

## Verb Tense in Scientific Writing

This handout uses examples from quantum computing to illustrate the most common ways in which verbs are used in scientific writing. Note that this is not a complete guide to tenses. For more on the topic, we recommend visiting Purdue's Online Writing Lab ([owl.purdue.edu](http://owl.purdue.edu)).

### Simple Tenses:

Past

Present



#### Statements of truth...

...that were considered valid in the past but not today

...that are considered valid today

Until the mid-twentieth century, the dominant paradigm in both science and technology was that of energy [...].<sup>1</sup>

*Note that it is incorrect to use present perfect in such a case (e.g. "has been") because the statement has no link to the present.*

Our new understanding of the universe is not in terms of the driving power of force and mass. Rather, the world we see around us arises from a dance between equal partners, information and energy [...].<sup>1</sup>

*Note that it is incorrect to use present continuous in such a case (e.g. "is arising") because the statement does not describe an event in progress.*

#### Main arguments or findings...

...that were made in the past

...that are in the process of unfolding

In 1982, Feynman conjectured that quantum computers might be able to simulate other quantum systems more efficiently than classical computers.<sup>2</sup>

*This case must use past simple because of "In 1982." But there are borderline cases in which present simple could also be used—e.g. "Feynman's 1982 article conjectures..." This wording implies that Feynman's claim is not just of historical interest but still relevant in today's debate.*

Here I show that a quantum computer can in fact simulate quantum systems efficiently as long as they evolve according to local interactions.<sup>2\*</sup>

Reporting in *Nature* [...], Alán Aspuru-Guzik and co-workers propose a method of cooling quantum systems that is closely analogous to Maxwell's demon.<sup>3</sup>

*Here, the author uses present instead of past tense because the news is very recent. Check the Present Perfect section for another option here.*

#### Steps in an experiment or process...

...that you actually performed in your own research

...that you are describing generically

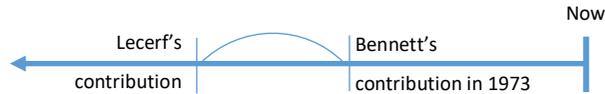
Experimentally, this quantum algorithm was implemented using the nuclear spins of the 1H and 13C atoms in a carbon-13 labelled chloroform molecule [...] as the input and work quantum bits [...].<sup>4</sup>

The D-J algorithm exploits quantum coherence to determine whether a quantum 'coin' is fair or fake while looking at it only once. The algorithm requires one 'input' spin and one 'work' spin [...].<sup>4</sup>

\* **The future** is sometimes used instead of the present to describe a paper's goals: "I will show that a variety of quantum systems, including quantum computers, can be 'programmed' to simulate the behavior of arbitrary quantum systems whose dynamics are determined by local interactions."<sup>2</sup>

## Perfect Tenses:

Past



Present



### To place one past event before another past event

In 1973, Bennett showed that all computations could be performed using only reversible logical operations. [...] Earlier work by Lecerf had anticipated the possibility of reversible computation, but not its physical implications.<sup>5</sup>

*“had anticipated” is used to place the moment one step further in the past—i.e. in the past from the perspective of Bennett’s contribution in 1973.*

### To describe past events that have a link to the present (and possibly future)

Over the past half century, the amount of information that computers are capable of processing and the rate at which they process it has doubled every two years [...].<sup>3</sup>

*“has doubled” is used because 1) this phenomenon has happened various times until today and 2) it will likely continue to happen. This tense also often combines with “since”:*

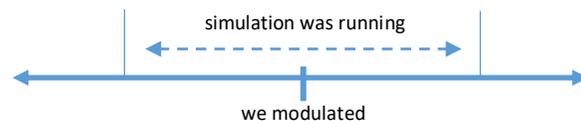
Since their introduction in 1980 quantum computers have been investigated extensively.<sup>2</sup>

*The present perfect can also be used to report on a scholar’s recent findings, especially when describing a claim they have made for some time:*

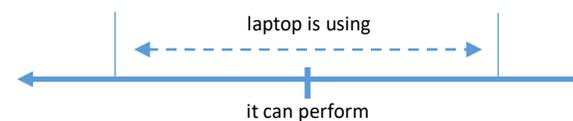
Kimble et al. have suggested that nonlinear interactions between photons and atoms in small-cavity quantum electrodynamics could be used to ‘dial up’ arbitrary unitary transformations of the photons.<sup>2</sup>

## Progressive Tenses:

Past



Present



### To describe an event that was in progress when another event occurred

While the simulation was running, we modulated the interactions between the quantum dots to mimic the dynamics of the spin system.

### To describe an event that is in progress when another occurs

When the ultimate laptop is using all its memory space it can perform  $2\ln(2)kBE/\pi\hbar S = 3\ln(2)kBT/2\pi\hbar \approx 1019$  operations per bit per second.<sup>4</sup>

*This tense may also be used on its own to describe an event that is presently unfolding.*

In particular, [...] ion-trap quantum logic devices of the sort that are currently being constructed by Monroe et al. could act as universal quantum simulators.<sup>2</sup>

<sup>1</sup>Lloyd, S. (2013). The universe as quantum computer. In *A Computable Universe: Understanding and exploring Nature as computation*, 567–581.

<sup>2</sup>Lloyd, S. (1996). Universal quantum simulators. *Science*, 1073–1078.

<sup>3</sup>Lloyd, S. (2014). Quantum optics: Cool computation, hot bits. *Nature Photonics*, 8(2), 90.

<sup>4</sup>Chuang, I. L., Vandersypen, L. M., Zhou, X., Leung, D. W., & Lloyd, S. (1998). Experimental realization of a quantum algorithm. *Nature*, 393(6681), 143.

<sup>5</sup>Lloyd, S. (2000). Ultimate physical limits to computation. *Nature*, 406(6799), 1047.