Onderwerpen masterproeven 2023-2025 aan de onderzoeksgroep “Operations Research and Scheduling”

- Mario Vanhoucke (ZAP)
- Louis-Philippe Kerkhove (ZAP)
- Tom Servranckx (PostDoc)
- Rojin Nekoueian (WP)
- Forough Vaseghi (WP)
- Guillaume Vermeire (WP)
- Nathan Steyaert (WP)

Aantal beschikbare onderwerpen: **30**
Totaal aantal studenten toegewezen aan een onderwerp: XX

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: Oktober 2023 (datum nog nader te bepalen door FSA)
- Indienen summary sheet: uiterlijk 15 februari 2024 (richtlijnen beschikbaar bij de begeleider)
- Indienen tussentijds rapport: uiterlijk 10 mei 2024
- Indienen executive summary: uiterlijk 3 oktober 2024 (richtlijnen beschikbaar bij de begeleider)
- Indienen thesis: Mei 2025 (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 summary sheet en tussentijds thesisverslag in jaar 1, en een executive summary en 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 Minerva 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 an 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 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.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project Scheduling, Multi-project, Project interdependencies
- 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: Practical application of Reference Class Forecasting

Previous research has already indicated the vast potential of Reference Class Forecasting (RCF), a technique that bases the forecasts for a certain project on the actual performance of similar historical projects (i.e. the reference class). However, the question remains when exactly can a certain project be called 'similar' to another project? Identification of the correct drivers of similarity could improve the selection of reference classes and thus the global performance of RCF. Furthermore, similarity might not always be found on the project level, but perhaps only on a lower work package level. Obviously, a substantial number of real-life projects are necessary to perform this research. An existing database is available as a basis, but should be extended with new projects.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project forecasting, Similarity, Empirical analysis
- 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: Framework for green technologies in construction projects: an empirical approach

Project managers aim at delivering project outcomes that generate the required benefits for the project funder. With the construction of energy-friendly and carbon-neutral buildings, this match between project outcomes (i.e. building's functionalities) and project benefits (i.e. sustainable way of living) is more than ever

impacted by clean and green construction. Innovative technologies are crucial for matching these project outputs and benefits, however, insufficient knowledge is available about the impact of these green technologies in construction projects. The objective of this thesis is to identify and categorise green technologies through interviews with field experts and quantify this information such that it can be processed in project scheduling software. An analytical approach to organise and map the technologies, outcomes and benefits should be presented based on - for example - quality function deployment (QFD). In this thesis, the student will develop a framework to identify and select green technologies for the construction sector as well as validate this framework using case data. Obviously, a substantial number of real-life projects are necessary to perform this research. An existing database is available as a basis, but should be extended with new projects.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project management, Construction planning, Sustainability, 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: Solution approaches for the resource-constrained project scheduling problem with alternative subgraphs using project measures

The resource-constrained project scheduling problem (RCPSP) is a well-known problem in which activities should be scheduled under limited availability of resources and precedence constraints. In the literature, a lot of project indicators have been developed to measure projects specifications. For instance, the Series–Parallel indicator (SP) measures whether the project network is more serial (activities in sequence) or parallel (simultaneous activities). In the resource-constrained project scheduling problem with alternative subgraphs (RCPSP-AS), the project structure is flexible and there exist several alternatives to execute project work packages. Hence, a lot of effort has already been done to find the optimal selection of alternatives. In this thesis, the student should find (near-)optimal solutions for the RCPSP-AS by selecting alternatives based on project measures (such as the SP indicator) and scheduling the corresponding selected activities.

- Advisor: Mario Vanhoucke
- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- 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: Robust and reliable priority rules for scheduling of projects with alternative subgraphs and stochastic activity duration

The resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of resource-constrained project scheduling problem (RCPSP) with work packages that can be executed in different alternative ways. In the basic RCPSP-AS, activities have a deterministic duration that is known in the scheduling phase. However, when projects are executed, the duration of activities might be extended or reduced due to disruptions caused by uncertain events. There exists several priority rules for the RCPSP-AS, but the quality of the resulting schedules has not been examined in the execution phase of the project (i.e. after the occurrence of these uncertain events). In this thesis, robust and reliable priority rules should be found for the RCPSP-AS in order to minimise the deviation between the planned and actual starting times of the (selected) activities.

