Onderwerpen masterproeven 2022-2024 aan de onderzoeksgroep “Operations Research and Scheduling”

- Mario Vanhoucke (ZAP)
- Annelies Martens (PostDoc)
- Tom Servranckx (PostDoc)
- Dries Bredael (WP)
- Rojin Nekoueian (WP)
- Forough Vaseghi (WP)

Aantal beschikbare onderwerpen: **26**
Totaal aantal studenten toegewezen aan een onderwerp: **0**

Belangrijke boodschap aan studenten: Voor sommige onderwerpen waar reeds studenten werden toegewezen laten we ook nog andere studenten toe. Indien interesse in een onderwerp dat reeds werd toegewezen, kan je alsnog een mail sturen naar de desbetreffende begeleider. De begeleider laat dan asap weten of het onderwerp nog kan gekozen worden. Uiteraard zijn alle openstaande onderwerpen nog beschikbaar.

Enkele belangrijke data:
- Indienen titel masterproef: uiterlijk 25 oktober 2022
- Indienen summary sheet: uiterlijk 15 februari 2023 (richtlijnen beschikbaar bij de begeleider)
- Indienen tussentijds rapport: uiterlijk 12 mei 2023
- Indienen executive summary: uiterlijk 3 oktober 2023 (richtlijnen beschikbaar bij de begeleider)
- Indienen thesis: Mei 2024 (datum nog nader te bepalen door FSA)

Wij zijn op zoek naar gemotiveerde studenten die zich met plezier willen inwerken in het domein van Operationeel Onderzoek & Management Science.

Wij verwachten van de studenten:

We verwachten van alle masterproefstudenten dat zij zelfstandig kunnen werken en dat zij een kwantitatieve ingesteldheid hebben. Voor sommige onderwerpen zijn we op zoek naar studenten die graag programmeren en die bereid zijn de basisprincipes van C++ onder de knie te nemen. Voor andere onderwerpen is kennis van programmeren totaal overbodig. Wat we vooral verwachten is:
- Inzet en motivatie vanaf begin oktober
- Samenkomsten op vooraf geregelde tijdstippen om de voortgang en/of resultaten gezamenlijk te bespreken
- Opmaak van de masterproef in LaTex
- Aanleren van de basisprincipes van C++ voor de start van het academiejaar (handleiding beschikbaar) (indien programmeerkennis vereist is voor de thesis)

De output bestaat uit een tussentijds thesisverslag in jaar 1 en een finale versie in jaar 2.

Jaar 1. Tussentijds verslag.

Het tussentijds verslag telt mee als deel van de finale evaluatie, en moet dus grondig worden opgemaakt. Download daarom de richtlijnen van het tussentijds verslag en lees deze aandachtig. Om deze richtlijnen wat concreet te maken, hebben we via onderstaande links drie voorbeeldverslagen beschikbaar gesteld:

- Verslag 1. Zwak verslag, Het verslag bevat geen enkele vernieuwing en is puur een samenstelling van bestaand onderzoek. De onderzoeksvraag is niet afgelijnd en het toekomstig werk werd niet perfect gedefinieerd.
- Verslag 2. Matig verslag. Het verslag bevat voldoende materiaal dat kan dienen als overzicht van de thesis, maar mist een grondig overzicht van het reeds gedane werk en bijhorende behaalde resultaten. Bovendien is het verslag niet origineel en vernieuwend.
- Verslag 3. Excellent verslag. Het verslag bevat concrete doelstellingen, voldoende vooruitgang en diepgang én een sterke kijk op het toekomstig werk. Schitterende verzorging.

Jaar 2. Finale thesis.

De praktische richtlijnen qua lettertype, vormgeving, etc. voor het finaal thesisverslag kan je op Ufora vinden. De inhoudelijke richtlijnen die wij als OR&S onderzoeksgroep nastreven vind je via de volgende link: finale thesis.

Wij bieden aan de studenten:
- Een onderwerp dat in de lijn ligt van onze huidige onderzoeksactiviteiten
- Opvolging van de ontwikkeling van het programma en de analyse van de resultaten

Bij elk onderwerp worden de contactpersoon, vereiste vaardigheden, maximaal # studenten en inhoudelijke aspecten kort vermeld. De inhoudelijke aspecten beschrijven kort waar de klemtoon van de masterproef ligt, maar dit kan uiteraard ten alle tijde, volgens de interesse van de student, aangepast worden.

