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Bond Market Simulation

Overbond

Simulation Abstract

From June 17th to June 19th, 2016, Overbond performed a bond market simulation that empirically demonstrated differences in market connectivity utilizing traditional communication channels and fintech enhancements. The Overbond team held a hackathon for 200 of the most talented software engineers from the University of Toronto and the University of Waterloo, two of the top engineering and computer science academic institutions in North America.

Background

The fixed income market functioning is over-the-counter. The fixed income market is highly opaque, driven by disparate, manual communication channels that carry high costs for all stakeholders. Current information infrastructure and its inefficiencies can be simulated by applying the maximum clique problem – a network problem applied in this project. The simulation results demonstrate significant cost reduction and increased network connectivity by implementing a more versatile infrastructure through fintech providers, such as Overbond.

The Problem

In graph theory, the maximum clique problem is a practical network problem that applies to a number of real world settings. The problem was selected as the most relevant computer science theoretical model representing the real-world bond market. The simulation was set up to mimic three real-world scenarios:

World 1 – a world where the Overbond platform does not exist. This world requires bond market participants to communicate through disparate, manual communication channels (phone, email).

World 2A – a world where 50% of bond market participants have established direct communication channels with one another through Overbond, in addition to traditional communication channels.

World 2B – a world where 80% of bond market participants have established direct communication channels with one another through Overbond, in addition to traditional communication channels.

Bond Market in Canada

There are three types of stakeholders in the bond market: issuers, dealers, and investors.

Communication Channels

In the real bond market, traditional communication channels (phone, email) are more expensive per transaction than digital fintech alternatives. With the goal of gauging the market accurately, issuers and investors need to repeatedly utilize traditional communication channels through multiple dealers, resulting in duplication of efforts.

As a result, issuers, dealers, and investors incur higher costs and lower efficiency by only utilizing traditional communication channels.

Today's Marketplace

Every year, $9.4T worth of bonds are exchanged in the Canadian fixed income market. Efficient communication channels are essential for exchanging accurate, up-to-date market information. Given the large number of institutional investors and corporate issuers in the marketplace, attaining efficient connectivity is increasingly important.

Overbond is a cloud-based platform that standardizes and streamlines communication between issuers, dealers, and investors. Not only does this permit all bond market participants to establish direct communication channels with ease, it also greatly reduces the cost of communication through removing friction and duplication.

Stakeholders	Number of Stakeholders	Communication Channels	Total Secondary Market Transaction Value
Issuers	628	Phone, Email	$9.4 Trillion
Dealers	10	Phone, Email	
Investors	754	Phone, Email	

In 2015, the Canadian bond market saw $9.4T in secondary market transactions.

The Problem – Connectivity Search

Establishing communication channels between stakeholders.

Network of Stakeholders

A network used for this simulation is constructed from a population of "nodes" representing real bond market stakeholders (issuers, dealers, and investors). These nodes are connected through "edges", real bond market communication instances utilizing one of the three communication channels (phone, email, and Overbond). A fully integrated network, a "clique", is formed when all nodes within the clique are connected to all other entities in that network. For example, in order to form a clique with five nodes, 120 unique edges are needed. This means 5 real bond market participants have communicated 120 times. This represents the real world, where two stakeholders do not exclusively use any one particular communication channel.

The objective of the simulation was to find the maximum clique in each world with the most efficient method – fewest search sequences and shortest runtime through optimization of data structures and search algorithms. Like most optimization problems, the answer can be derived from a brute force method, although the runtime will be astronomically high. The software engineers were challenged to find a solution that is both functionally correct and fast in execution.

Finding the Largest Clique

The software engineers were provided with a dataset for each world. The datasets included the number of nodes in the world, all edges in the world, and the type of communication channel (phone, email, and Overbond). The dataset comprised of 2,000 nodes and over 200,000 edges. It would take an average modern computer processor over 100,000 years of computing time to execute a rudimentary, unsophisticated algorithm for this problem. The total number of nodes in the simulation represented the total number of stakeholders in the real Canadian bond market and the proportions between the stakeholder groups were appropriately scaled.

The Solution – Winning Algorithms

Given the complexity of the problem and the sheer volume of the dataset simulated, the top 5 algorithms were based on widely different computer science disciplines.

Team	Discipline	Algorithm	Computation Time
UW1	Software Engineering	Brute-force method with sophisticated optimization strategies	1.986s
UofT1	Computer Science	Heuristic method to compare relative clique size	2.020s
UofT2	Computer Science	Heuristic method that employs set theory	3.407s
UW2	Mathematics	Graph theory solution	9.215s
UofT3	Software Engineering	Implementation of multiple languages to maximize efficiency	24.754s

Different Approaches

The mathematical approach implemented an elegant graph theory solution with minimal computational complexity.

The software engineering approach proposed a simple, concise solution that employed a number of optimization strategies to achieved the most efficient runtime.

