Designing driver Hamiltonians for continuous-time quantum walks: the results

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Our research investigated possible improvements to a quantum algorithm called a continuous-time quantum walk. We applied the quantum algorithm to a combinatorial optimisation problem called max-cut. In this poster we provide the results of our project.

The workflow:

We used Python to investigate continuous-time quantum walks.

INPUTS

Set parameters:

```
gamma=1.3
tf=10
t_steps=1000
```

Create the driver Hamiltonian:

```
your_driver={0:-1,1:-1,2:-1,3:-1,4:-1,5:-1,6:-1,7:-1}
hd=generate_driver(your_driver)
```

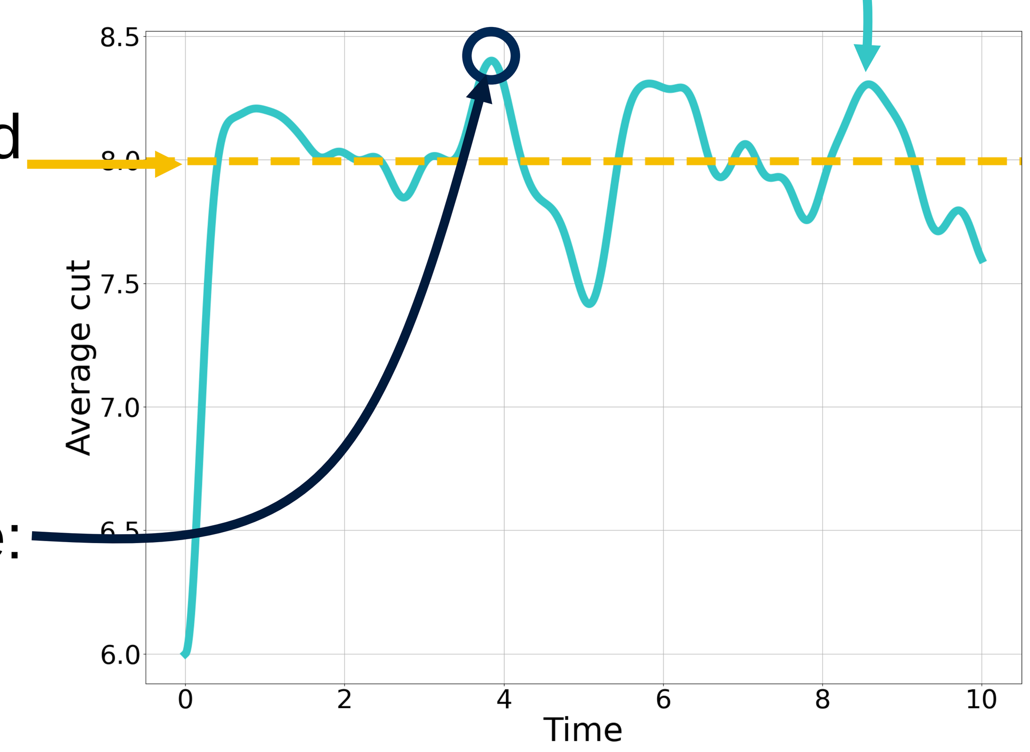
Changing the numbers in the Python dictionary changed the amount of quantum fluctuation. The above driver Hamiltonian is the transvers-field.

