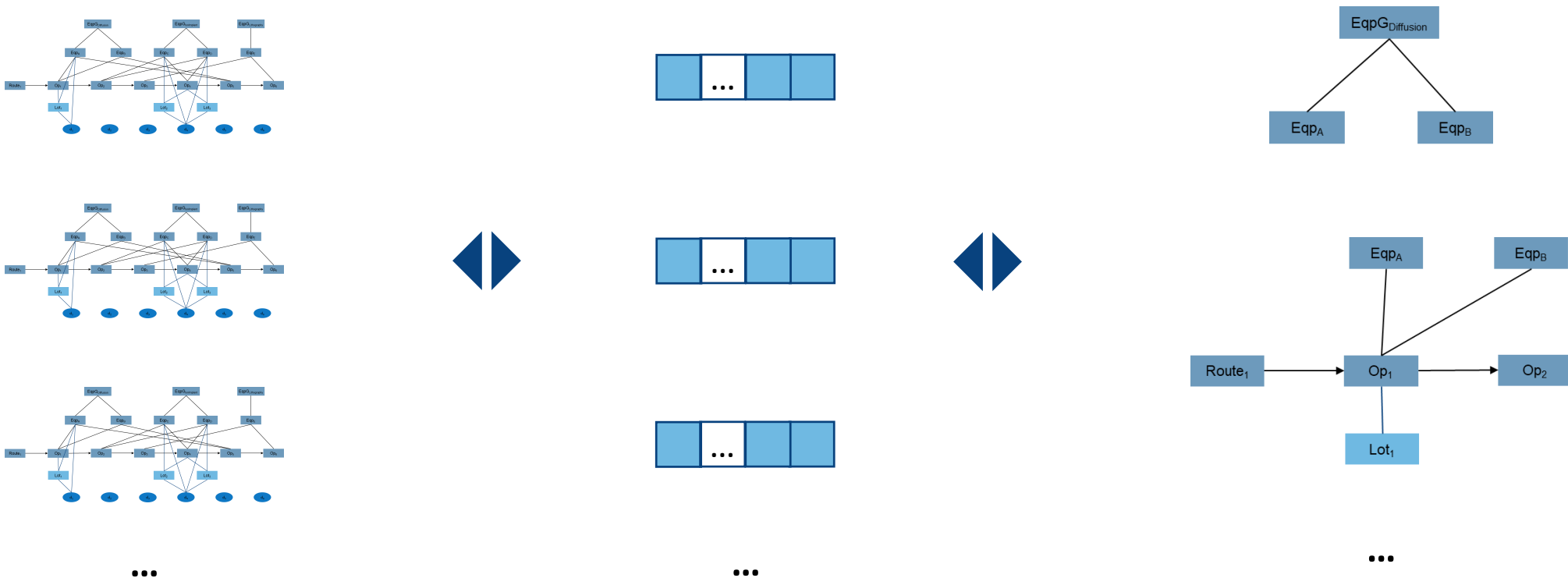


Using Representation Learning to Embed Fab State Graphs

Graph embedding allows to encode fab state graph with low-dimensional vector

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2 Learn embeddings of graphs based on their subgraphs

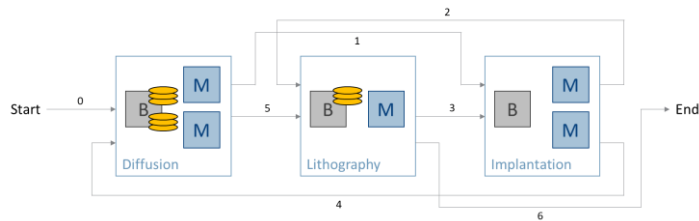


From Fab State to Graph Representation to Graph Embedding

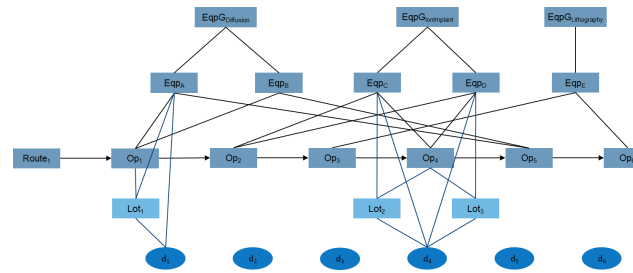
Representing and embedding fab states of the MiniFab