- Advisor: Mario Vanhoucke
- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- Required skills: Project scheduling, Optimisation
- Extra information:

- This thesis is suitable for one student. 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: Solving the resource-constrained project scheduling problem with alternative subgraphs using reinforcement learning

The resource-constrained project scheduling problem (RCPSP) is a challenging optimisation problem that involves scheduling a set of activities with limited resources and precedence constraints. The resource-constrained project scheduling problem with alternative subgraphs (RCPSP-AS) is a generalisation of the RCPSP in which work packages can be executed according to several alternative ways. It is important that alternative activities are selected in a way that the project makespan is minimised (i.e. the project is finished as soon as possible). Reinforcement learning is a type of machine learning where an agent learns to make decisions through trial-and-error while interacting with its environment. In the context of the RCPSP-AS, the agent can be considered the scheduler and the environment can be considered the project with its tasks, resources and alternative subgraphs. The agent takes actions (selecting alternative activities) and receives rewards based on the quality of the resulting schedule.

- Advisor: Mario Vanhoucke
- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- Required skills: Project scheduling, Optimisation
- Extra information:
  - This thesis is suitable for one student. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Data collection and analysis for projects with alternative subgraphs

One of the extensions of the resource-constrained project scheduling problem (RCPSP) is the inclusion of alternative subgraphs, labelled RCPSP-AS, in which work packages can be executed in several alternative ways among which one should be selected. The RCPSP-AS is an optimisation problem that arises in various industries such as manufacturing, construction and software development. It involves scheduling a set of tasks with limited resources, where task dependencies and resource constraints must be carefully considered in order to achieve the best possible project completion time. As part of this thesis, you will have the chance to delve into the heart of real-world projects from different industries and analyse their scheduling and resource allocation complexities.

- Advisor: Mario Vanhoucke
- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- 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 required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Resource-constrained project scheduling with alternative subgraphs considering set-up time for resources

The resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of the basic RCPSP with work packages that can be executed in different alternative ways. Different resources (e.g. machines) require different setups (with their corresponding setup times), which need to be done prior to the possible start of an activity. Considering resource setup times for alternative subgraphs and alternative activities implemented with different resources, (near-)optimal schedules that minimise the project makespan should be developed.

- Advisor: Mario Vanhoucke

- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- Required skills: Project scheduling, Optimisation
- Extra information:
  - This thesis is suitable for one student. 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: Multi-objective resource-constrained project scheduling with alternative subgraphs

The resource-constrained project scheduling with alternative subgraphs (RCPSP-AS) is an extension of the RCPSP in which work packages that can be executed in different alternative ways. There might exist multiple objectives for this scheduling problem, such as cost/time/idleness minimisation and resource levelling maximisation, that can be considered independently or combined. Consider a construction company building a house using different technologies to complete — for example — the window installation. If the company hires extra workers for some days, some activities could potentially be executed in parallel and the building could be delivered in a shorter period of time. Moreover, if some resources could be added temporarily to the system and the penalty for project delay is more than the cost for the temporary workforce, an optimal schedule has non-idle resources with the possibility of adding some extra resources in some time periods considering project makespan and project cost objectives. The aim of this thesis is to investigate the trade-offs that exist between different (conflicting) objective for the RCPSP-AS.

- Advisor: Mario Vanhoucke
- Contact person: Rojin Nekoueian (rojin.nekoueian@UGent.be)
- Required skills: Project scheduling, Optimisation
- Extra information:
  - This thesis is suitable for one student. 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: The Relevance of Risk Re-Analysis (Periodic Re-evaluation) in Evaluating Corrective Actions for Project Control

As the project progresses, the dynamic nature of project environments can lead to changes in factors influencing activity durations and overall project performance. Regular risk re-analysis allows project managers to adapt to evolving conditions and modify the latest project data. The need for risk re-analysis acknowledges that a static approach to corrective actions may overlook emerging risks or inefficiencies, while a dynamic assessment ensures that project management remains proactive and agile in response to changing circumstances. By periodically reassessing the risk, the study ensures that the corrective actions remain aligned with project objectives and resource constraints, enhancing the potential for successful risk mitigation. The goal of this thesis is to investigate the effectiveness and relevance of risk re-analysis in corrective action process in project control.