Inhoudelijke aspecten zijn:
- Literatuurstudie: ondersteunend, eventueel uitgebreid, uitgebreid of hoofddoel van de masterproef
- Case study/oefening: neen, optioneel of hoofddoel van de masterproef
- Software gebruik: neen, optioneel of ja
- C++: neen, optioneel of ja (of eventueel een andere taal, bv. Java, VBA in excel, etc.)

Research topics

Students are free to propose any other topic related to project management or operations research. Alternatively, they can select one of the challenging topics from the list below.

Topic: An analysis of empirical and case study data in project management: planning, risk or control.

A crucial part of project management research is the validation and extension of research ideas and methodologies proposed in the literature using empirical data. The difference between the controlled, artificial setting and the real, practical environment implies that certain techniques will need to be adjusted in order to better fit with the needs of project managers. Also, theoretical results might deviate from practical and empirical experience resulting in relevant managerial insights. Finally, empirical research might show that certain techniques perform better for certain types of projects or industries. The focus can lie on one of the following three themes (or a combination) as described below:

- Project planning: Resource-constrained project scheduling and its extensions are topics that are investigated widely in the literature, and the OR&S group has done a lot of research for these challenging domains. There is a increasing interest to collect and analyse data about project schedules with flexibility, multi-skilled workforces, project portfolios, etc.
- Project risk: Schedule risk analysis requires detailed risk information on the activity level as well as data about external risk factors. The more accurate the data, the more reliable the results of a traditional simulation study. Further, (external) risks at the activity level affect the final project duration and cost. Techniques such as reference class forecasting help in assessing the impact of these risks on the project outcome. This thesis focuses on data collection and empirical validation of this challenging domain.
- Project control: Project control is traditionally done using Earned Value Management (EVM) methodologies. Studies have shown that (1) numerous extensions are available that extend the EVM methods to more realistic methodologies and (2) theoretical results often deviate from practical and empirical experience. In recent years, techniques such as tolerance limits for project control and corrective actions (activity crashing, fast tracking and variability reduction) received increased attention. Since most studies have used artificial data, these techniques should be validated on empirical data.

Empirical research can be conducted in one of the following ways (or a combination) as described below: (1) Analysis of existing data, (2) Collection (and analysis) of new data and (3) Generation of case study data. First of all, the OR&S research group has collected a large dataset of real project data over the past years that can be used by the student(s) to test hypotheses and investigate existing methodologies. Secondly, the student(s) can contact companies to collect new project data, using a standardised methodology of the OR&S research group, and afterwards analyse this data. Thirdly, the student(s) can develop complex case studies based on an extensive literature review or web-based methods. Based on a good knowledge of the project management problem, these case studies can be used to obtain novel insights and/or test existing hypotheses using a controlled, yet pragmatic approach. More information about the existing data, as well as the tool to analyse new results, can be found at www.projectmanagement.ugent.be/research/data.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project Management, Scheduling, Risk analysis, Earned Value Management

- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use is optional (MS Excel, ProTrack, …)
  - Modeling and analysis: Main goal of the thesis

Topic: A simulation study on the timing of project control warning signals and actions

Project control entails monitoring the project progress during execution to ensure that the project finishes on time and within budget. Tolerance limits are a tool that generates warning signals during project execution when the project is expected to exceed its deadline. These warning signals act as triggers for action by the project manager. Due to uncertainty and risks, it is possible that warning signals are false (e.g., the project will not exceed its deadline) or that actions taken by the project manager are inefficient (e.g., they are not able to reduce the remaining project duration). The goal of this simulation study is reviewing to what extent the timing of signals and actions (for instance, in the early or late phase of the project) has an impact on their correctness and efficiency.

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- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis.
  - Case study is not possible.
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: A simulation study to compare the effectiveness and reliability of different types of tolerance limits

Project control entails monitoring the project progress during execution to ensure that the project finishes on time and within budget. Tolerance limits are a tool that generates warning signals during project execution when the project is expected to exceed its deadline, and these warning signals act as triggers for action by the project manager. Different types of tolerance limits have been studied in literature (e.g. static, analytical and statistical tolerance limits), but there performance has not yet been compared. The aim of this thesis is examining which types of tolerance limits should be used by the project manager for which types of project or for which project phase, by conducting an extensive simulation study.