OUTPUTS

Average cut value from the continuous-time quantum walk for the max-cut graph

The time averaged cut value: 8.00…

The maximum average cut value: 8.40…



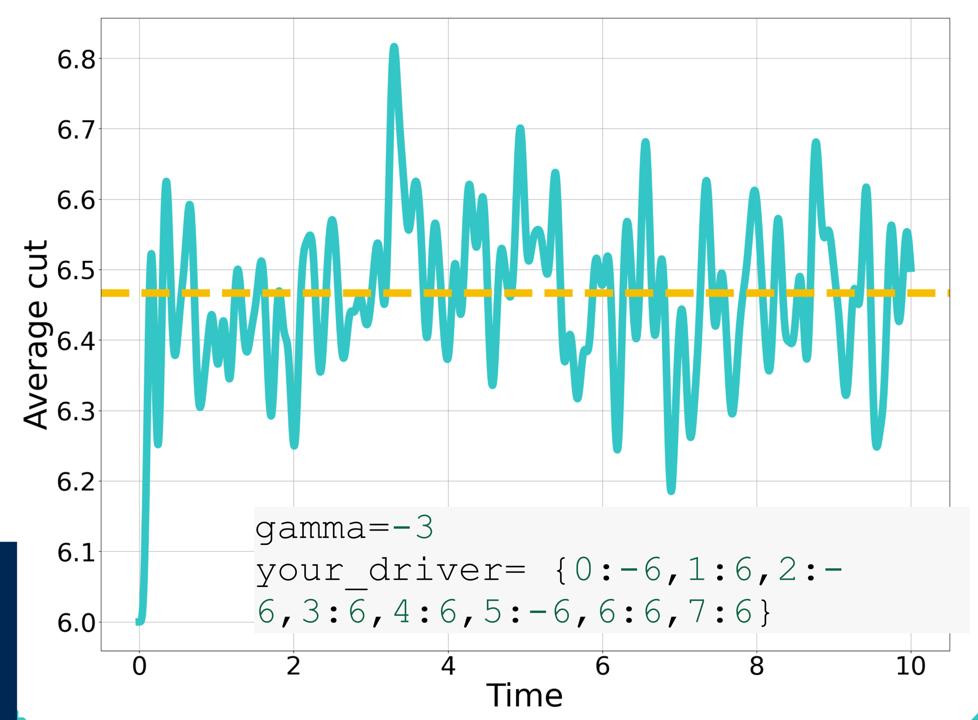
We want the <u>time averaged cut value</u> to be as **big** as possible!

Results:.

1.

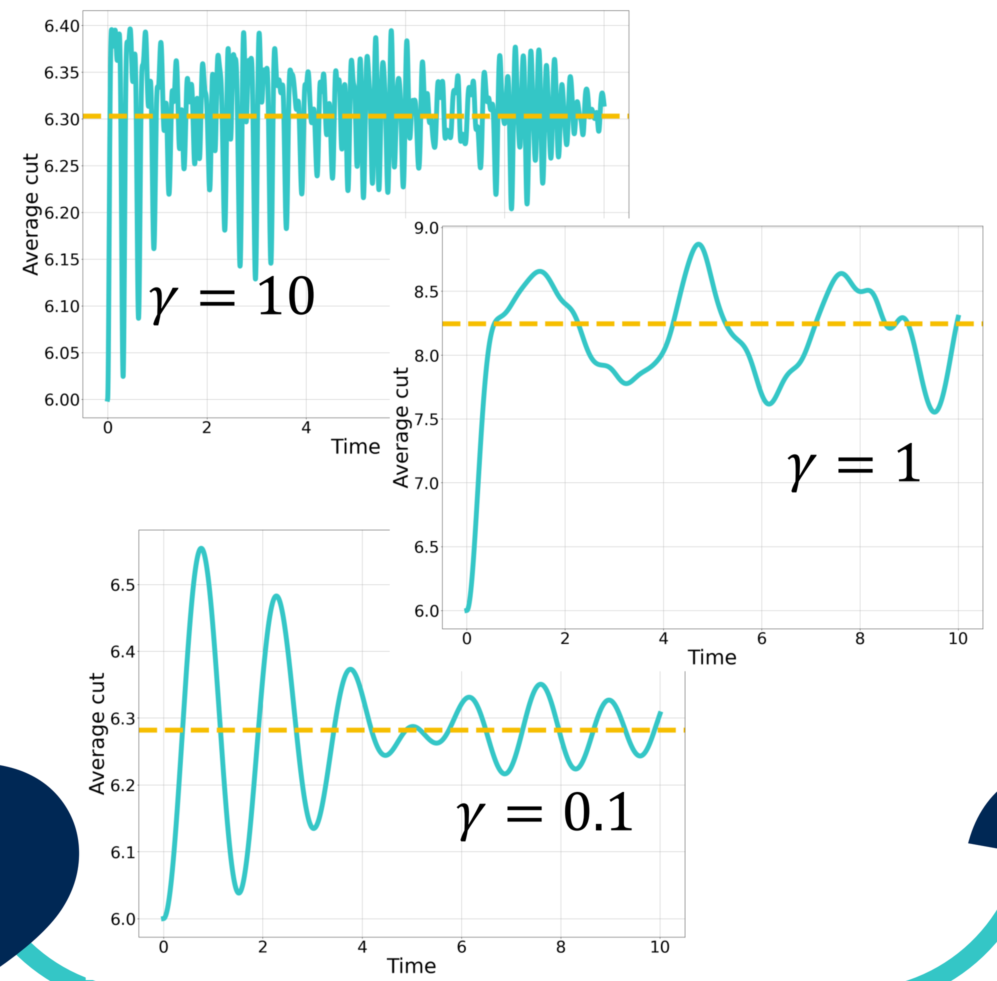
Negative numbers makes a better cut.
Positive numbers are further away from the transverse field.