- Advisor: Mario Vanhoucke
- Contact person: Forough Vaseghi (Forough.Vaseghi@UGent.be)
- Required skills: Project management, Project control, Risk analysis, Stochastic network analysis
- 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 / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Cost-Benefit Analysis for Prioritizing Corrective Actions and Enhancing Project Performance

Employing cost-benefit analysis within the risk analysis and corrective action process allows project managers to make data-driven decisions when prioritizing corrective actions. By quantifying the costs

(e.g. effort, time and resources) and benefits (e.g. reduction in project duration and risk mitigation) associated with each action, project managers can assess the return on investment (ROI) of implementing specific corrective measures. The goal of this thesis is to prioritize high-impact actions with favorable ROI, which results in efficient resource allocation and maximizes the potential for reducing project duration, minimizing project delays and mitigating project risks. By focusing on cost-effective actions that yield significant benefits, project managers can enhance project performance and achieve optimal outcomes within resource constraints.

- Advisor: Mario Vanhoucke
- Contact person: Forough Vaseghi (Forough.Vaseghi@UGent.be)
- Required skills: Project management, Project control, Cost-benefit analysis, Stochastic network analysis
- 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 / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Budget-Constrained Cost-Benefit Analysis for Risk Mitigation Strategies

In budget-constrained scenarios, project managers can adapt the cost-benefit analysis to prioritize risk mitigation strategies that align with the available budget. By assessing the costs and benefits of each corrective action and factoring in the budget limitations, project managers can identify strategies that offer the best return on investment (ROI) given the allocated resources. This approach ensures that risk mitigation efforts are cost-effective and optimized to achieve performance improvement while staying within budgetary constraints. The focus in this thesis is on adapting the traditional cost-benefit analysis to accommodate budget constraints specifically for risk mitigation strategies. The goal is to identify strategies that offer the best ROI within the allocated resources, maximizing risk reduction while staying within budgetary limitations.

- Advisor: Mario Vanhoucke
- Contact person: Forough Vaseghi (Forough.Vaseghi@UGent.be)
- Required skills: Project management, Project control, Cost-benefit analysis, Stochastic network analysis
- 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 / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Impact Analysis of Corrective Actions on Project Duration Reduction and Risk Mitigation

An impact analysis is a vital tool for evaluating the effect of each corrective action on project duration reduction and risk mitigation. This analysis involves the implementation of corrective actions and the quantification of the resulting changes in activity durations and project risks. By comparing the initial and revised project timelines and risk profiles, project managers can identify the most influential corrective actions that lead to significant reductions in project duration and risk levels. Prioritizing impactful actions ensures a targeted approach to performance enhancement with a focus on actions that have the most significant positive impact on project outcomes. The goal of this thesis is to explore the relevance of impact analysis within the corrective action process and conduct a comparative analysis with other existing approaches.

- Advisor: Mario Vanhoucke
- Contact person: Forough Vaseghi (Forough.Vaseghi@UGent.be)
- Required skills: Project management, Project control, Impact analysis, Stochastic network analysis
- 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 / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Cost-Optimization Impact Analysis for Budget-Constrained Projects

In budget-constrained projects, project managers can perform a cost-optimization impact analysis to identify corrective actions that offer the most significant performance improvement relative to their costs. By comparing the costs of corrective actions to the potential reductions in project duration and risk, project managers can focus on actions that provide the highest value for money spent. This analysis ensures that corrective actions align with budget constraints and deliver tangible benefits in terms of reduced project duration, minimized delays and effective risk management. The analysis of this thesis ensures that corrective actions are not only effective in reducing project duration and managing risks, but are also aligned with budget constraints and optimally using the available resources.

- Advisor: Mario Vanhoucke
- Contact person: Forough Vaseghi (Forough.Vaseghi@UGent.be)
- Required skills: Project management, Project control, Impact analysis, Stochastic network analysis
- 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 / R / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Case study on skills in project management: Empirical data collection and solution approach.

The goal of this thesis is to collect empirical project data that incorporates skills. In the well-known resource-constrained project scheduling problem (RCPSP), every activity has a demand for resource types (e.g. workers). In this case, we are looking for projects that have a demand for skills that are possessed by these resources. The student will visit companies and gather real-life data for a thorough analysis. Additionally, the student will develop a procedure that assists in dealing with the data in order to gain new knowledge and managerial insights.

