2019!

Submission deadline: March 31st 2019

Evaluate

$$1 \cdot 1! + 2 \cdot 2! + 3 \cdot 3! + \cdots + 2019 \cdot 2019!$$

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Discussion

Let $a_p = p \cdot p!$ Then $a_p = ((p+1) - 1) \cdot p!$ Therefore

$$a_p = (p+1)! - p!$$

Thus

$$\sum_{p=1}^{2019} a_p = (2! - 1!) + (3! - 2!) + \cdots + (2020! - 2019!)$$

Therefore

$$1 \cdot 1! + 2 \cdot 2! + 3 \cdot 3! + \cdots + 2019 \cdot 2019! = 2020! - 1.$$