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Topic: A resource-based approach to project duration forecasting

During the execution of projects, forecasting techniques are applied to estimate the expected final project completion time. In a recent research study, a novel forecasting approach has been developed that explicitly takes into account the detrimental effects of disruptive events (such as weather-related issues or the recent COVID-19 pandemic) on the project resources (and thus on the project completion time). Although the novel approach has shown to have a higher forecasting accuracy compared to traditional project duration forecasting approaches, it has not been compared to the recent state of the art. Therefore, the aim of this thesis is to compare the proposed approach to the state of the art by means of a large simulation experiment , and, based on this analysis, propose improvements to the novel forecasting approach to improve its accuracy even further.

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- Required skills: Project management, project control, project forecasting
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis.

- Case study is not possible.
- Software use: P2 Engine / Python / C++
- Modeling and analysis: Main goal of the thesis

Topic: Modeling and simulating the impact of activity duration dependencies and side-effects of corrective actions during the project control process

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. Several types of corrective actions have been proposed to get the project back on track and ensure timely project completion (i.e. activity crashing, fast tracking and variability reduction). However, corrective actions on an activity might cause side-effects on other activities, such as quality losses and an increased probability that rework might be required. Further, activity durations are not necessarily independent, since they can be correlated with other activities or might suffer from a project-wide estimation bias. The goal of this thesis is to model these side-effects and activity dependencies and to conduct a simulation study in which the impact of these elements on the project outcome is examined.

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- Required skills: Project management, project control
- Extra information:
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  - Case study is not possible
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Simulation study on strategies for the corrective action taking process to improve the project control decision making process

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. The corrective action taking process comprises several decisions that should be made simultaneously, i.e. how much and which activities should be taken corrective actions on, which type of actions should be taken and how large should the action be in order to achieve timely project completion without incurring excessive costs. The aim of this study is to identify different strategies for the corrective action taking process and conduct a simulation experiment to review the effectiveness of these strategies.

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- Extra information:
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  - Case study is not possible.
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Optimal planning of an admission unit in hospitals to decrease the length of stay of hospitalised patients

An admission unit in hospitals is used to pool admission tasks from all nursing wards in one unit in order to fluently hospitalise patients who need a procedure (surgery, etc.) in order to decrease admission variation and increases bed utilisation. In AZ Sint-Jan the admission unit only covers 50% of the admissions leading to a procedure. The aim of this thesis is to find a planning method and investigate the capacity needs in order to increase this percentage. The capacity constraints are amongst others the limited time window, the number of admission boxes and the number of nursing staff, while the stochastic influences are the unplanned admissions and no shows. Subsequently, the planning method should be used on data from AZ Sint Jan hospital in Bruges to theoretically validate the approach and propose managerial solutions and insights.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project Management, Hospital Planning, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.

- Literature review is supportive but not the main theme of the thesis
- Case study is required
- Software use: Depends on how the research will be approached
- Modeling and analysis: Main goal of the thesis

Topic: Refined forecasting of future demand towards bed occupation informs operational planners in accurate decision-making

Admissions in a hospital are planned months ahead, without any knowledge of future care needs and unplanned admissions. The aim of this topic is to forecast future bed occupation based on amongst others leave of physicians, activity of outpatient clinic and previous demand rates in order to accurately forecast demand for next day, week or month.

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- Required skills: Project Management, Hospital Planning, Optimisation
- Extra information:
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  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Optimal planning of nuclear and radio therapy units in hospitals can increase the availability of devices to treat patients

The nuclear and radio therapy unit in hospitals involve multiple devices to treat and scan patients. The planning of these nuclear and radio therapy units is hard because patients need multiple treatments in a limited time window, the planning for a patient can change during treatment, the patients can be assigned to multiple devices and the planning involves uncertainties such as no shows. This topics aims at finding the ideal planning method to minimise delay in planning and patient waiting times.

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- Required skills: Project Management, Hospital Planning, Optimisation
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  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Multi-attribute decision-making to select alternatives in the project structure

The project management process consists of scheduling the project activities, analysing the project risk and monitoring the project progress. However, these steps assume that the scope of the project is determined by the project manager (i.e. the required activities are determined, the skilled resources are identified and the complex relations between activities are analysed). In other words, the project manager will have to choose between different alternative ways to execute work packages in the project or even select appropriate subcontractors to execute the work packages, prior to project scheduling. This is a complex decision-making problem since the alternatives/subcontractors will be scored on different attributes that all contribute to the project objective. In general, information is collected about the expected or past performance of alternatives for high-level attributes such as financial metrics or production output. In project management, lower-level attributes that are related to the project scheduling process could be used. In this thesis, the student will identify relevant attributes for selecting alternatives in the project scheduling process and develop a framework for multi-attribute decision-making.

