



ARQMath

Answer Retrieval for Questions on Math
<https://www.cs.rit.edu/~dprl/ARQMath>



#ARQMath

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— Goals —

Advance math-aware search
Advance semantic analysis of mathematical notation and text

— Collection —

Archived posts from **Math Stack Exchange** (community QA forum)
(~1 million questions; ~28 million LaTeX formulas)
Stored in linked XML files

Tools to parse data into question threads provided (python)
HTML for threads provided (for study, checking, and evaluation)

Separate Formula Indices (TSV files):
appearance encodings: *LaTeX*, *Presentation MathML*
semantic encoding: *Content MathML*

Task 1: Find Answers to Math Questions (98 Topics)

Given a posted question (in 2019) as a query:
 search **answer posts (2010-2018)**
 return **relevant answers**

Query

How can I evaluate $\sum_{n=0}^{\infty} (n+1)x^n$?

Asked 8 years, 5 months ago · Active 4 months ago · Viewed 34k times

▲ How can I evaluate

384

▼

★ I know the answer thanks to [Wolfram Alpha](#), but I'm more concerned with how I can derive that answer. It cites tests to prove that it is convergent, but my class has never learned these before so I feel that there must be a simpler method.

146

In general, how can I evaluate

$\sum_{n=0}^{\infty} (n+1)x^n$?

sequences-and-series convergence power-series faq

edited Sep 24 '17 at 12:09

Parcly Taxel
51.7k ● 13 80 ▲ 120

asked Apr 3 '11 at 21:41

Backus
2,072 ● 3 12 ▲ 8

Search Results

- 1 No need to use Taylor series, this can be derived in a similar way to the formula for geometric series. Let's find a general formula for the following sum:

$$S_m = \sum_{n=1}^m nr^n.$$
 ...
- 2 It is equivalent to $x(x+1)(x+5)(x+6) + 96 = 0$
 Now

$$(x^2 + 6x)(x^2 + 6x + 5) + 96 = 0$$
 ...
- 3 If you want a solution that doesn't require derivatives or integrals, notice that

$$1 + 2x + 3x^2 + 4x^3 + \dots = 1 + x + x^2 + x^3 + \dots$$

$$+ x + x^2 + x^3 + \dots$$

$$+ x^2 + x^3 + \dots$$
 ...

Task 2: Formula Search (in-context)

(87 Topics)

Given formula in a question post from Task 1 (2019):
search **formulas in question and answer posts (2010-2018)**
return **relevant formulas w. associated posts**

Query

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$\sum_{n=1}^{\infty} \frac{2n}{3^{n+1}}$

I know the answer thanks to [Wolfram Alpha](#), but I'm more concerned with how I can derive that answer. It cites tests to prove that it is convergent, but my class has never learned these before so I feel that there must be a simpler method.

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Search Results

1

$$\sum_{n=0}^{\infty} (n+1)x^n$$

2

$$\sum_{n=0}^{\infty} (n+1)x^n$$

3

$$\int_0^1 \frac{\ln(x+1)}{x^2+1} dx$$

Evaluation for Task 2: Formula Search (in-context)

Project: a / Batch: aa □ Auto-accept next Task Return Task Skip Task Expires in 23:56

Instructions: Select the **Relevance** of the highlighted formula within each post to the query formula (shown at bottom-left).

Thread	Post	Relevance
<p>Title: When does a function NOT have an antiderivative?</p> <p>Question:</p> <p>I know this question may sound naïve but why can't we write $\int e^{x^2} dx$ as $\int e^{2x} dx$? The former does not have an antiderivative while the latter has.</p> <p>In light of this question what are sufficient conditions for a function NOT to have an antiderivative. That is do we need careful examination of a function to say it does not have an antiderivative or</p>	<p>Thread</p> <p>If there are no constraints on F then nothing can be done. F or example if $F(x)=x^2$ then the integral becomes the famously non-elementary $\int e^{x^2} dx$</p>	<p>High</p> <p>Medium System failure</p> <p>Low Do not know</p> <p>Not Relevant</p> <p>Annotator comment</p>
	<p>Thread</p> <p>I don't know where to find the proof but if you restrict your domain to \mathbb{R} then the following equation is known to have <i>no solution in terms of elementary functions</i>. $\int e^{x^2} dx$ In addition the elliptic integrals (arc-length of an ellipse) do not necessary have solutions <i>in terms of elementary functions</i>. For instance: $L = \int \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$ Take the equation of an ellipse: $ax^2 + by^2 = c^2$</p>	<p>High</p> <p>Medium System failure</p> <p>Low Do not know</p> <p>Not Relevant</p>

Multi-level
relevance

Evaluation tools
built with Turtle:
<https://github.com/hltcoe/turtle>

Per topic: Unique formulas pooled by appearance; posts sampled from threads
Formulas in sampled posts evaluated separately (i.e., **in-context**)
Runs for both tasks ranked via nDCG' (nDCG using only evaluated hits)

Sakai, T. & Kando, N. (2008). On information retrieval metrics designed for evaluation with incomplete relevance assessments. *Information Retrieval*.

— Baseline Systems —

Our baseline systems are open-source
Each will be configured to index the ARQMath collection

Task 1: Approach0 (Zhong et al., <https://approach0.xyz/search>)
Ad-hoc math-aware search engine (text + math)
formulas: semantic encoding

Task 2: Tangent-s (Davila et al., <https://www.cs.rit.edu/~dprl/software.html>)
Formula search engine (math only)
formulas: appearance + semantic encodings

Wei Zhong, Hui Fang: OPMES: A Similarity Search Engine for Mathematical Content. ECIR 2016: 849-852

Kenny Davila, Richard Zanibbi: Layout and Semantics: Combining Representations for Mathematical Formula Search. SIGIR 2017: 1165-1168



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Please join us!

Send Email to: rxzvcs@rit.edu

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