Polynomial Search

An all-sky search method for continuous gravitational waves from binary neutron stars

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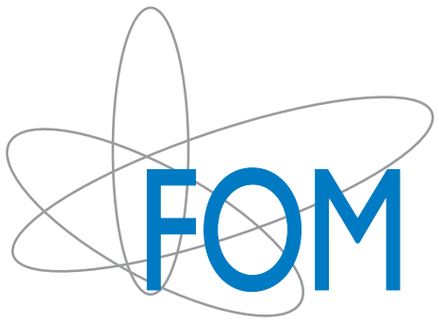

Signal sources

- Neutron stars can be observed if they pulsate towards Earth or if they have a binary companion
- Around 200 millisecond pulsars are known
- It is likely that there many more exist in the Virgo detector range

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Signal detection

- A binary signal is described by 13 parameters
- Detection depends on accurate modelling on short time scales
- For an all-sky search, modelling everything is not feasible

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Polynomial Search

- Signal model: $\Phi(t) = \phi_0 + f_0 t + \frac{\alpha}{2} t^2 + \frac{\beta}{6} t^3$
- Valid for short periods (SFT) up to one fourth of the binary period
- Require that the beam pattern remains approximately constant

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Templates

- We compute the cross-correlation in the frequency domain
- For each value of α and β, we need to make templates
- f_0 can be matched by shifting the template along the data
- ϕ can be matched implicitly by offset in time

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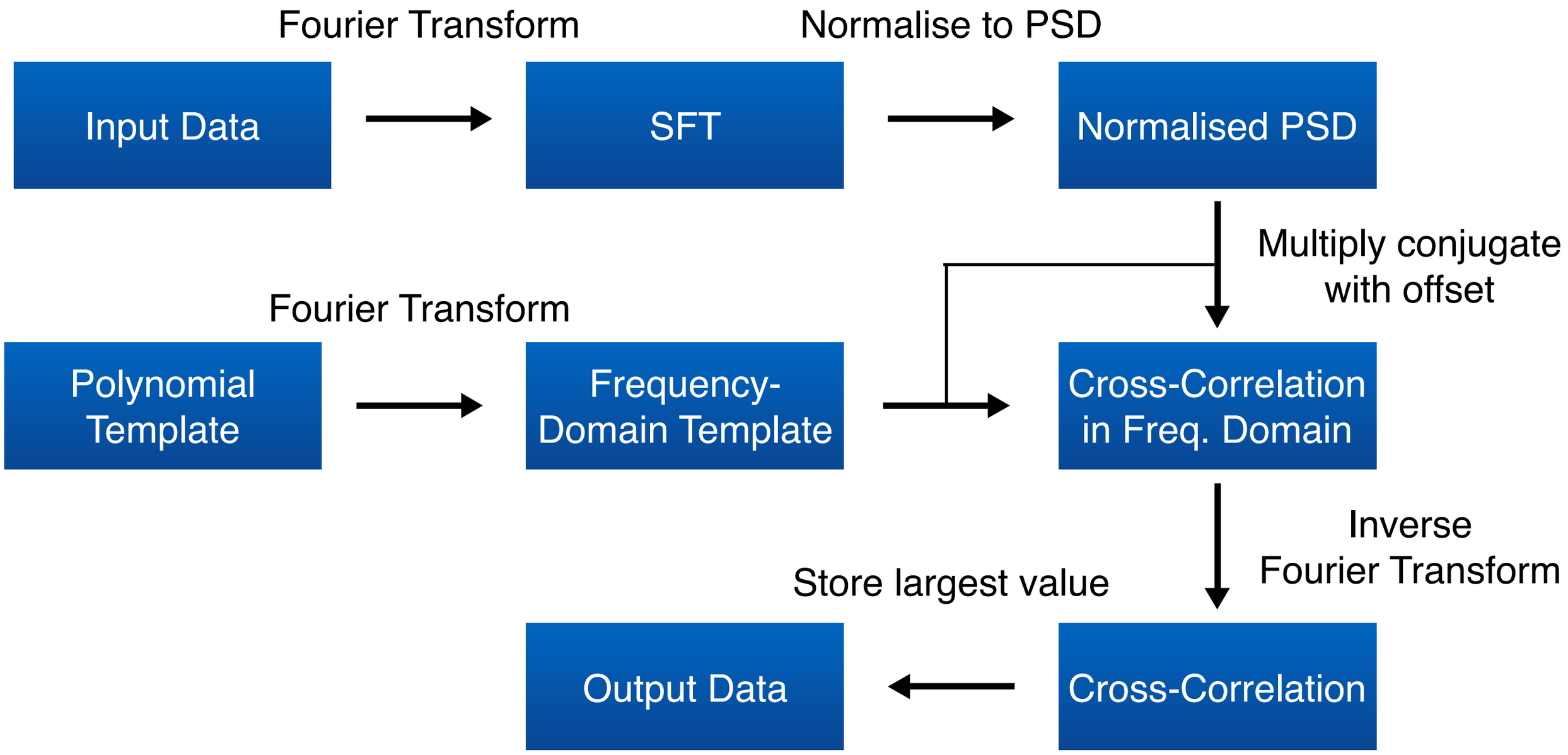
Flow Chart



