

PySilsub—a toolbox for silent substitution

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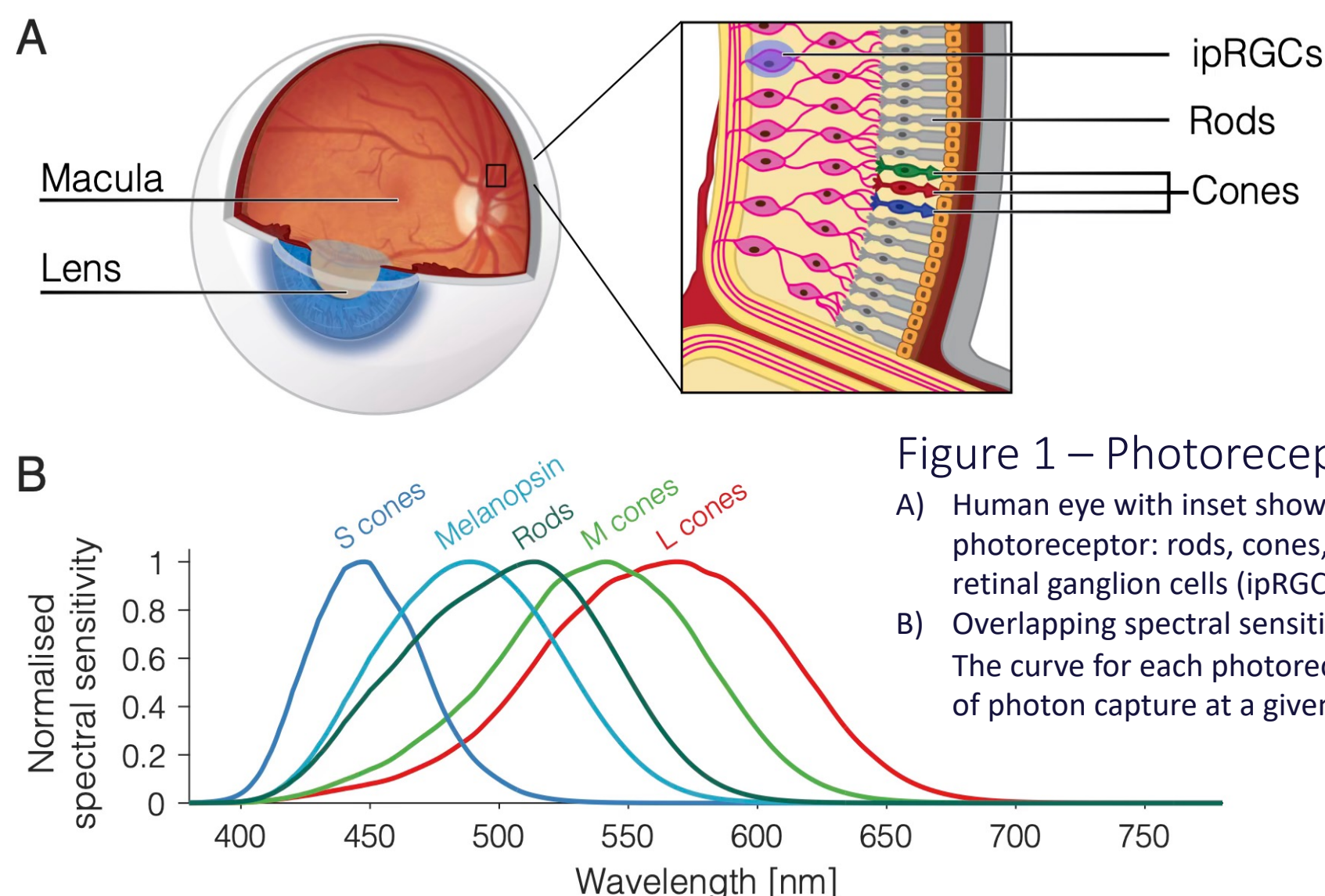
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Introduction

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- Human retinæ are packed with photosensitive cells—rods for low-light vision, three types of cone for daylight vision, and intrinsically photosensitive retinal ganglion cells (ipRGCs) for controlling non-image forming functions (e.g., circadian photoentrainment, pupil size)
- Significant overlap in spectral sensitivities means that most lights will stimulate all photoreceptors, but to varying degrees
- Silent substitution** (Estévez & Spekreijse, 1982) provides a principled basis for selectively stimulating individual classes of photoreceptor(s), which is useful in research and clinical settings
- PySilsub** is a novel Python package for silent substitution featuring object-oriented support for individual colorimetric observer models, multi-primary stimulation devices, and solving silent substitution problems with linear algebra and constrained numerical optimization



