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1 INTRODUCTION

The problem is to check the emptyness of the intersection of the regular language R mhich is represented as FSA A with number of states n, and context-free language L in less then $O(n^3)$. The equvalent problem is a context-free reachability problem [1].

First step is a reduction of the given problem to BMM(n) (with possibly polylogarithmic factors). We hope that such reduction helps us to get algorithm for CFL reachability with $\widetilde{O}(BMM(n))$ time complexity where $\widetilde{O}$ meens polylog factors.

2 ALGEBRAIC VIEW

Steps for reduction of our problem to purely algebraic problem.

(1) Utilize Rytter's [3] ideas to construct a grid graph $\mathcal{G}$. All are similar to the linear input parsing, with some detales.
  (a) We use states numbers instead of positions.
  (b) To do it we should guarantee that state numbers are in $[0..n-1]$.
  (c) As a result, grid graph can has cycles.
  (d) Edges congruation property still holds.

(2) We can see, that $\mathcal{G}$ is a Cartezian product of two graphs: $\mathcal{G}_H$ (a horisontal row of $\mathcal{G}$) and $\mathcal{G}_V$ (a vertical row of $\mathcal{G}$) with respective adjacency matrices. Adjacency matrix of $\mathcal{G}$ is $M(\mathcal{G}) = M(\mathcal{G}_V) \otimes I + I \otimes M(\mathcal{G}_H)$ where I is identity matrix of size $n \times n$ and $\otimes$ is a Kronecker product.

(3) Instead of SSSP in the Rytter's algorithm we should compue APSP as a atomic step. We should to do it beacause there is now start position in the graph (FSA). Then we should proof that the number of such steps is $O(\log n)$. Thus we want to compute $\mathrm{vec}(X) * M(\mathcal{G})^k = \mathrm{vec}(X) * [M(\mathcal{G}_V) \otimes I + I \otimes M(\mathcal{G}_H)]^k$. Where X is a matrix of already proved facts, and $M(\mathcal{G})^k$ is a transitive closure of the adjacency matrix of the $\mathcal{G}$. Is it possible to do it in $\widetilde{O}(BMM(n))$?

(4) Note that instead of $(B^T \otimes A) * \mathrm{vec}(X) = \mathrm{vec}(C)$ we can solve $A * X * B = C$ (one of fundamental properties of equitations with Kronecker product [4]). The idea is to use this property. In our case it helps to reduce multiplication of $n^2 \times n^2$ matrices to multiplication of $n \times n$ matrices. **But** multiplication in our semiring is noncommutative. Namely, weights are from noncommutative idempotatnt semiring. So we need to investigate properties of Kronecker product over such semiring. Related research by Thomas Reps: "Newtonian Program Analysis via Tensor Product" [2]

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