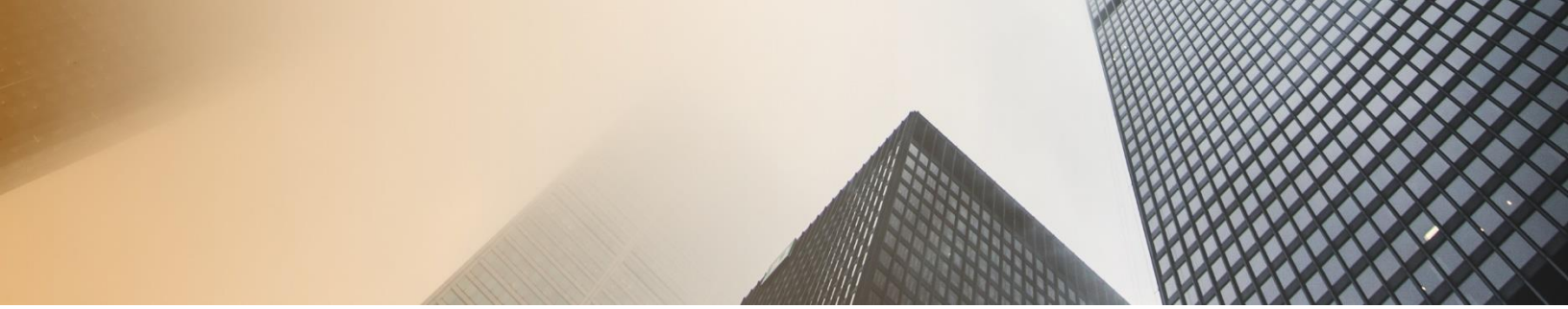
The computer science approach tried a combination of multiple different programming languages in an effort to optimize runtime.

Employing Sophisticated Technology

Solutions were executed using the Amazon Elastic Compute Cloud (Amazon EC2) – a cloud-based virtual server. The EC2 server achieved clock speed of 3.3GHz on its 8 virtual cores.

Winner

The fastest time employed a combination of speed and elegance to solve the 2,000-node, 200,000-edge problem in just 1.986s.



The Result – Optimal Connectivity

The bond market will benefit from a standardized platform that will streamline communication channels.

Simulation World	Types of Channels	Types of Stakeholders	Cost per Channel	% is Overbond	Total Cost	# of Connections	Cost per Connection
World 1	Phone, Email	Issuer	Phone = $1	0%	$18	10	$1.80
World 2A	Phone, Email, Overbond	Dealer	Email = $0.8	50%	$1,058,554	1,139,295	$0.93
World 2B	Phone, Email, Overbond	Investor	Overbond = $0.5	80%	$596,832	1,139,295	$0.52

Comparing Worlds

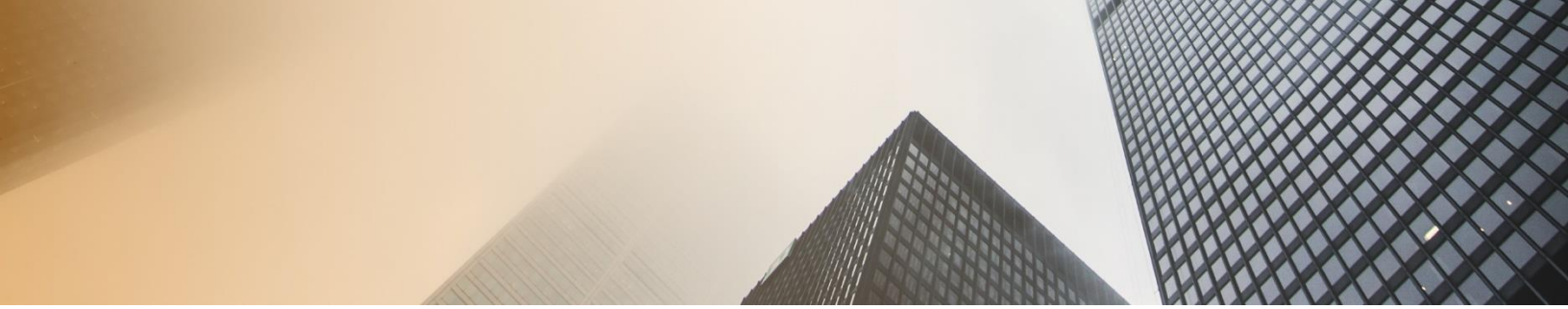
Through a cost base calculation that is applied to each world, it is clear that world 2B – the most connected through Overbond – is the most cost efficient.

Whereas it costed $1.80 on average for a communication channel between two stakeholders in World 1, the cost is significantly reduced with more Overbond utilization in World 2B – $0.93 on average per communication channel. It is even less costly at $0.52 per communication channel in the highly utilized 2A Overbond world.

Without the Overbond infrastructure in place, the bond market has high overhead costs from traditional communication channels. With a high adoption of Overbond, that cost is decreased by over 70%.

Conclusion

In a marketplace where we are witnessing rapidly improving technology capabilities, the improved market connectivity results in improved efficiency and cost.



About Overbond

Overbond brings all bond market participants together. It is a platform that makes primary bond issuance digital, transparent and secure. Overbond connects corporate and government issuers with dealers and investors directly.

