

## New Convolution Identities for Classical Number Sequences via Symmetric Function Methods.

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### INTRODUCTION & AIM

Random recurrence sequences arise in probability theory, combinatorics, and dynamical systems.

In this work, we introduce a ternary random Tribonacci sequence defined by a stochastic perturbation of the classical Tribonacci recurrence.

The main objective is to study:

- the combinatorial structure of the sequence,
- the exact probability distribution,
- generating functions,
- expectation and variance,
- and asymptotic Gaussian behavior.

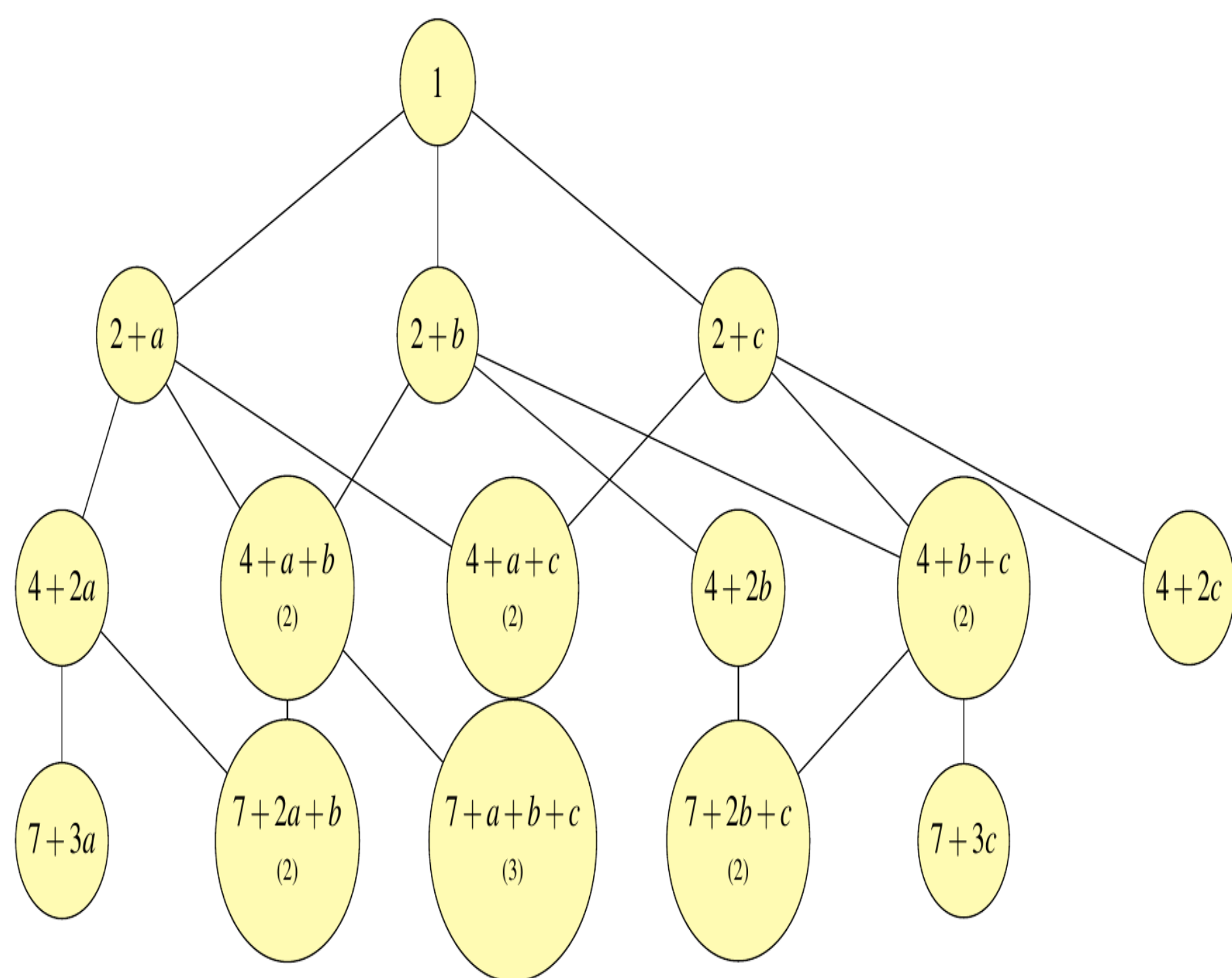
### METHOD

We define

$$GT_n = GT_{n-1} + GT_{n-2} + GT_{n-3} + w_{n-3},$$

where  $w_n$  takes values in  $\{a,b,c\}$  with probabilities  $p,q,r$ .

Using a ternary tree representation, we analyze all possible realizations of the sequence and derive explicit generating functions.



