

# Generalized LL Parsing Generalization

Semyon Grigorev, Artem Gorokhov

Saint Petersburg State University, Programming Languages and Tools Lab

semen.grigorev@jetbrains.com, gorohov.art@gmail.com



## Abstract

Sed fringilla tempus hendrerit. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Etiam ut elit sit amet metus lobortis consequat sit amet in libero. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Phasellus vel sem magna. Nunc at convallis urna. isus ante. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing. Quisque vestibulum eros eu. Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi. Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin. Proin sollicitudin. Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh.

## Introduction

Nowadays input data for parsing algorithms are not limited to be linear strings, and context-free grammars are used not only for programming languages specification. One of classical examples is a context-free path querying for graph data bases where input is a graph and path constraints are specified by a grammar. There are also other generalizations of parsing, such as multiple input GLL parsing presented at Parsing@SLE-2016 by Elizabeth Scott and Adrian Johnstone, Abstract LR parsing [?] and other techniques for parsing of dynamically generated strings.

We have some experience in the areas mentioned above [?, ?]. GLL-based context-free path querying algorithm [?] implemented by the authors is faster than solution which was presented at ISWC-2016 [?]. We have some ideas of graph parsing applications. For example, context-free pattern search in metagenomical assemblies, which can be applied not only to regular input, but to context-free compressed input which is relevant for metagenomic assembly processing. All existing applications seem to be special cases of the Bar-Hillel [?] theorem for context-free and regular language intersection, and can be generalized, but today many of them are developed as stand alone solutions. Thus, the goal of our work is to create an abstract framework for parsing based on generalization of GLL parsing algorithm [?] proposed by Elizabeth Scott and Adrian Johnstone. We also want to investigate practical areas of application and to create solutions based on our framework to demonstrate its practical value.

### Objectives

- Donec fringilla, velit id lobortis commodo, eros dui consectetur mi, ut interdum lorem dui sed mauris.
- Nulla ac nulla rhoncus est bibendum ullamcorper:
- Quisque vestibulum, nisl sit amet gravida ultricies dis parturient montes, nascetur ridiculus musobortis commodo, eros dui consectetur mi.

## Materials and Methods

Fusce magna risus, molestie ut porttitor in, consectetur sed mi. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Pellentesque consectetur blandit pellentesque. Sed odio justo, viverra nec porttitor vel, lacinia a nunc. Suspendisse pulvinar euismod arcu, sit amet accumsan enim fermentum quis. In id mauris ut dui feugiat egestas. Vestibulum ac turpis lacinia nisl commodo sagittis eget sit amet sapien.

## Mathematical Section

Nulla vel nisl sed mauris auctor mollis non sed.

$$E = mc^2 \tag{1}$$

Curabitur mi sem, pulvinar quis aliquam rutrum. (1) edf (2) ,  $\Omega = [-1, 1]^3$ , maecenas leo est, ornare at.  $z = -1$  edf  $z = 1$  sed interdum felis dapibus sem.  $x$  set  $y$  ytruem. Turpis  $j$  amet accumsan enim  $y$ -lacinia; ref  $k$ -viverra nec porttitor  $x$ -lacinia.

Vestibulum ac diam a odio tempus congue. Vivamus id enim nisi:

$$\begin{aligned} \cos \bar{\phi}_k Q_{j,k+1,t} + Q_{j,k+1,x} + \frac{\sin^2 \bar{\phi}_k}{T \cos \bar{\phi}_k} Q_{j,k+1} = \\ - \cos \phi_k Q_{j,k,t} + Q_{j,k,x} - \frac{\sin^2 \phi_k}{T \cos \phi_k} Q_{j,k} \end{aligned} \tag{2}$$

and

$$\begin{aligned} \cos \bar{\phi}_j Q_{j+1,k,t} + Q_{j+1,k,y} + \frac{\sin^2 \bar{\phi}_j}{T \cos \bar{\phi}_j} Q_{j+1,k} = \\ - \cos \phi_j Q_{j,k,t} + Q_{j,k,y} - \frac{\sin^2 \phi_j}{T \cos \phi_j} Q_{j,k}. \end{aligned} \tag{3}$$

Nulla sed arcu arcu. Duis et ante gravida orci venenatis tincidunt. Fusce vitae lacinia metus. Pellentesque habitant morbi.  $A \underline{\xi} = \underline{\beta}$  Vim  $\underline{\xi}$  enum nidi  $3(P+2)^2$  lacinia. Id feugain A nun quis; magno.

## Results

Donec faucibus purus at tortor egestas eu fermentum dolor facilisis. Maecenas tempor dui eu neque fringilla rutrum. Mauris *lobortis* nisl accumsan. Aenean vitae risus ante.