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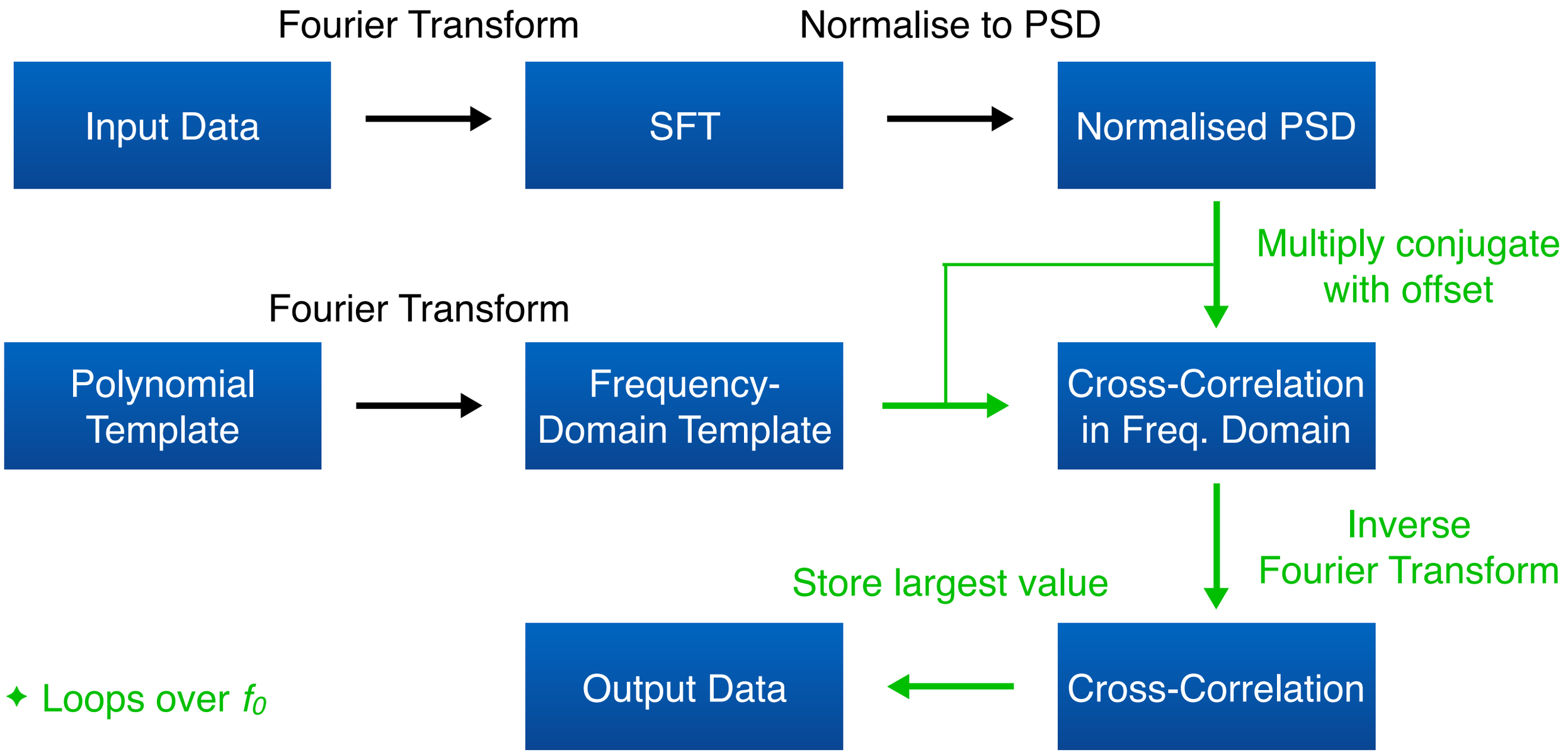
Flow Chart