<u>Example:</u>



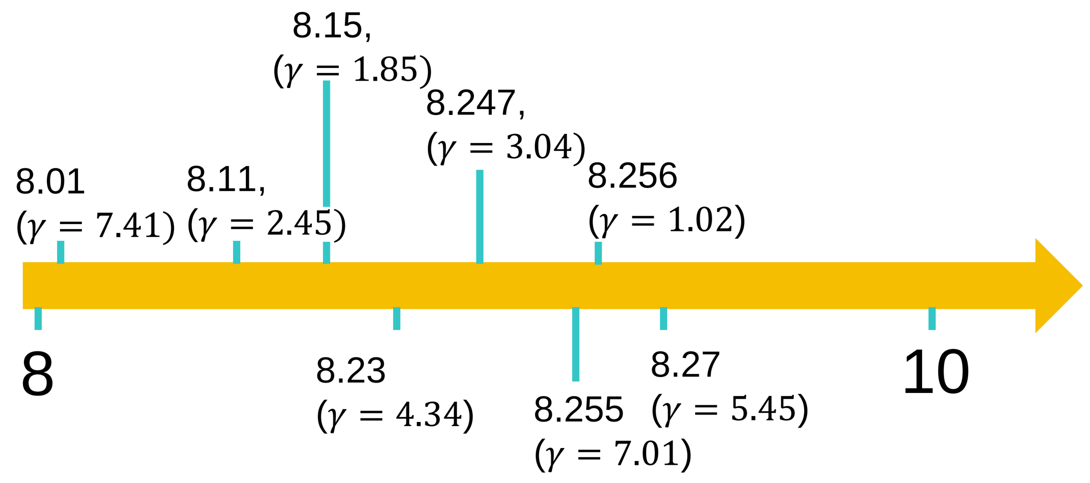
2.

If your γ is too big or too small, H_d and H_p become unbalanced. This means a bad average cut.



3.

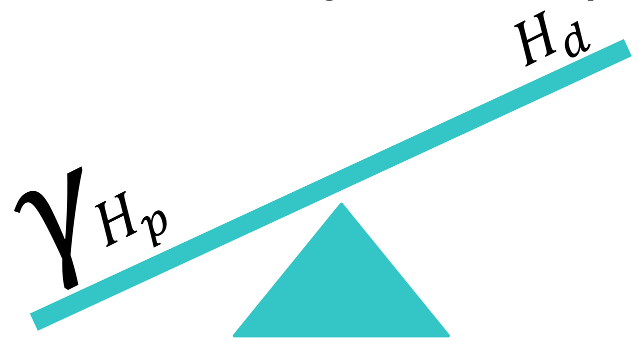
All the drivers do roughly the same!



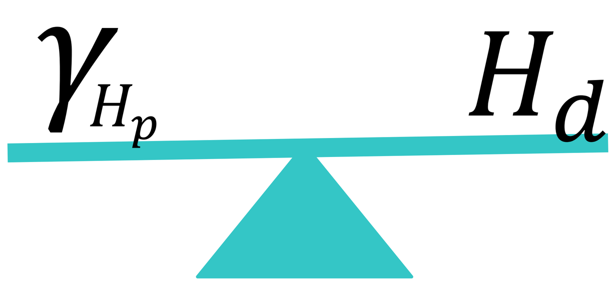
The figure above shows the time averaged cut value for many different drivers with γ chosen to maximise the cut value.

Our model:

If your γ is too big or too small making your Hamiltonian unbalanced resulting in no fluctuations. Fluctuations allow for searching of solutions. If there is no searching then the average cut value will be bad. Think of it like a see-saw! Side note: increasing your gamma by a lot may make your driver to do a lot of work which may take a long time to give you the results you want. Dynamics (anything that moves) are slower.



E.g. If the γ is too big, the H_d should be increased in order for there to be fluctuations



Now the H_d is increased to be the same size as gamma, now meaning there will be fluctuations

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