Semiconductor manufacturing fab



Graph representation of fab state



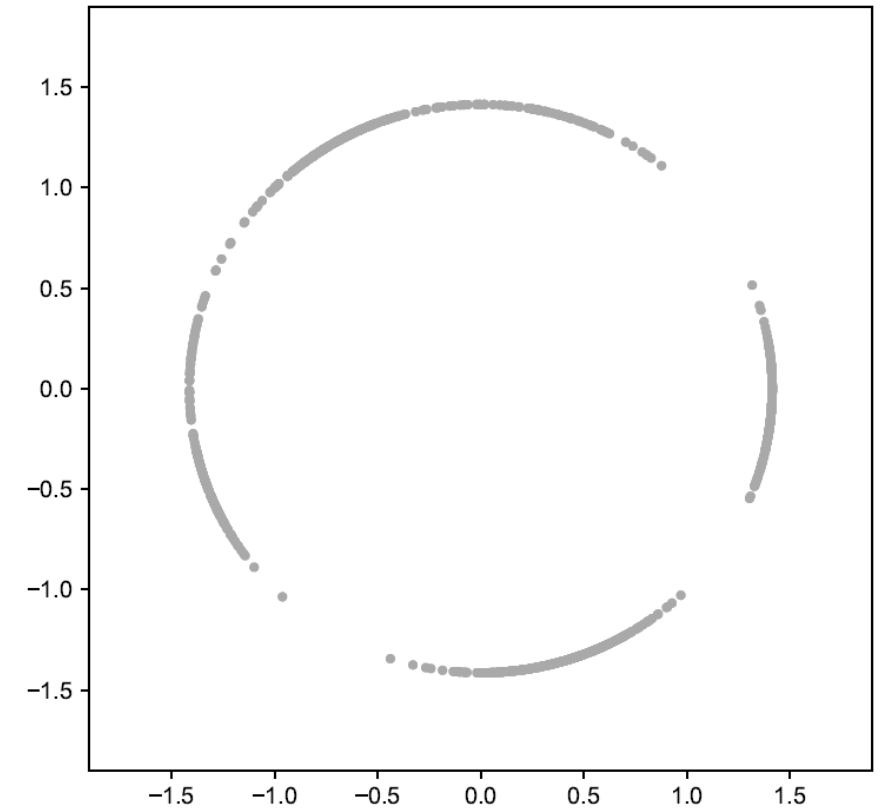
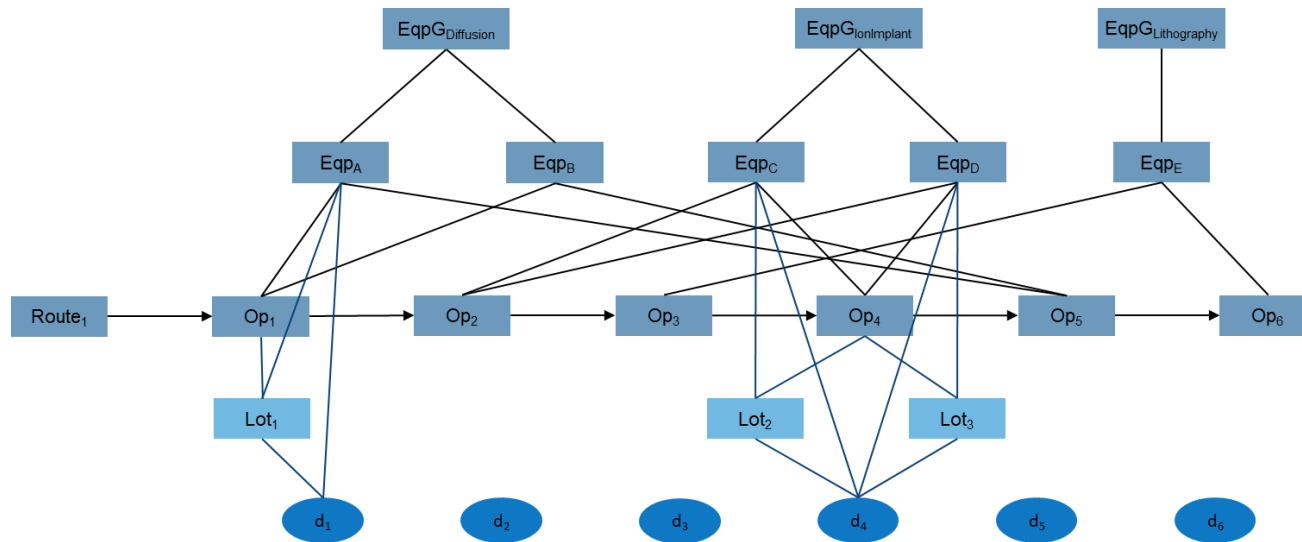
(Low-dimensional) Embedding vector



How do numerical results look like when applying this approach?

