Trust is Risk: Generalized Max Flow for Strategies between Idle and Conservative

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Abstract. Previous versions of Trust is Risk present the Conservative and the Idle strategy as distinct and unrelated. This work is an attempt to generalize this idea into a continuous spectrum of strategies, the two ends of which correspond to the two previously defined strategies. Prior to querying the system for an indirect trust towards Bob, Alice can attribute a specific expected strategy to each one of the participating players, or even fine-tune the response of each player to a steal action from each one of the players she directly trusts. The system then executes the generalized MaxFlow [1] to determine the indirect trust from Alice to Bob, given the specified strategies of the rest of the players.

1 Introduction

In our previous work, we presented three distinct strategies for the players: the Idle, the Conservative and the Evil strategy. The process of determining the indirect trust from Alice to Bob involved assigning the Idle strategy to Alice, the Evil strategy to Bob and the Conservative strategy to all other players. The indirect trust from Alice to Bob would then be the worst case scenario for Alice when Bob initiates a "chain reaction" of steal actions. This value was proven to be equal to the maximum flow from Alice to Bob. Consider however the two following cases:

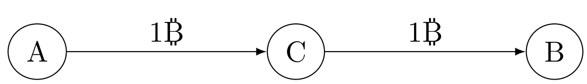

Fig. 1: $\mathcal{G}_1$, Few hops

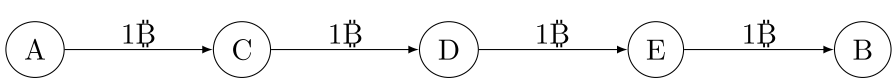

Fig. 2: $\mathcal{G}_2$, Many hops

One could argue that intuitively it should be $Tr_{\mathcal{G}_1, A \rightarrow B} > Tr_{\mathcal{G}_2, A \rightarrow B}$, since the longer chain of players connecting A and B in $\mathcal{G}_2$ introduces more uncertainty as to whether B is trustworthy. Nevertheless, according to our prior approach, it is $Tr_{\mathcal{G}_1, A \rightarrow B} = Tr_{\mathcal{G}_2, A \rightarrow B}$ since $maxFlow_{\mathcal{G}_1}(A, B) = maxFlow_{\mathcal{G}_2}(A, B)$.

To mitigate this problem, we introduce a generalization of the previous approach that can take care of this observation. The mechanism that we propose is analogous to an attenuation factor that accounts for the number of hops, but is better suited for the ambience of maximum flow. Each edge (v, w) of the graph is enhanced with an additional number called *loss factor*, which intuitively represents the "leakage" ratio on this edge, or the percentage of the damage incurred by w that is carried over to v through this edge, in case w is stolen some funds.

2 Strategy Generalization

More specifically, apart from the capacity c_e, each edge e is assigned a gain factor $\gamma_e \in [0, 1]$. [Definition of new conservative strategy] The MaxFlow algorithm is substituted with the generalized MaxFlow algorithm [proof needed]. For the sake of example, consider the following two graphs:

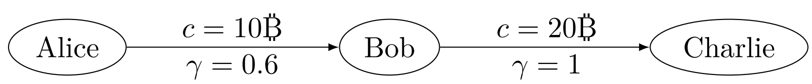

Fig. 3: $Tr_{Alice \rightarrow Charlie} = 6$₿

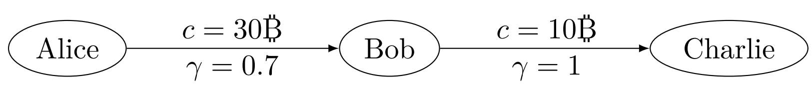

Fig. 4: $Tr_{Alice \rightarrow Charlie} = 7$₿

A gain factor of 0 means that v will tolerate any amount of stolen funds by w without trying to replenish them by stealing others that directly trust her, whereas a gain factor of 1 means that v will try to replenish any amount of stolen funds by w. If the gain factor is 0 on edges (v, w) for all $w \in \mathcal{V}$, then v is following the Idle strategy, whereas if the gain factor is 1 on edges (v, w) for all $w \in \mathcal{V}$, then v is following the Conservative strategy. The incoming direct trusts to the Evil player should all have a gain factor equal to 1, since we consider that she steals all her incoming direct trust.

References

1. Wayne K. D., Tardos E.: Generalized Maximum Flow Algorithms. Ph.D. thesis: Cornell University (1999)