Ontology	#triples	Query 1		Query 2	
		time(ms)	#results	time(ms)	#results
skos	252	10	810	1	1
generations	273	19	2164	1	0
travel	277	24	2499	1	63
univ-bench	293	25	2540	11	81
foaf	631	39	4118	2	10
people-pets	640	89	9472	3	37
funding	1086	212	17634	23	1158
atom-primitive	425	255	15454	66	122
biomedical-measure-primitive	459	261	15156	45	2871
pizza	1980	697	56195	29	1262
wine	1839	819	66572	8	133

Table 1: Evaluation results for Query 1 and Query 2

Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi. Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin. Proin sollicitudin. Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh.

Nulla ut porttitor enim. Suspendisse venenatis dui eget eros gravida tempor. Mauris feugiat elit et augue placerat ultrices. Morbi accumsan enim nec tortor consectetur non commodo. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing. Quisque vestibulum eros eu. Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi. Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin.

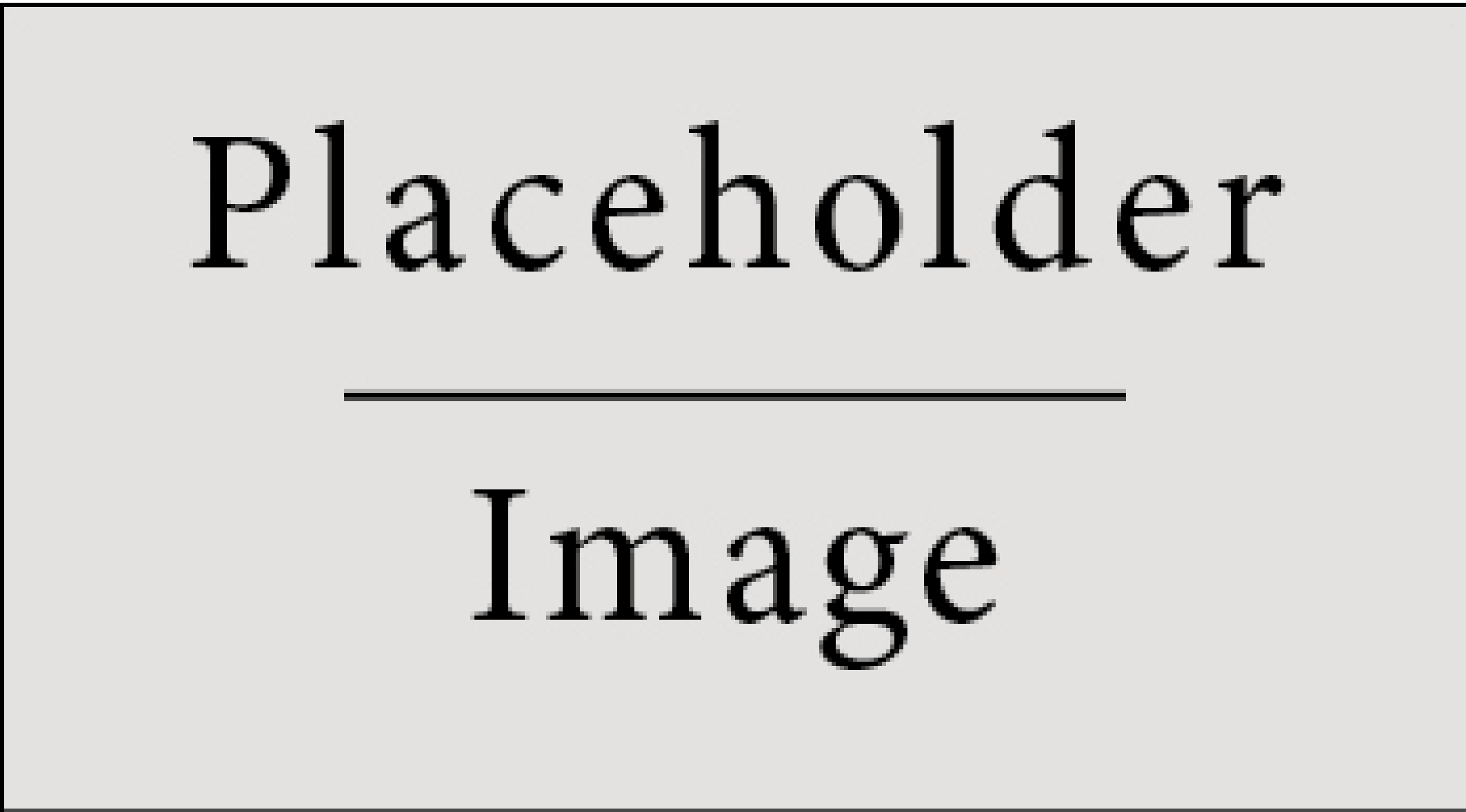


Figure 1: Figure caption

In hac habitasse platea dictumst. Etiam placerat, risus ac. Adipiscing lectus in magna blandit:

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 2: Table caption

Vivamus sed nibh ac metus tristique tristique a vitae ante. Sed lobortis mi ut arcu fringilla et adipiscing ligula rutrum. Aenean turpis velit, placerat eget tincidunt nec, ornare in nisl. In placerat.