Graph Embedding of different Fab States of the MiniFab

Numerical results for two-dimensional embedding space

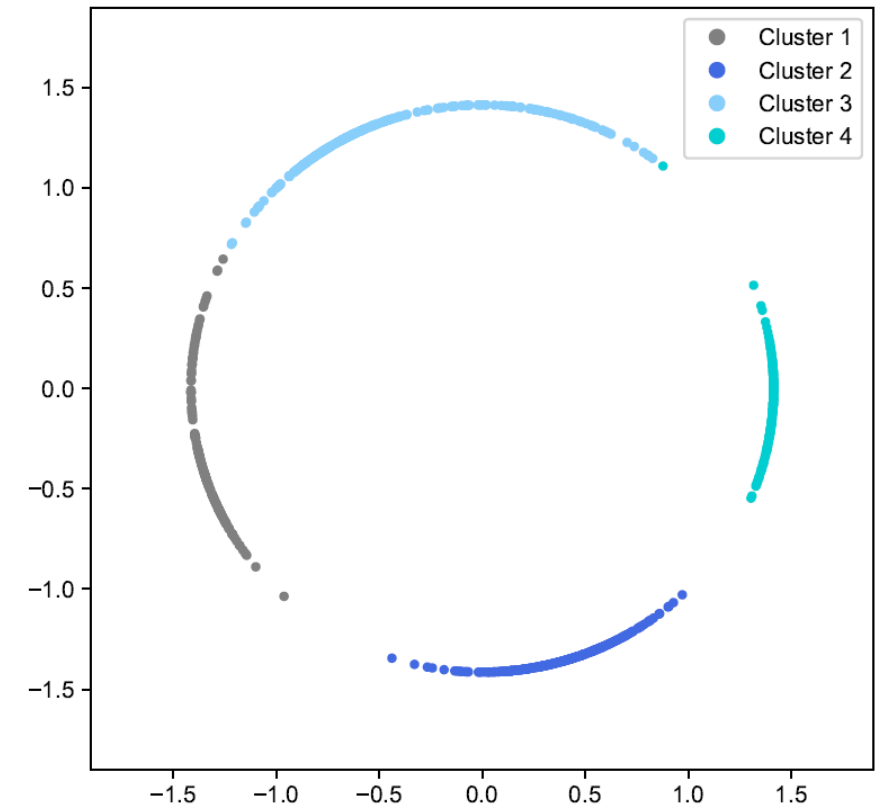
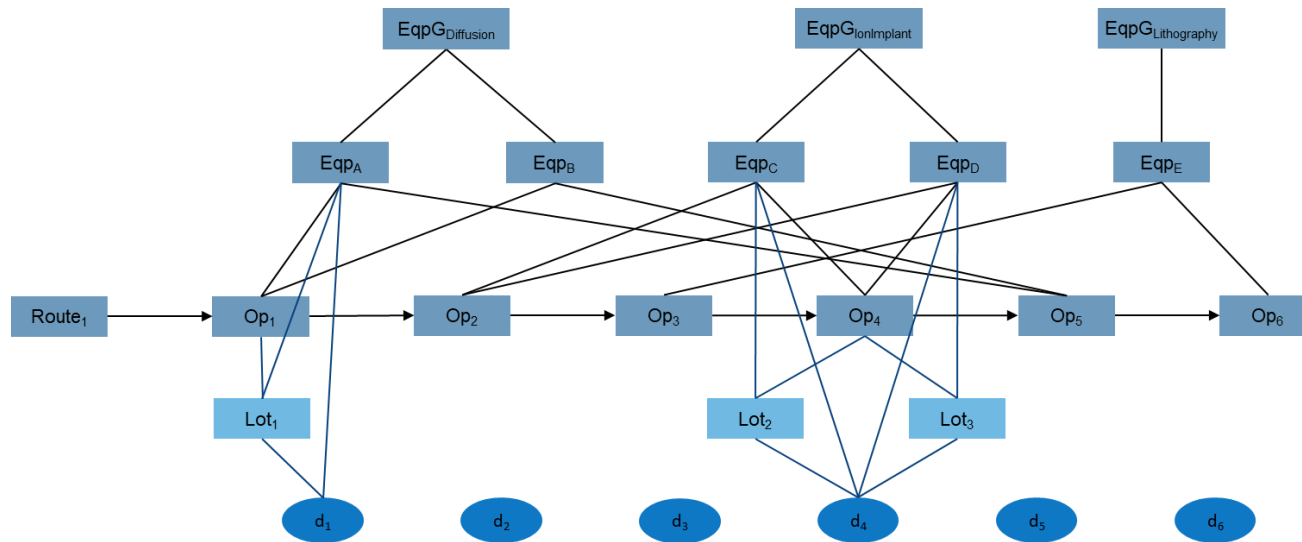


