# Second Order Operators in the NASA Astrophysics Data System

Second Order Operators (SOOs) are database functions which form secondary queries based on attributes of the objects returned in an initial query; they can provide powerful methods to investigate complex, multipartite information graphs. The NASA Astrophysics Data System (ADS) has implemented four SOOs, *reviews*, *useful*, *trending*, and *similar* which use the citations, references, downloads, and abstract text.

All current ADS SOOs take a list of articles as input, normally as returned by a query, and return a list of articles as output. The four SOOs currently in the ADS are:

1. **Similar**. The *similar* operator takes the text of the abstracts of the papers in the 1st order list, combines them into a single 'document', then ranks all the abstracts in the ADS by their text based similarity to this combined document, and returns the ranked list.
2. **Useful**, The *useful* operator takes the reference lists from the papers in the 1st order list, combines them and returns this list, sorted by how frequently a referenced paper appears in the combined list.
3. **Reviews**. The *reviews* operator takes the lists of articles which cited the papers in the 1st order list, combines them, and returns this list sorted by how frequently a citing paper appears in the combined list.
4. **Trending**. The *trending* operator takes the lists of (anonymous) users who read the papers in the input list, finds the lists of papers which each of them read, combines these lists, and returns the combined list, sorted by frequency of appearance.

An extensive discussion of these capabilities has been published in the BAAS:
https://baas.aas.org/pub/2020i0207/release/1
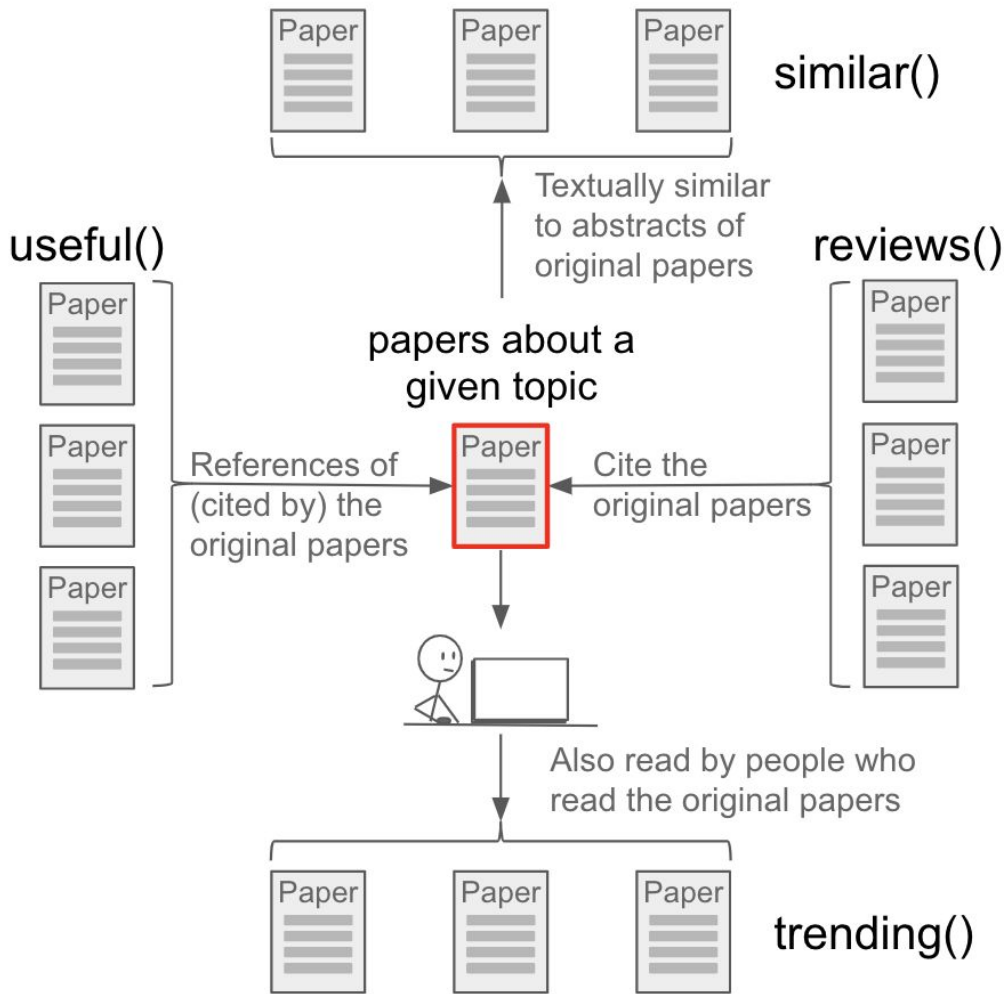
For example, the query *reviews(exoplanet atmospheres)* returns:

1 ☐	2018exha.book.....P	2018/08	cited: 21			
	The Exoplanet Handbook					
	Perryman, Michael					
2 ☐	2016SSRv..205..285M	2016/12	cited: 79			
	Exoplanetary Atmospheres—Chemistry, Formation Conditions, and Habitability					
	Madhusudhan, Nikku; Agúndez, Marcelino; Moses, Julianne I.; Hu, Yongyun					
3 ☐	2014prpl.conf..739M	2014	cited: 84			
	Exoplanetary Atmospheres					
	Madhusudhan, N.; Knutson, H.; Fortney, J. J.; Barman, T.					
4 ☐	2014PASA...31...43B	2014/11	cited: 21			
	The Dawes Review 3: The Atmospheres of Extrasolar Planets and Brown Dwarfs					
	Bailey, Jeremy					
5 ☐	2015PASP..127..941C	2015/10	cited: 65			
	Observations of Exoplanet Atmospheres					
	Crossfield, Ian J. M.					
6 ☐	2019ARA&A..57..617M	2019/08	cited: 32			
	Exoplanetary Atmospheres: Key Insights, Challenges, and Prospects					
	Madhusudhan, Nikku					