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APART 2: A generalized MATHEMATICA `Apart` function

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ABSTRACT

The MATHEMATICA function `Apart` has been generalized to any dimension in APART package [1], we upgrade this package to the 2nd version, in which the core part has been completely rewritten. The new version is more efficient than the 1st version of APART, and the output is now more compact and more suitable for the input for the FIRE [2] or FIESTA [3].

New version program summary

Program title: APart 2.0

Catalogue identifier: AEMK_v2_0

Program summary URL: http://cpc.cs.qub.ac.uk/summaries/AEMK_v_0.html

Program obtainable from: CPC Program Library, Queen's University, Belfast, N. Ireland

Licensing provisions: Standard CPC licence, http://cpc.cs.qub.ac.uk/licence/licence.html

No. of lines in distributed program, including test data, etc.: 96744

No. of bytes in distributed program, including test data, etc.: 884975

Distribution format: tar.gz

Programming language: Mathematica.

Computer: Any computer with Mathematica installed.

Operating system: Any capable of running Mathematica.

Classification: 11.1.

Catalogue identifier of previous version: AEMK_v1_0

Journal reference of previous version: Comput. Phys. Comm. 183(2012)2158

Does the new version supersede the previous version?: Yes

Nature of problem: As discussed in [1], the general procedure to compute a cross section for a physical process in perturbative quantum field theory involves generating the corresponding amplitude via Feynman diagram and performing the loop integrals in dimensional regularization [7]. The essential part in the computation is to reduce these loop integrals to a small number of standard integrals, which are called master integrals (MI), via the systematic methods of integration by parts (IBP) identities [8, 9] and Lorentz invariance (LI) identities [10]. The basic reduction algorithm is introduced by Laporta [11], which defines an ordering for Feynman integrals, generates IBP identities and solves the corresponding linear equations. Alternative methods to exploit IBP and LI identities for reductions can be found in [12–17]. There are many public computer programs for implementations of different reduction algorithms: AIR [18], FIRE [19] and Reduze [20]. To facilitate the input for Fire [19], Reduze [20], etc. we need to decompose the linear independent propagators to independent ones, this procedure can be done by the APart package [1] which generalizes the Mathematica function APart from one dimension to any N dimensions.

Solution method: We have proven that all linear independent propagators can be decomposed into the summation of linear independent ones in [1], APart is such a Mathematica package that implements such a reduction method and generalizes the Mathematica Apart function from 1 to any N dimensions.

Reasons for new version: The Mathematica pattern matching in the last version may become very slow when the number of variables becomes large, this calls for a revised version with a more efficient

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reduction. The feature with all positive or negative sign of some variables is favored in combined usage of FIRE [2] and FIESTA [3].

Summary of revisions: We introduce an abstract and compact representation for the linear composition of the independent variables, this results in a more efficient and fast reduction during the APart partial fraction, we also introduce an extra feature to make the sign of some variables always positive or negative during the reduction.

Running time: A few seconds or less.

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