Setting:

- MiniFab with 3 lots in production
- 1000 different fab states

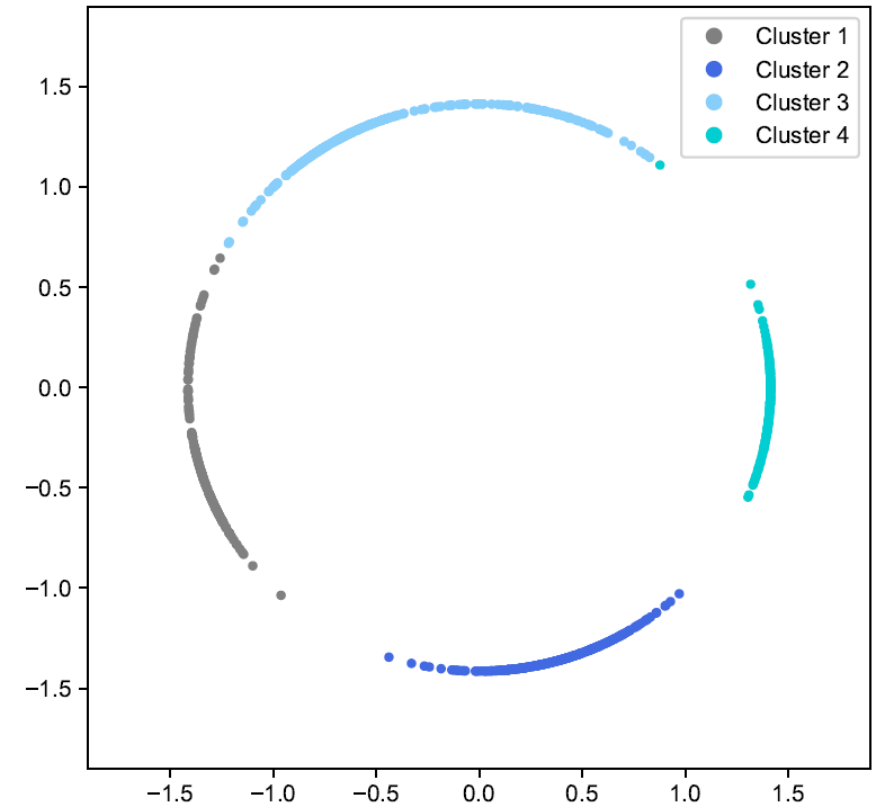
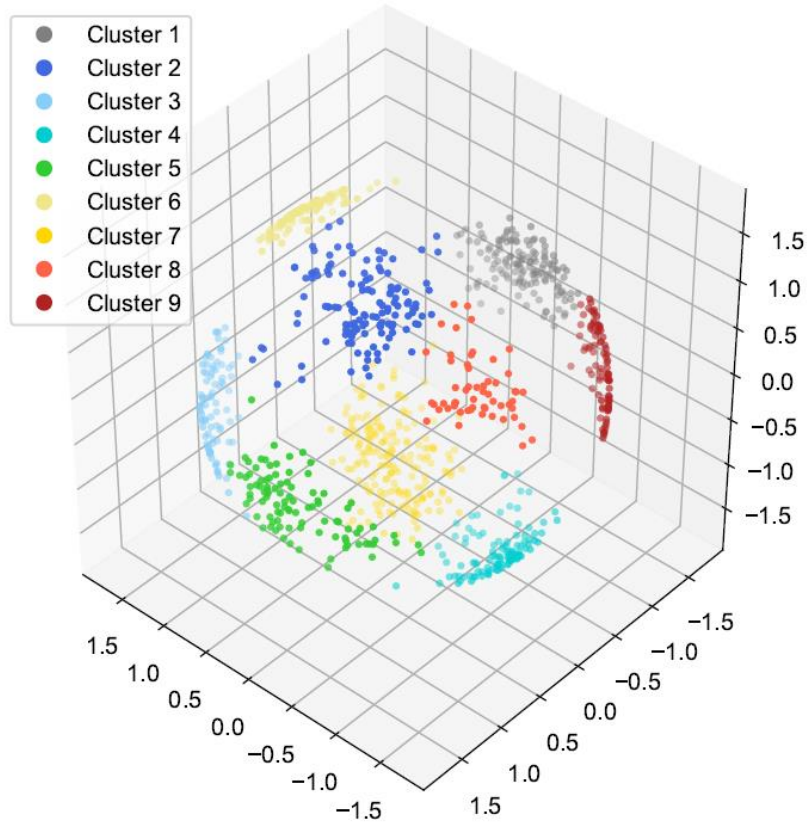
Graph Embedding of different Fab States of the MiniFab