✦ Loops over f_0

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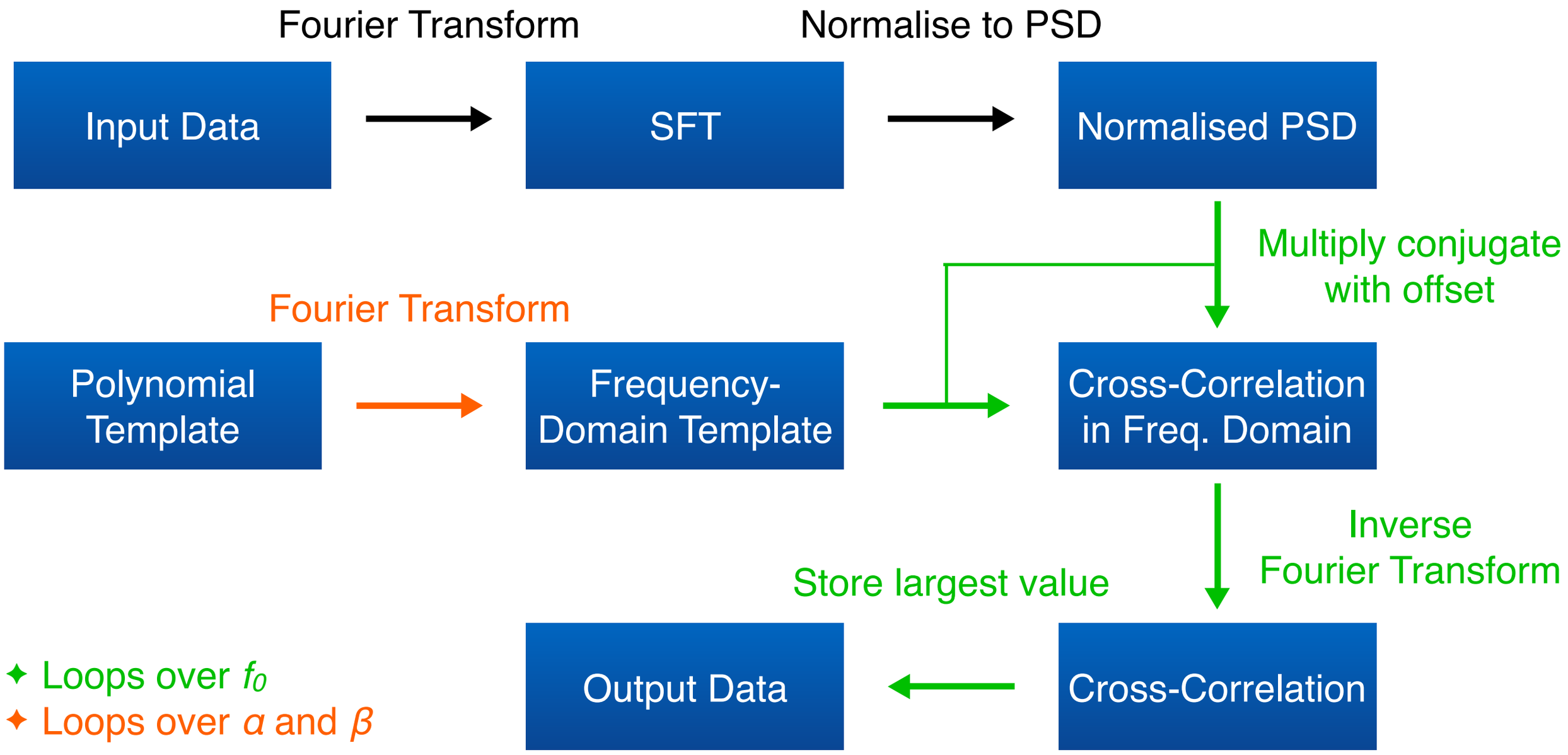
Flow Chart



- Loops over f_0
- Loops over α and β

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Paralellisation

- Time segments are analysed separately
- The analysis can be split in frequency segments with very little overhead
- In principle, smaller-scale parallelisation is possible too

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Computing time spent

- Analysing a 16 Hz band of 1 SFT takes ~ 1 core-hour
- Most of the time is spent on performing FFTs
- We currently use FFTW 3

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GPGPU Opportunities

- FFT operations (most potential)
- Computing of the cross-correlation
- Normalisation
- Template generation

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GPGPU Challenges

- Polynomial Search is implemented in C++
- With the current code structure, data might need to be copied to and from GPU memory
- Overhead is significant already even when running on a CPU

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Conclusion

- Offloading part of the algorithm to GPUs could be very worthwhile
- The work still needs to be done

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Thanks for your attention

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