- Advisor: Mario Vanhoucke
- Contact person: Guillaume Vermeire (Guillaume.Vermeire@UGent.be)
- Required skills: Project management, Construction planning, Sustainability, 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: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Case study on sustainability in project management: empirical data collection and artificial data creation.

The goal of this thesis is to collect empirical project data that incorporates sustainability. In the well-known resource-constrained project scheduling problem (RCPSP), every activity has a demand for resource types. In this case, we are looking for projects that take sustainability or energy consumption into account. The student will visit companies and gather real-life data which will allow the student to adapt artificial data files in order to include the sustainability objective. Additionally, the student will develop a procedure that assists in solving these data instances.

- Advisor: Mario Vanhoucke
- Contact person: Guillaume Vermeire (Guillaume.Vermeire@UGent.be)
- Required skills: Project management, Construction planning, Sustainability, 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: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Modeling and simulating uncertainty in resource absence and its impact on costs of projects.

The goal of this thesis is to introduce probabilistic aspects concerning resource absence in solving the multi-skilled resource constrained project scheduling problem (MSRCPSP). In this case, each resource is portrayed as a renewable, multi-skilled worker. However, in reality, there exists the possibility of resource unavailability due to various factors such as illness or other contingencies. In order to achieve this goal, the student will design an algorithm to tackle artificial project data instances and evaluate the impact on cost and makespan when resources are absent.

- Advisor: Mario Vanhoucke
- Contact person: Guillaume Vermeire (Guillaume.Vermeire@UGent.be)
- Required skills: Project management, Construction planning, Sustainability, 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: Impact of learning and forgetting on the performance of multi-skilled resources.

In the multi-skilled resource constrained project scheduling problem (MSRCPSP), resources are considered renewable multi-skilled workers. These workers master skills at a specific skill-level, which will be influenced by the frequency of their assignment to activities requiring those skills. Therefore, the student will devise learning and forgetting curves, which will be applied to artificially generated datasets to assess their effects on the project objectives. The student will design an algorithm that can solve the artificial project instances in order to gain valuable insights into managing resource availability and skill levels.

- Advisor: Mario Vanhoucke
- Contact person: Guillaume Vermeire (Guillaume.Vermeire@UGent.be)
- Required skills: Project management, Construction planning, Sustainability, 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: Protecting a CPM-based project network against targeted sabotage.

There are many situations in which a project manager should not fear any conflict. For example, when you're striving to finish a gardening project, you can expect to mostly sail through without having to worry about competitors (though exceptions may apply). In many cases though, you have to understand that there may be others around who have goals which are not completely aligned with yours. The project manager who faces adversaries willing to go any length to obstruct you has quite the challenge. It's not unusual for uncertainty to be taken into account, but rarely does the project manager take into account that delays may be deliberate and targeted. In this thesis, you will model sabotage in project networks, and you will construct algorithms which find the optimal course of action for the project manager. This can incorporate concepts as uncertainty and a time-cost tradeoff.

- Advisor: Mario Vanhoucke
- Contact person: Nathan Steyaert (nathan.steyaert@UGent.be)
- Required skills: Project scheduling, Optimisation, Game theory
- 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 optional
  - Software use: C++, potentially python or Java
  - Modeling and analysis: Main goal of the thesis

Topic: Managing CPM-based secret projects with maximal delay of the revealing moment

There may be many reasons as to why you would keep a project or parts of a project secret. For example, your project may have a negative impact on competitors and these competitors will try to do something about your project. Another possibility is that the ideas you reveal through this project will get stolen. Managing a project while trying to hide it from the public and from your competitors is a delicate task. You have to take into account which actions will reveal what, and to which degree you can do something about the reveals. You'll have to take into account which resources (people, money,…) you possess, and make guesses about what your opponent(s) their capabilities are. In this thesis, you will model secrecy in project networks, and attempt to construct algorithms which find the optimal course of action for the project manager.

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- Required skills: Project scheduling, Optimisation, Game theory
- 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 optional
  - Software use: C++, potentially python or Java
  - Modeling and analysis: Main goal of the thesis

Topic: Protecting a resource-constrained project against targeted sabotage.