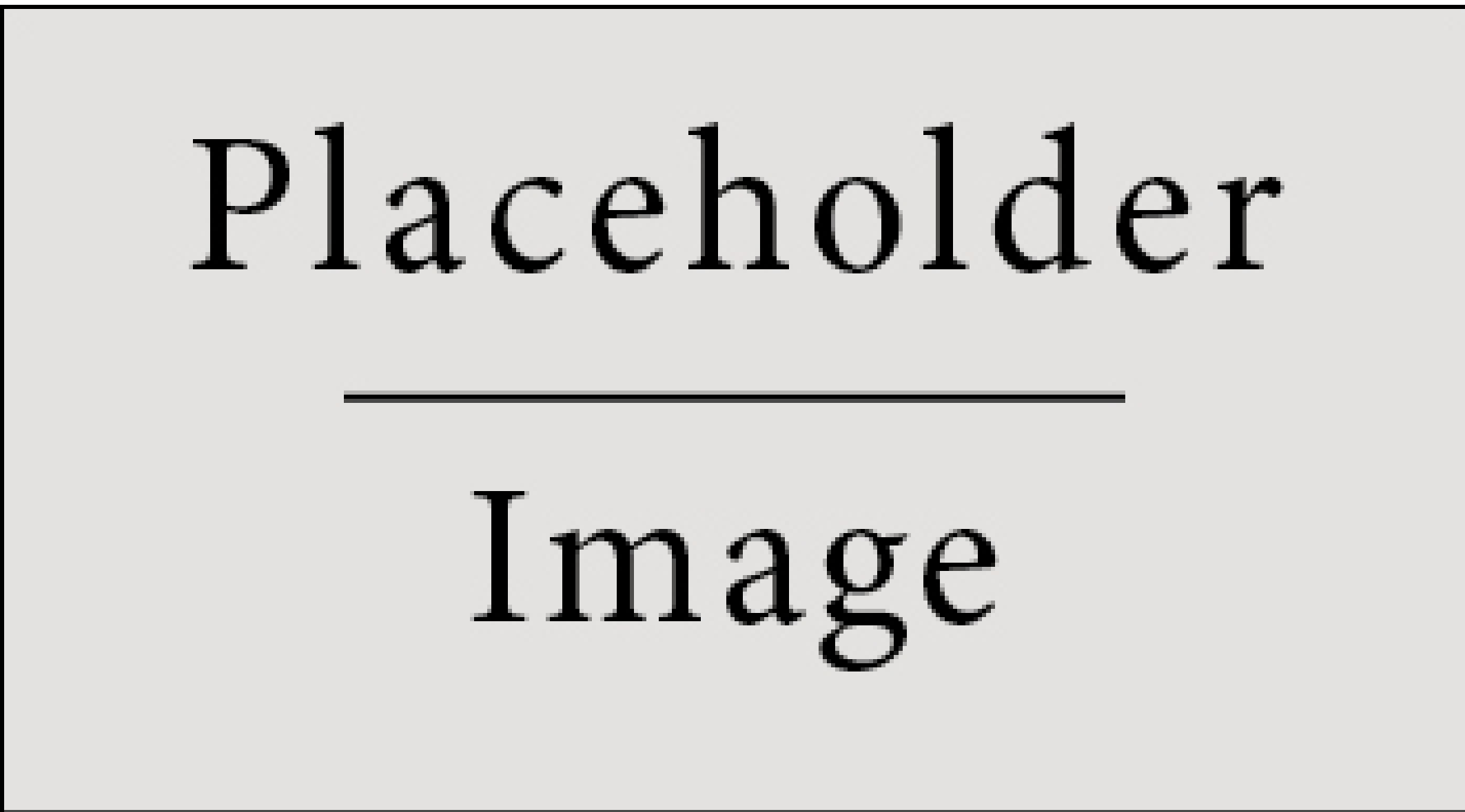


Figure 2: Figure caption

## Conclusions

- Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh. Phasellus fermentum rutrum elementum. Nam quis justo lectus.
- Vestibulum sem ante, hendrerit a gravida ac, blandit quis magna.
- Donec sem metus, facilisis at condimentum eget, vehicula ut massa. Morbi consequat, diam sed convallis tincidunt, arcu nunc.
- Nunc at convallis urna. isus ante. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing.

## Forthcoming Research

Vivamus molestie, risus tempor vehicula mattis, libero arcu volutpat purus, sed blandit sem nibh eget turpis. Maecenas rutrum dui blandit lorem vulputate gravida. Praesent venenatis mi vel lorem tempor at varius diam sagittis. Nam eu leo id turpis interdum luctus a sed augue. Nam tellus.

## Acknowledgements

Etiam fermentum, arcu ut gravida fringilla, dolor arcu laoreet justo, ut imperdiet urna arcu a arcu. Donec nec ante a dui tempus consectetur. Cras nisi turpis, dapibus sit amet mattis sed, laoreet.