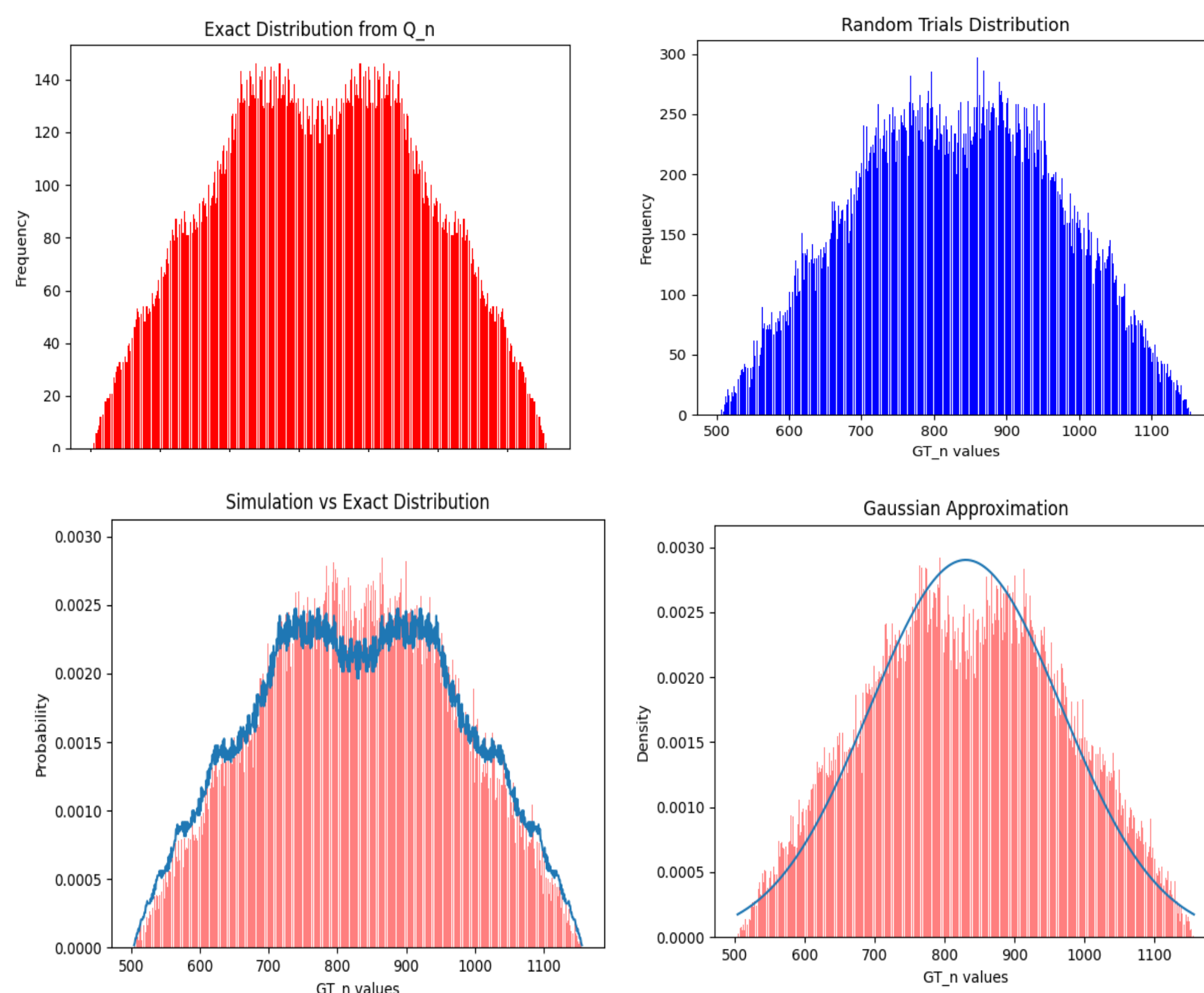
### RESULTS & DISCUSSION

Explicit formula

$$GT_n = T_n \sum_{k=1}^{n-2} T_k w_k.$$

Expectation  $\mathbb{E}[GT_n] = T_n + (pa + qb + rc) \sum_{k=1}^{n-2} T_k$

Variance  $var(GT_n) = \sigma^2 \sum_{k=1}^{n-2} T_k^2$



The empirical and exact distributions show excellent agreement.

The distribution exhibits a bell-shaped profile with an underlying discrete structure.

The Gaussian approximation confirms asymptotic normality.

### CONCLUSION

- A ternary random Tribonacci model was introduced.
- Exact distributions were obtained through generating functions.
- Closed formulas for expectation and variance were derived.
- The sequence converges asymptotically to a normal distribution.

### FUTURE WORK / REFERENCES

- Higher-order random recurrences
- Larger perturbation alphabets
- Fractal and combinatorial analysis