There are many situations in which a project manager should not fear any conflict. For example, when you're striving to finish a gardening project, you can expect to mostly sail through without having to worry about competitors (though exceptions may apply). In many cases though, you have to understand that there may be others around who have goals which are not completely aligned with yours. Resource-constrained projects are projects which have to deal with some scarcity of renewable resources. For example, there may be a limited amount of engineers who can work at the same time, and therefore certain activities can't be performed at the same time. Of course, projects which are optimised for efficient resource use could have this as a weak point when deliberately attacked. For example, one of the engineers could receive a better contract at a competitor and uproot the entire schedule. In this thesis, you will model sabotage in resource-constrained project networks, and attempt to construct algorithms which find the optimal course of action for the project manager.

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Topic: Modelling interdiction on networks and applications for operations research

Behind the theory of sabotaging projects and interdicting networks lies a concept lesser known to business engineers: graph theory. To efficiently counter sabotage, and if you're inclined to do so, perform sabotage yourself, you'll need to understand the mechanics of networks. Usually, projects are described as graphs with certain properties, and our goal is to exploit these properties efficiently. We will apply the theory of graphs and network interdiction to project management in particular, but it is also relevant in for example breaking up drug trafficking, and a small diversion into these problems is possible. In this thesis, you'll dive into the theory of graph theory and optimisation over graphs, aiming to develop better algorithms to protect and sabotage.

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Topic: Analysis of sabotage strategies with application to a historical or future megaproject

It is not too difficult to see as to why one would try to hinder other countries developing nuclear weapons. The advantage this gives to rival nations is so large that you may want to go to great lengths to prevent this from happening - or at least delay it as much as possible. Other megaprojects may similarly have some clear enemies. Examples include the construction of a fusion reactor, the construction of a large-scale railway network and construction of a bypass. In this thesis, you will model sabotage on project networks, and apply it to a historical project with many activities. You will have to estimate potential delays yourself, and put yourself in the position of both saboteur and project manager. You'll have to consider both the theory behind sabotage and the practicalities when actually managing (or sabotaging) a project yourself.

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Topic: Advancing Operational Research through Large Language Models (LLM): An Empirical Business Case Study

This dissertation explores the intersection of operational research and large language models (LLM). The study should be grounded in a real-world business setting, and aims to create an innovative application that contributes to both academic knowledge and practical business operations. The student(s) must investigate and illustrate the potential of this integration of traditional techniques such as simulation and optimization with novel LLM models. Specifically, the dissertation is likely to focus on two key benefits offered by LLMs (but is not limited to these aspects). First, the ability to create structured data from unstructured inputs, broadening the range of possible applications. Second, the ability to interpret complex mathematical results, and provide them in a more user-friendly format for the end user. Especially when it comes to sensitivity analysis and the finetuning of models this could be a significant advantage. It is possible that specific candidate companies and cases will be communicated at a later date, but the responsibility of finding a suitable company and case ultimately lies with the student.

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- Required skills: Large language models, Optimisation, Simulation
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  - 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: Python or possible others
  - Modeling and analysis: Main goal of the thesis

Topic: Re-envisioning Fashion Supply Chain Optimization: Incorporating Environmental Objectives alongside Profit Maximization

Over the years, supply chain optimization has primarily focussed on maximizing profits, employing mathematical models to achieve optimal operational efficiency and cost-effectiveness. The goal of this dissertation is to investigate how these models can be adjusted to account for environmental objectives, as well as profit maximization objectives. Environmental objectives are often reported in sustainability reports (for example by companies such as Inditex), but the majority of reported parameters relate to the sourcing of materials, rather than the efficiency of operations. The goal of this dissertation is to investigate how methods aimed at improving operational efficiency can also be integrated into these methods. The

dissertation's empirical component involves conducting a computational experiment utilizing real or realistically simulated retail data. The purpose of this experiment is to unveil the potential disparity, if any, between optimizing for conventional economic objectives and for environmentally-centered ones. These findings will not only enrich the theoretical understanding of the integration of environmental objectives into supply chain optimization but may also stimulate industry-wide adoption of eco-conscious business practices.