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- Required skills: Project scheduling, optimisation, simulation
- Extra information:
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  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++, optionally RanGen

- Modeling and analysis: Main goal of the thesis

Topic: The impact of alternative options on hierarchical objectives: a quantitative and qualitative evaluation.

A project is successfully managed when it is completed within time and budget…and within the project scope that has been promised to the client. The scope objective is often overlooked during project management since it is assumed that the project scope is fixed and pre-determined. However, the project manager can identify and investigate alternative ways to execute subparts of the project, called work packages, in order to improve the time or budget performance of these work packages, without considering the impact on the overall project scope (i.e. the alternative options might change the scope of the project). Therefore, the positive or negative impact of each alternative option on the low-level objectives (i.e. at the work package level) should be assessed, but this impact should be propagated bottom-up in the hierarchy of objectives towards the high-level objectives (i.e. at the project level). The student(s) should investigate whether the techniques from Requirement Engineering can be applied to project scheduling with alternative options. In this thesis, a hierarchy of objectives for project scheduling should be investigated and both quantitative and qualitative evaluation techniques should be compared.

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  - Software use: C++, optionally RanGen
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Topic: Optimising multi-mode, multi-project portfolio scheduling of competing projects

A project portfolio can have one overall goal but many ways (projects) of achieving that goal. We call these projects competing projects because the successful conclusion of one project renders the others obsolete. This is a common characteristic in R&D project scheduling. A lot of uncertainty is involved in scheduling these projects. Project failure is a significant risk that leads to a waste of the invested resources. This risk is higher when the (activities of the) project are rushed to reduce its makespan. An alternative approach is to minimise risk of failure by allowing for more time in each R&D stage (activity) but this might lead to significant project delays. The optimal approach is probably somewhere in the middle. Additionally, for this study, we are interested in how earlier activities could impact the failure and delay risk of later activities. The goal of this thesis is to develop a model of the problem statement. A simulation study is required to analyse the effects of these uncertainties on the problem statement and to derive a robust solution strategy.

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- Required skills: Project scheduling, optimisation, simulation
- Extra information:
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  - Case study is possible
  - Software use: C++, CPLEX or Gurobi
  - Modeling and analysis: Main goal of the thesis

Topic: Network partitioning strategies for multi-project scheduling

In multi-project scheduling, a portfolio of projects is considered where projects typically have no precedence relations between each other. When the goal is to minimise the Average Project Delay (APD), A well-known, effective strategy is to schedule the projects in a certain order, prioritising the most urgent projects. However, when we consider a project portfolio where projects do have precedence relations between the activities of their project and another, this strategy becomes infeasible without adaptations. One approach to alleviate this, is to artificially construct ‘sub- projects’ within the overarching project where the subprojects only have precedence relations to their (artificial) start-activity and from their finish-activity. The goal of this thesis is to find an effective partitioning strategy to construct these artificial sub-projects and to analyse the performance of the prioritisation strategy with these sub-projects as input to minimise the APD through a simulation study.

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Topic: A case study on multi-project selection with project interdependencies

Most of literature on the (resource-constrained) project selection (and scheduling) problem considers that the pool of candidate projects within the portfolio are completely independent from each other. This is often an unrealistic assumption since various types of positive or negative relations between the projects could exist in practice. The existence of those possible beneficial or disadvantageous effects further complicates the decision-making problem. For example, including one project can force the exclusion of another project or can mandate the inclusion of a third project. Furthermore, the early completion of one project can cannibalise the reward associated with another project, or higher resource efficiencies could be the result of running certain activities of different projects simultaneously. The goal of this study is to find an example of this problem in industry. The empirical data gathered will then be used to conduct an analysis on the implications and importance of these interdependencies on the decision-making problem. The main objective is to quantify the importance of integrating these interdependencies in the decision-making phase. A case study is therefore recommended, although an experiment on artificial data is feasible too for this subject.