PySilSub – key modules

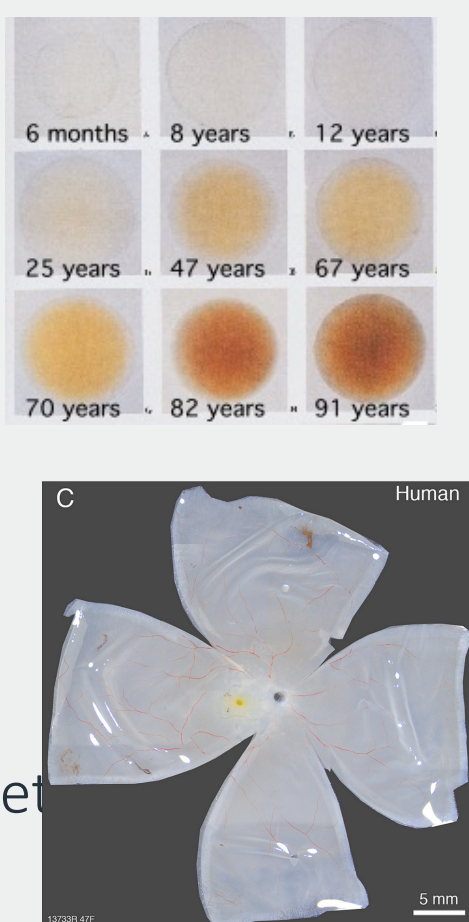
pysilsub.observers

Lens yellowing with age shifts the spectral response of photoreceptors

Macular pigment alters spectrally sensitivity of foveal receptors

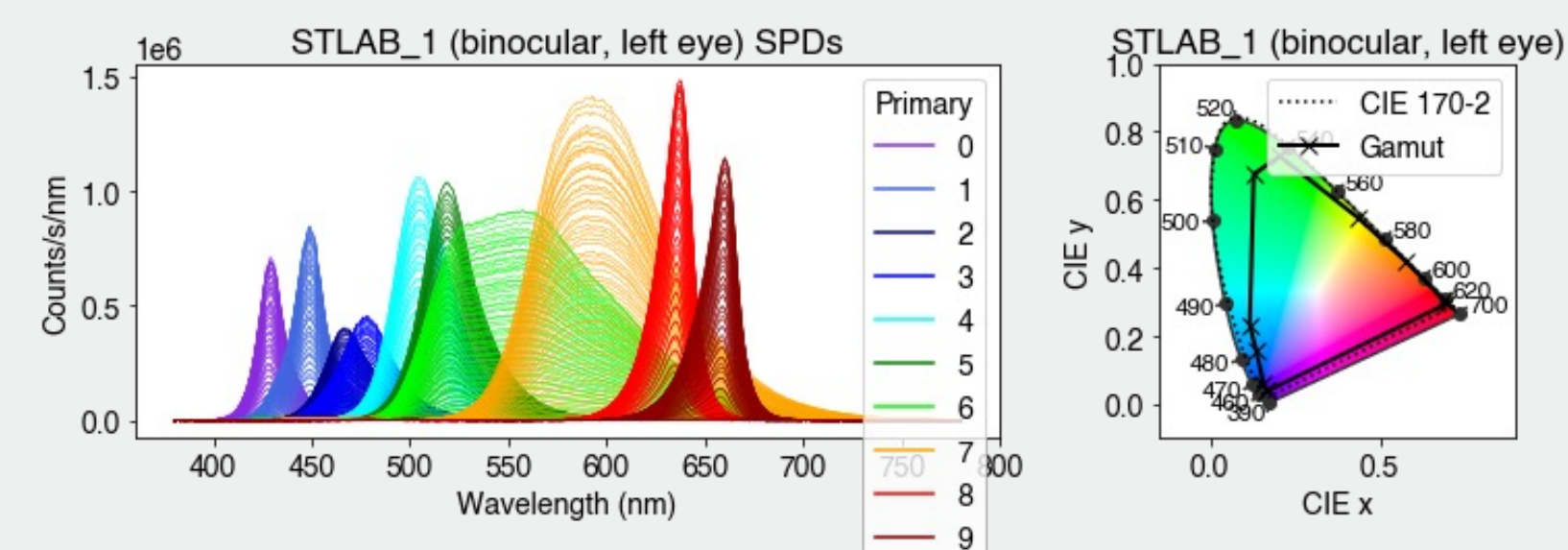
Grünert & Martin (2020)

