Answer Retrieval for Questions on Math

https://www.cs.rit.edu/~dprl/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 \( \sum_{n=0}^{\infty} (n + 1)x^n \)?

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.

In general, how can I evaluate

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

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:

\[ S = \sum_{n=1}^{\infty} ax^n. \]

Notice that

\[ -S = \sum_{n=1}^{\infty} nax^n = \sum_{n=1}^{\infty} (n-1)ax^n. \]

2. It is equivalent to \( x(x+1)(x+5)+96 = 0 \)

   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

\[
1 + 2x + 3x^2 + 4x^3 + \cdots = 1 + x + x^2 + x^3 + \cdots + x^2 + x^3 + \cdots + x^4 + \cdots
\]
**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**

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

**Search Results**

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

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

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

- [sequences-and-series](#)
- [convergence](#)
- [power-series](#)
- [tag](#)

**Details**

- [How can I evaluate](#)
- [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. In general, how can I evaluate](#)
- [How can I evaluate](#)

- [Parcly Taxel](#) 51.7k 15 86 120
- [Backus](#) 2,072 3 12 8

- [edited Apr 3 '17 at 21:41](#)
- [edited Sep 24 '17 at 12:09](#)
Evaluation for Task 2: Formula Search (in-context)

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)

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](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](https://www.cs.rit.edu/~dprl/software.html))
Formula search engine (math only)
formulas: appearance + semantic encodings


ARQMath

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Please join us!
Send Email to: rxzvcs@rit.edu

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