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- Required skills: Project selection, project scheduling, optimisation, simulation
- Extra information:
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Topic: Resource dedication in dynamic, dispersed multi-project selection

Consider a pool of renewable resources that is available in a central storage facility. These resources are used to complete projects at various locations and the task of the multi-project planner at the central warehouse is to dedicate a fixed number of resources to these geographically dispersed projects at their commencement. The more resources the planner dedicates to a specific project, the faster the project would be completed and the higher the financial reward that is received. However, the available resources are limited and, therefore, assigning too many resources could lead to shortages in the occasion that unforeseen new projects would demand scarce resources. In the occasion of a resource shortage, the manager would have to reassign and physically move resources from one location to another, which comes at a higher cost because it also disrupts the execution of the project at that location. It could therefore be more optimal to assign less resources to certain projects, even though the completion time would be longer and, hence, the payoff lower. This thesis requires both optimisation and simulation techniques. The first task is to formally define the problem and its characteristics. Afterwards, different problem-specific solution strategies are required to optimise the initial resource dedication decision. Because new projects arrivals are random to the planner, a simulation study is required to compare the different strategies proposed by the student.

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Topic: Multi-project scheduling with stochastic activity durations

The deterministic version of the Resource-Constrained Multi-Project Scheduling Problem (RCMPSP), as an extension of the single-project variant, is well-studied in literature. However, whereas multiple studies on

stochasticity exists for the single-project scheduling problem, few studies exist that integrate uncertainty in the RCMPSP. One possible research endeavour is to analyse the impact of uncertain activity durations on the existing solution strategies for the problem. Because the existing solution strategies assume the activity durations are known and fixed beforehand, the inclusion of this uncertainty could be detrimental to the solution quality of these strategies. The most common and simplest solution methods are the use of priority rules that define which activity from which project should be planned next in the schedule. The effectiveness of these priority rules has been studied intensively on the deterministic variant of the RCMPSP, however, it is unknown how they perform in the situation where the activity durations are uncertain. Delays in certain activities would render the initial schedule infeasible and, therefore, rescheduling of the activities would be required. The goal of this thesis is to compare the effectiveness of these known priority rules on the stochastic version of the RCMPSP. We are interested in how often these priority rules would require the schedule to be recalculated due to infeasibilities. Additionally, a new solution strategy should be devised that takes the risk of activity delays into account to reduce the likelihood that the initial schedule becomes infeasible and, thus, needs to be rescheduled.

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- Required skills: Project scheduling, optimisation, simulation
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Topic: Machine learning priority rule for the resource-constrained project scheduling with alternative subgraphs

Resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of the resource-constrained project scheduling problem (RCPSP) in which the work packages can be executed in different, alternative ways. The RCPSP-AS consists of a selection and a scheduling subproblem. A priority rule is a heuristic method to obtain single schedules for scheduling problems. In the existing literature, priority rules have been widely developed for the basic RCPSP, but finding a good-performing priority rule for a specific variant of this basic scheduling problem is ambitious. The aim of this thesis is to develop a machine learning approach to combine a set of priority rules for the selection and scheduling subproblem of the RCPSP-AS. These machine learning strategies are then used to select the best-performing priority rule for each work package.

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- Required skills: Project scheduling, optimisation
- Extra information:
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  - Software use: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Preemptive resource-constrained project scheduling with alternative subgraphs

Activity preemption is an assumption that aims to improve the practical relevance of the resource-constrained project scheduling problem (RCPSP). This assumption allows activities to be preempted or stopped at any time and restarted later on at no additional cost. Considering preemption for activities with a fixed duration, this duration will be split into several duration units. Therefore, it is possible to optimally utilise leftover resources in order to minimise the project makespan. In the resource-constrained project scheduling problem with alternative subgraphs (RCPSP-AS), work packages can be executed in different alternative ways. For some alternatives, these resource leftovers are noticeable and could be used by allowing activity preemption. Including activity preemption within the RCPSP-AS in order to find optimal schedules that minimise the project makespan will change current solutions and algorithms for the RCPSP-AS, which is the aim of this thesis.

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- Required skills: Project scheduling, optimisation

- Extra information:
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  - Software use: C++
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Topic: Resource-constrained project scheduling with alternative subgraphs considering set-up time for resources

Resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of the resource-constrained project scheduling problem (RCPSP) with work packages that can be executed in different alternative ways. Different resources (e.g. machines) might have different set-up times for activity execution and these setups needs to be done before an activity starts. Considering resource set-up times for alternative work packages and activities implemented with different resources, optimal schedules that minimise the project makespan should be developed in this thesis.