- Control for the effects of age and field size
- Generate spectral sensitivity functions for individual colorimetric observers



pysilsub.devices

- Create a forward model of any multipriamary stimulation system for which accurate calibration data are available
- Predict output, perform gamma correction,

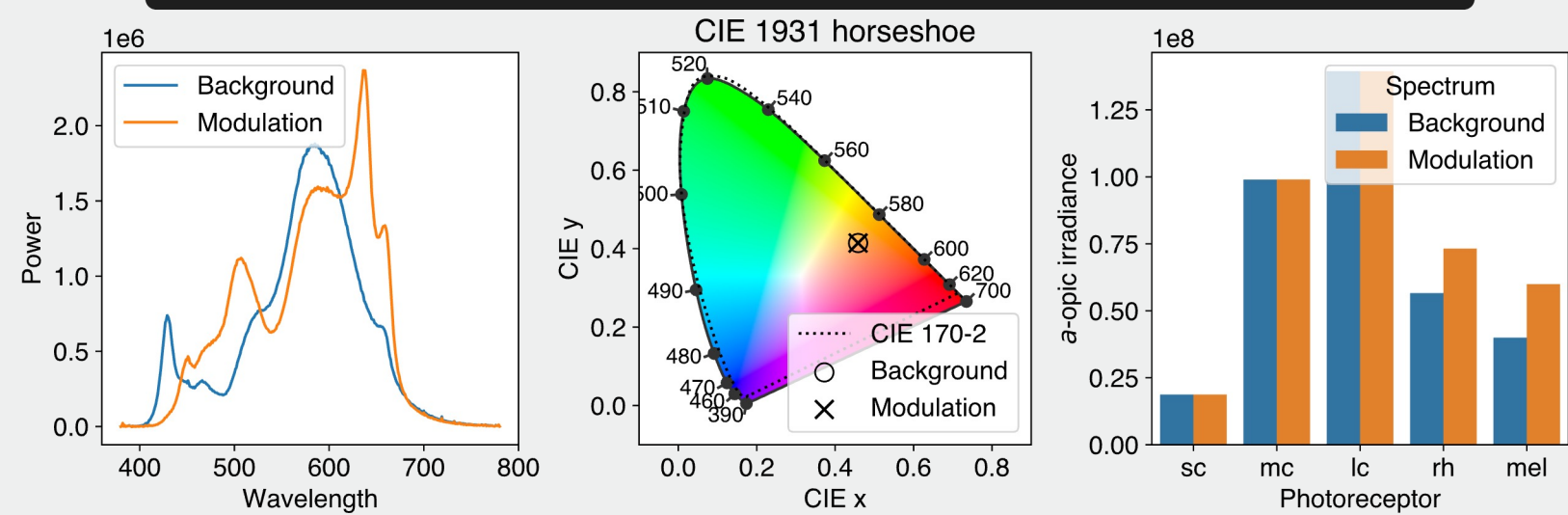


pysilsub.problems

- Target melanopsin with 50% contrast (no background specified) whilst ignoring rods and minimizing cone contrast

```
from pysilsub.problems import SilentSubstitutionProblem as SSP

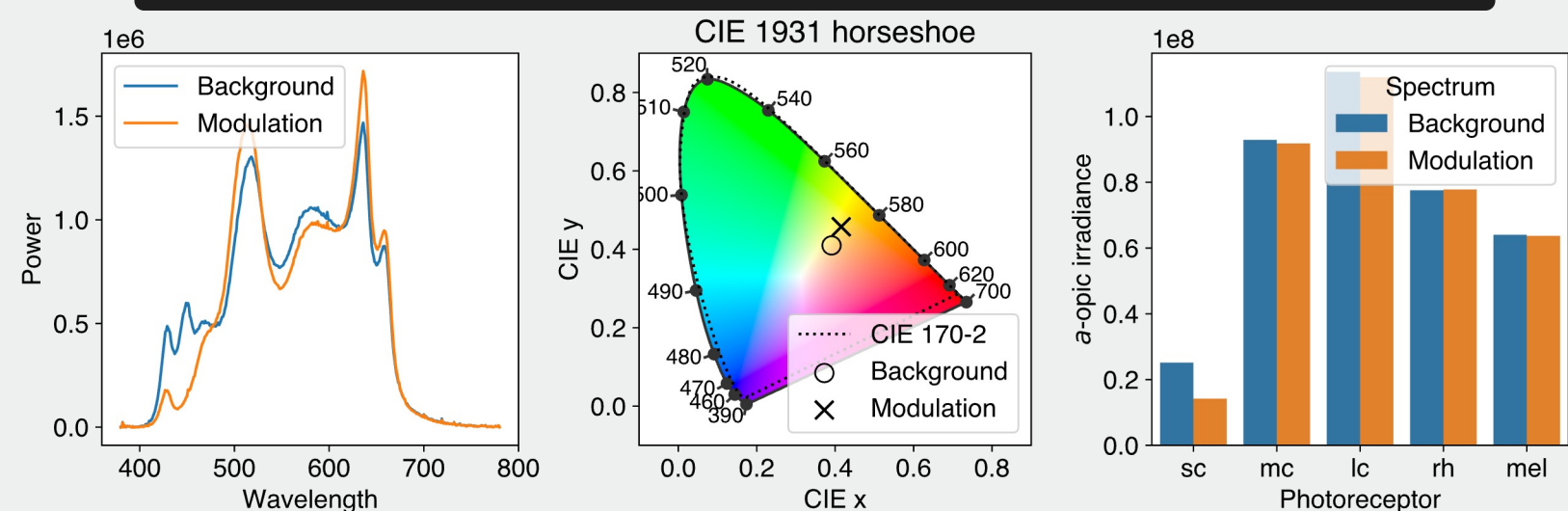
problem = SSP.from_package_data('STLAB_1_York') # Load example data
problem.ignore = ['rh'] # Ignore rod photoreceptors
problem.minimize = ['sc', 'mc', 'lc'] # Minimise cone contrast
problem.modulate = ['mel'] # Target melanopsin
problem.target_contrast = .5 # With 50% contrast
solution = problem.optim_solve() # Solve with optimisation
fig = problem.plot_solution(solution.x) # Plot the solution
```