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- Required skills: Supply chain, Optimisation, Sustainability
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  - Software use: Python or possible others
  - Modeling and analysis: Main goal of the thesis

Topic: Enhancing Sensitivity Analysis in Supply Chain Optimization Through Generative AI: An Investigation into Quality and Efficiency

Sensitivity analysis, while being an indispensable tool in supply chain optimization, often faces neglect due to its laborious nature. The potential of Generative Artificial Intelligence (AI) as a mechanism to streamline and enhance the sensitivity analysis process holds significant promise. The dissertation will investigate this possibility, aiming to uncover how a generative AI can be instrumental in improving the efficiency and quality of sensitivity analysis. To this end one or more traditional supply chain optimization problems are to be selected and computational experiments are conducted. A key challenge is to develop a way of measuring the quality and efficiency of the sensitivity analysis as it is performed in an automated fashion, and comparing this to relevant benchmarks. The objective of the dissertation is to contribute significant knowledge, exceeding the anecdotal evidence provided by a single prototype. By better understanding the implications of employing generative AI in supply chain optimization, the work could offer academics and industry practitioners valuable insight into how they might improve decision-making processes, and achieve better outcomes in terms of cost, time, and resource efficiency.

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Topic: A Bayesian approach to inventory management in (fashion) retail

Retail inventory management is about placing the right quantity of inventory in the correct location. Where traditional retail can focus on replenishment and economic order quantity style models, this is not the case for fashion retailers. These retailers are faced with novel products every season, often without the ability to order additional inventory within seasons. Current strategies often rely on excessive inventory buffers, causing significant waste that has a high environmental impact. While the movement to steer away from fast fashion is growing, a field of tension is likely to remain as long as companies operate in free market conditions. Hence, improvements to company operations are one avenue that must be explored to increase environmental and economic efficiency of fashion companies. The objective of this dissertation is to investigate the application of Bayesian statistics in this context. Specifically the degree to which predictions can be improved by making use of causal models, relying on underlying cause-effect relationships that are assumed by product experts. Moreover, the additional effect of working with Bayesian updating once sales are observed is to be investigated. The dissertation works using a real or realistically generated dataset and compares the real-world forecasting performance of multiple models. Real-world performance implies that the degree to which decisions based on different models would be different and structurally better because of the use of such models.

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- Required skills: Bayesian approach, Inventory management, Retailing
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
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  - Software use: Programming is required
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Topic: Modelling size distributions in apparel retail

Estimating the precise quantity and distribution of sizes to procure and distribute as an apparel retailer is a complex task. An inaccurate estimation can result in an excess of certain sizes and a scarcity of others, leading to missed sales opportunities and reduced customer satisfaction. Excessive inventory, a common consequence of overestimation, results in unsold merchandise that frequently ends up in landfills or incinerators. This problem is exacerbated by traditional retailers adopting strategies that aim to maintain a comprehensive range of sizes across all stores. While this strategy reduces lost sales, it inherently leads to surplus inventory. The goal of this dissertation is to develop new methods to determine the sizes that will be purchased. This task needs to take into account not only better forecasting of true unconstrained demand but also the operational realities of a typical retailer. As part of this study, realistic data will be generated with the capability to vary select parameters such as the size of the store network, uncertainty of demand, and the composition of the product assortment. This approach will allow for the derivation of general rules about best practices for size management of apparel retailers. If desired, the methods can also be validated using real data.

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Topic: Quantitative approaches to reduce online return behaviour

The rise of online shopping has brought along with it the issue of high return rates, presenting a significant challenge for e-commerce businesses. Online return behaviour, often driven by factors such as the inability to try on items, misrepresentation of products, or discrepancies in size and fit, leads to increased operational costs for retailers who have to process and restock the returned items. Furthermore, returns negatively impact the environment, as the process of handling and transporting goods back and forth significantly increases the carbon footprint. This return culture is particularly prevalent in the fashion industry, where the return rates are higher than in other sectors. Consequently, understanding and managing online return behaviour has become crucial for retailers aiming to improve their profitability, customer satisfaction, and sustainability. This dissertation adopts a quantitative approach to product returns. The aim is to explore methods for predicting returns based on product, customer, and order information. Furthermore, the objective is to investigate to what extent practical actions can be linked to these findings, resulting in real-world reductions in return behaviour.

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