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  - Case study is possible
  - Software use: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Multi-objective resource-constrained project scheduling with alternative subgraphs

Resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of the resource-constrained project scheduling problem (RCPSP) with work packages that can be executed in different alternative ways. There might exist several objectives for this scheduling optimisation. Cost minimisation, makespan minimisation, resource levelling maximisation or resource idleness minimisation are examples of objectives that can be considered together for the RCPSP-AS. Let us consider a construction company that builds a house using different, alternative technologies. For some alternative technologies, the activities could be executed in parallel in case that the company would hire extra workers for some days. Therefore, the company can deliver the building in a shorter project completion time. The decision to temporarily add resources to the system depends on the penalty for late project delivery and the cost for adding resources. As a result, the optimality of the decision to add resources in some periods depends on the combined minimisation of the project makespan and cost.

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- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Technology selection for a project portfolio, including projects with alternative technologies in common

A project portfolio is a set of projects that are selected in order to satisfy specific goals (e.g. cost and risk minimisation) of an organisation. Projects of a portfolio can use alternative technologies for the execution of work packages. These technologies could be shared among different projects in the portfolio. Since each technology has its own specification (e.g. usage of specific resources and specific duration of activities) using different technologies for projects in a portfolio makes the project management process more complex. Therefore, it is easier for a project manager to share the same technologies among multiple projects. Also, using the same technologies might be less risky since the same resources can be shared between projects and thorough information is only needed for a limited number of technologies rather than a lot of different technologies. However, putting more pressure on one type of resource will increase the probability of resource breakdowns. In summary, this thesis aims to identify the optimal, alternative technologies for a project given the specific goals of the company.

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Topic: Determining the project completion time of complex project networks: an analysis of the impact of the project network topology

One of the most important factors to calculate the distribution of the project completion time for a project network is its network structure, both in terms of complexity (complexity index CI) and in terms of topology (serial/parallel indicator SP, activity distribution indicator AD, Length of Arcs indicator LA and Total Float indicator TF). For complex project networks (CI>0), the project completion time distribution cannot be determined exactly and should be approximated by using analytical bounding approaches or Monte Carlo simulation. The goal of this thesis is to analyze the relation between the network topology and the performance of the approximation approaches.

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- Extra information:
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  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: P2 Engine / Python / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: An analysis of the impact of activity duration distributions on the project completion time of stochastic project networks

The project completion time of stochastic project networks is determined by the distribution of the project activities. These activity distributions can vary in terms of distribution type and distribution parameters. In this thesis, the impact of different types of distribution that have been used in literature (normal, lognormal, exponential, beta, etc.), and the impact of the distribution parameters should be analyzed from a managerial point of view (accuracy and computational effort). In order to conduct this analysis, both analytical approximation methods and simulation methods can be used.

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Topic: A computational study on bounding methods for the distribution of the project completion time in stochastic activity networks

While the project completion time of projects with a complexity index (CI) of zero can be determined exactly, the analytical evaluation of the distribution of the project completion time for activity networks with a CI higher than zero is an NP-complete problem for which approximation methods like bounding are required. In this thesis, the most promising of these bounding algorithms should be computationally evaluated to compare their suitability for practical applications in terms of accuracy and computational cost. The main goal is to find the most important properties of the networks (complexity index, serial/parallel indicator, etc.) that influence the results of the methodologies.

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Topic: A comparison of the impact of different corrective actions on project outcome before or/and during the execution of the project

Sometimes a project needs to be completed earlier than the defined deadline or on time with very small variability. In such cases, the project manager should reduce the mean or variance of the project duration. In addition, due to uncertainty and variability during the execution of the project, changes in the duration of the project are inevitable. That is why the project manager takes corrective actions during project control to make the necessary changes based on stakeholders' desires or to take the project back on track. The goal of this thesis is to compare the impact of different corrective actions to reduce the mean or variance of makespan distribution as much as possible (higher impact) keeping the effort as minimum as possible. The effort means the number of activities that are selected for the corrective action taken process.

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  - Model/analysis: Main goal of the thesis

Topic: Investigating the impact of changes in mean and variance of activity duration distribution on the project duration distribution to find the most important activities for corrective action taken process

Changes in the mean and variance of project completion time after changes in the mean and variance of individual activities can be different due to the criticality and sensitivity of activities. Hence, before taking action on activities during project control, the project manager needs to identify the activities which have a positive impact on the outcome of the project, considering the goal of corrective actions and the activities which are more important to increase the effectiveness of actions and to reduce the effort. The goal of this thesis is to perform a sensitivity analysis to estimate the amount of change in mean and variance of project completion time for a variety of changes in mean and variance of individual activities.

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