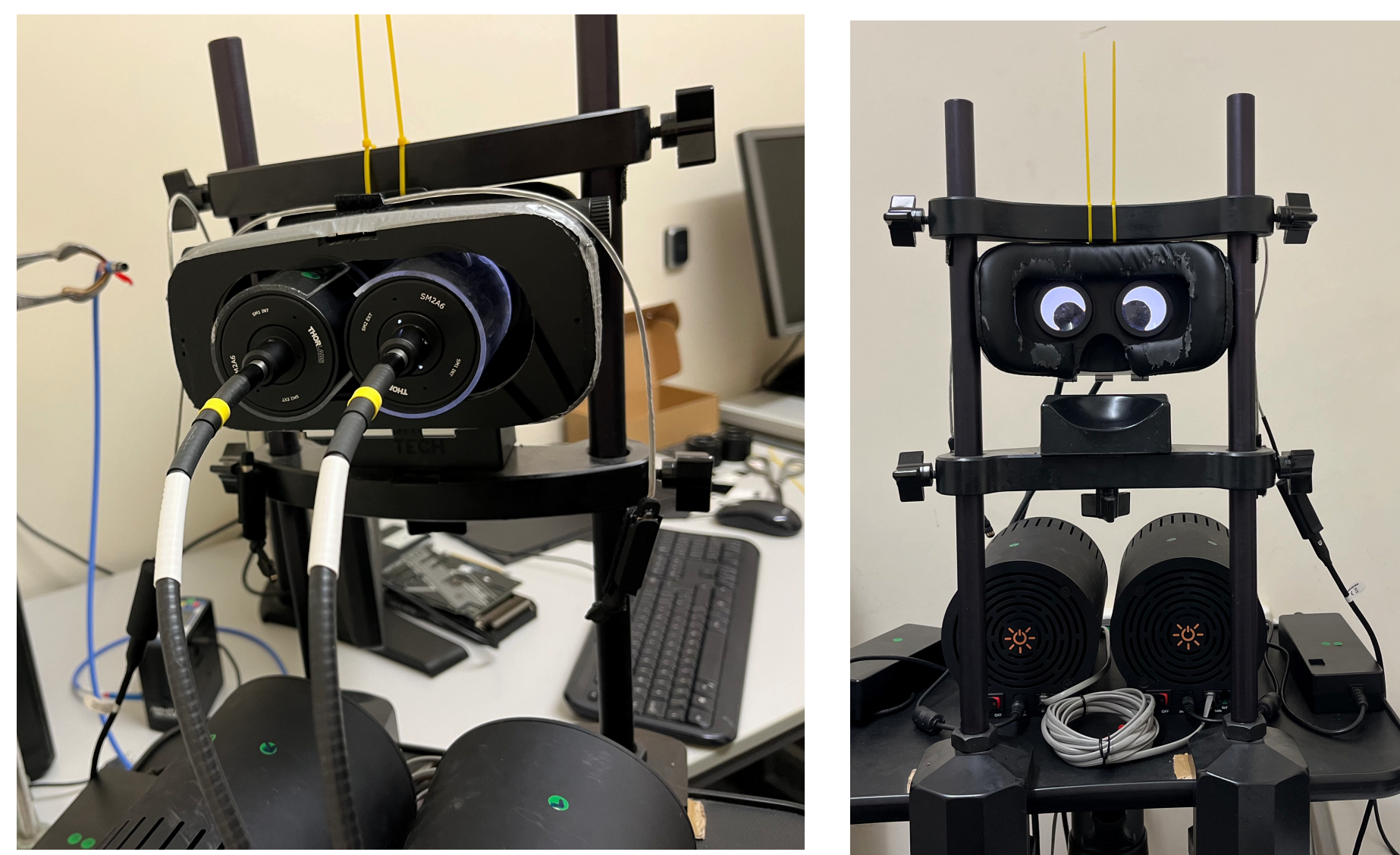
- Target S-cones with –45% contrast around a specified background whilst ignoring rods and minimizing contrast on melanopsin and L/M cones

```
from pysilsub.problems import SilentSubstitutionProblem as SSP

problem = SSP.from_package_data('STLAB_1_York') # Load example data
problem.background = [.5] * problem.nprimaries # Specify background spectrum
problem.ignore = ['rh'] # Ignore rod photoreceptors
problem.minimize = ['mc', 'lc', 'mel'] # Minimise contrast on L/M cones and mel
problem.modulate = ['sc'] # Target S-cones