Numerical results for two-dimensional embedding space – analysis of embeddings



Graph Embedding of different Fab States of the MiniFab

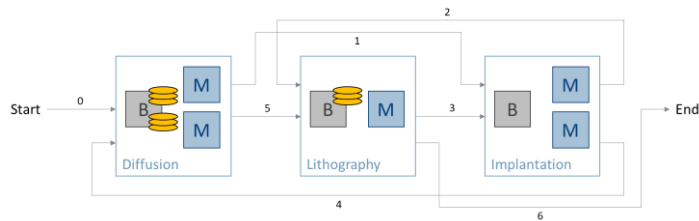
Numerical results for two- and three-dimensional embedding space



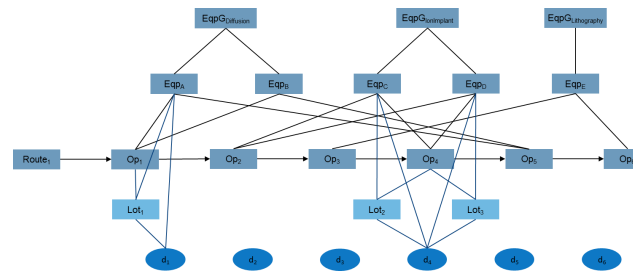
Graph Representation and Embedding of Fab States

An approach to encode fab states

Semiconductor manufacturing fab



Graph representation of fab state



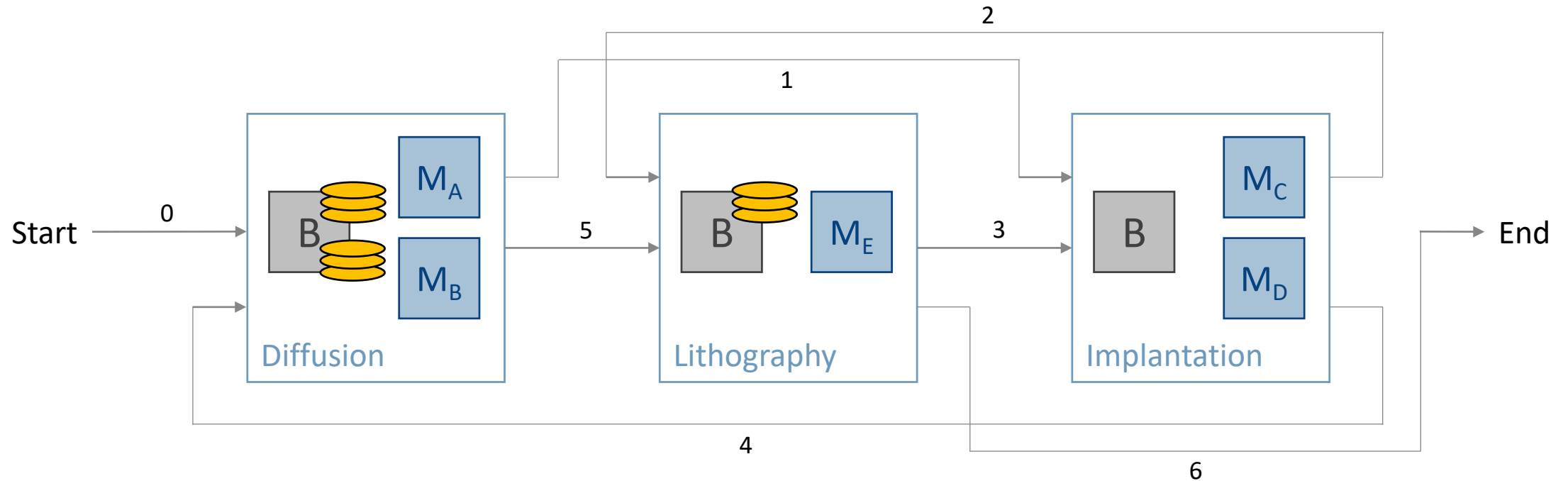
(Low-dimensional) Embedding vector



▶ MiniFab use case indicates that low-dimensional embeddings of fab states preserve some structural information of the original fab state (modelled as a graph).

Graph Representation and Embedding of Fab States

An approach to encode fab states



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