

# Web Portal for Matching Loan Requests and Investment Offers in Peer-To-Peer Lending

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## ABSTRACT

*Online Peer-To-Peer lending has seen some growing media attention since its recent creation. Nonetheless, the systems which provide deal brokerage in this context have yet to be given significant consideration within the scientific community. This paper is part of a broader effort to setup a Peer-to-Peer lending community in Portugal. This work focuses on solving the infrastructural problem of combining investment offers from potential lenders with loan requests from potential borrowers. The combination process must strive for an optimal result, which pleases lenders and borrowers alike, despite their opposing agendas. Simultaneously the combination result should also benefit the platform's business model, so as to keep it sustainable and profitable. Several optimization metaheuristics, powered by a constraint programming module, were applied to efficiently explore the problem's solution space and to find optimal solutions. The results achieved with this approach show how metaheuristic-driven optimization can be successfully applied to Peer-to-Peer lending combination problems.*

*Keywords:* Auction, Interest, Lending, Metaheuristics, Optimization, Peer-to-Peer, Rate

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## 1. INTRODUCTION

Arguably one of the most powerful concepts to emerge from the Internet was that of the social web: a network made not only of machines, but also of people who could now relate directly, no matter how geographically apart. This new interaction paradigm not only challenged existing business models, but also motivated

completely new ones. Some of the business models that were most impacted were those that involved intermediation. This was the case with the various forms of recruitment portals (where employees and employers could meet directly), auction portals (where buyers and sellers could come together), and, more recently, business social networks (where business partners could connect) (Cunha, Varajão, Gonçalves, Alva-

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renga, Martins, & Martins, 2012). The next step would be direct person-to-person lending or peer-to-peer lending, starting with Zopa in the United Kingdom in February 2005 (The Register, 2005).

This work builds on efforts made from early 2007 to the present day to create an online Social or Peer-To-Peer (P2P) Lending platform, operating in Portugal (Martinho & Reis, 2010). P2P lending can be defined as lending and borrowing, directly between individuals ("peers") without the participation of a traditional financial institution.

The success of the project was seen as greatly dependent on the individual satisfaction of both lenders and borrowers, despite their opposing agendas. It was thus required to create a mechanism that could combine loan requests and investment offers in a fashion which pleased the greatest amount of participants, while protecting the interest of the platform operator. It was this key problem that motivated this paper.

The main objective of this work was then to build a system capable of successfully finding optimal combinations of loan requests - defined by the amount requested and the maximum rate at which the potential borrower is willing to repay the money - and investment offers - defined by the amount offered by the lender and the minimum interest rate at which the potential lender is willing to receive its money back. Simultaneously, the system should attempt to maximize the amount of money traded, due to the volume based business model of the project.

The rest of this paper is organized as follows. The next section formulates the combination problem extensively, to explain the relevant inputs for the combination system. Section *Optimization Metaheuristics* provides a short overview of well-known optimization metaheuristics, which were found relevant for the work at hand. Section *Metaheuristics Based Optimization* details the system design, used to create the metaheuristic optimization framework and to apply it to the loan matching problem. Section *Experimental Results* presents the results achieved using the developed system.

Finally section *Discussion and Conclusions* discusses the obtained results and highlights future research paths for this work.

## 2. COMBINATION PROBLEM FORMULATION

The problem of combining loan requests and investment offers, can be considered as an optimization problem, taking the decision variables as the rates at which loans are matched, together with the amounts involved. The constraints would be set by the conditions specified by the members, when placing their terms for intended rates and amounts. The objective function would take into account the stated goals of the platform: to maximize the satisfaction of both borrowers and lenders, while contributing for the platform's profitability.

### 2.1. Formal Problem Definition

More formally the problem  $P = (S, f)$  can be defined as a generic optimization problem by specifying the set of parameters:

- $N$  is the number of lenders participating;
- $M$  is the number of borrowers participating;
- $R_{\min_i}$  is the minimum rate at which lender  $i$  is willing to lend its money;
- $R_{\max_j}$  is the maximum rate at which borrower  $j$  is willing to borrow money;
- $A_{\max_i}, A_{\min_i}$  are the maximum and minimum amounts of money, lender  $i$  is willing to lend;
- $A_{\max_j}, A_{\min_j}$  are the maximum and minimum amounts of money, borrower  $j$  wants to borrow.

The set of the decision variables

$$X = \{r_{11}, a_{11}, r_{12}, a_{12}, \dots, r_{ij}, a_{ij}, \dots, r_{NM}, a_{NM}\},$$

where:

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