problem.target_contrast = -.45 # With -45% contrast
solution = problem.linalg_solve() # Solve with linear algebra
fig = problem.plot_solution(solution) # Plot the solution
```



PySilSub – how are we using it?

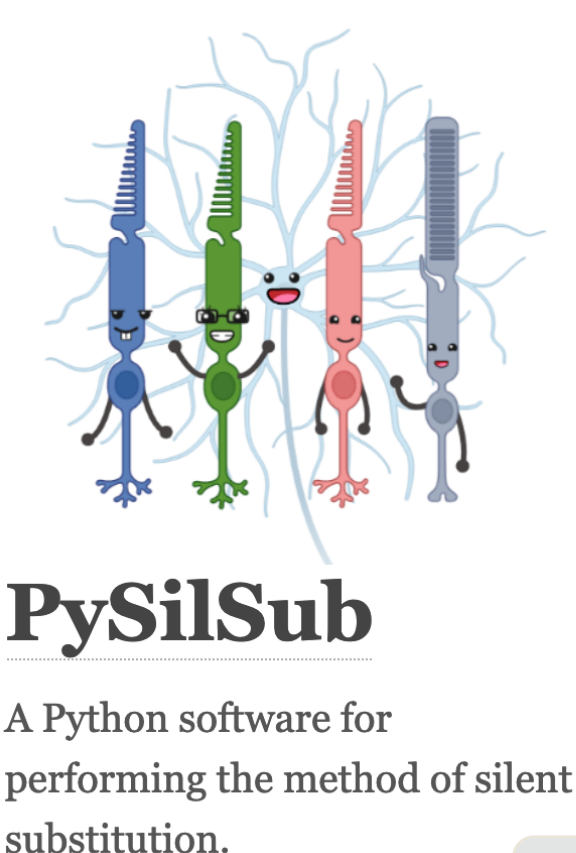


Something about how it's being used here

PySilSub – lots more info and examples online

Welcome to PySilSub's documentation!

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`pip install pysilsub`

<https://github.com/PySilentSubstitution/pysilsub>

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