The digital world is offering an amazing range of possibilities for everyone, especially for people with disabilities. Come and join us as a **Master 2 intern** to leverage science and technology to offer life-changing solutions for people with visual impairment.

Optimizing newspaper layout with design-preserving magnification: Study of a new combinatorial/geometric packing problem

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MOTIVATION: From the numerous daily activities affected by low vision, reading is most strongly impacted due to partial visual field loss, lower acuity, and the standard formatting of documents. In particular, **newspapers pose a unique challenge**. Yet news reading has become an essential activity in modern society as a form of social connection, entertainment, and learning. As a consequence, there is a strong call for accessible news reading technologies.

STATE-OF-THE-ART: The emergence of the digital form of information has brought new opportunities in terms of customisations for people with low vision (Legge, 2016). Two solutions are now available. The first solution is to read the **electronic version of the print edition** on digital devices such as e-readers or iPads. The main advantages are to be close to the original reading experience (e.g., familiarity in design, clear overview of the content, news valuation) and to offer use intuitive touch screen gestures for zooming and reading (e.g., pinch-to-zoom). One major drawback is related to the navigation at both global (e.g., between articles, sections, columns, media content) and local (e.g., line to line) levels. The second solution is to read the **online edition** on a variety of screen sizes thanks to responsive design. It has several advantages related to technical features (e.g., hyperlinks, the possibility of searching, tuning parameters of the reading display) and to the content itself (e.g., continuous updates). One major drawback is the lack of design: Websites mostly present news in a linear fashion, thus missing the editorial organization found in printed newspapers.

What is currently missing is a solution that **transposes the design from the printed edition and the functionality from the online edition** to make a synthesis based on usability, which would greatly benefit all readers and particularly low vision ones.

INTERNSHIP OBJECTIVES: We foresee an original approach that we call design-preserving magnification, to solve the local/global navigation problem. In a nutshell, our idea consists in keeping the global view always self-consistent, even with magnified content.

Interestingly, our formulation raises **a new kind of packing problem**, which is the bottleneck of the approach and focus of this internship. **Packing problems** are a class of **optimization** problems in mathematics that involve attempting to pack objects together into one or several containers respecting some constraints, and optimizing some functions (Lodi, A., et al., 2002). One of the famous packing problems is the Tetris problem. It can be described as follows: Given a domain and a set of elements of fixed shapes that one can rotate, the problem consists in deciding if it is possible to place every element to fill in the domain without overlap.

In this internship, the goal is to study an extension of the Tetris problem where **each element could have different shapes**. This new problem seems hard to solve (NP-complete and even hard to approximate), and we need to design efficient algorithms (the number of variables is at least 10^5). The study of the complexity (e.g., NP-hardness, APX-hardness) of the problem and variants is the first step of the internship. In (the very likely) case the problem is NP-hard, this internship aims to **develop and analyze efficient algorithms for this new packing problem**, such as dynamic programming algorithms, linear programming, branch-and-bound algorithms, efficient exact algorithms, and algorithms for some classes of instances. See the reference book (Vazirani, V. V., 2001) for an overview of the main algorithm techniques (e.g., Chapter 9 dedicated to Bin Packing problem). Then, an essential contribution will be to **implement algorithms** and to test them in synthetic but also real cases.

SKILLS YOU WILL LEARN: algorithmics and complexity, theoretical computer science in general, and notions of computational design

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- Legge, G. E. (2016). Reading Digital with Low Vision, Visible Lang. 2016 Aug; 50(2): 102–125.
- Lodi, A., et al. (2002). Two-dimensional packing problems: A survey. European Journal of Operational Research, 141(2):241 – 252, 2002
- Vazirani, V. V. (2001). Approximation algorithms. Springer.

SUPERVISORS: One significant originality of this project is to combine expertise in graph theory and optimization from in the **ABS team (https://team.inria.fr/abs)** and in low vision from the **BIOVISION team (https://team.inria.fr/biovision)**. It will be co-supervised by two experts in these fields: **Dorian Mazauric** and **Pierre Kornprobst**

CONDITIONS:

- Duration: 6 months
- Where: Inria Sophia Antipolis - Méditerranée, France (https://www.inria.fr/en/centre/sophia).
- Salary: ≈ 550 euros per month.
- Housing: Inria has agreements with student residences and is proposing rooms at 90 euros/ month for 6 months (after confirmation of the request by Inria).
- Check out our website to learn more about working environment and conditions.

CURRICULUM OF THE CANDIDATE: Applicants should have a strong algorithmic background and C++ skills, a keen interest in design, low vision or both, and a relevant Master, for example in computer science or applied mathematics.

FOLLOW-UP: Funding opportunities to continue for a Ph.D.

TO APPLY: https://team.inria.fr/biovision/internship-applications