

Research experience

Tong Wu

Sun yat-sen University, China

March 18, 2021

Project now Registration and 3D reconstruction of the images of serial tissue sections

Term projects in Matlab

- 1 Recognize music by recording: Shazam
- 2 Solve linear inverse problem: ADMM
- 3 Image inpainting and denoising: PDE-based anisotropic diffusion

Interests in game & AI

- 1 CUMCM: Solution to the game of Crossing the Desert (like monopoly)
- 2 UCB CS188: Pac-man game

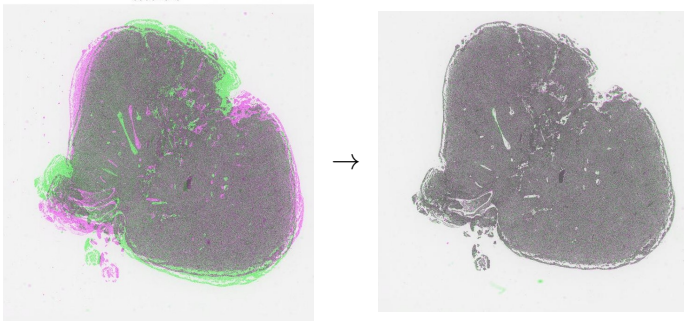
Image registration

- 1 An optimizaiton problem:

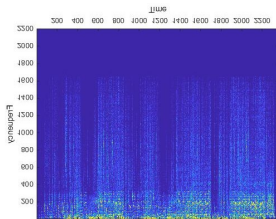
$$T^* = \arg \max_T \text{sim}(I, T(J))$$

I is fixed image, J is floated image(need registration)

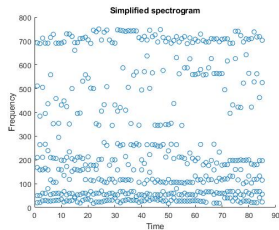
- 2 Used Powell to search the optimal parameters for affine transformation T , and achieved good primary results.



- 1 Target: recognize music by recording (distorted by noise)
- 2 Got the spectrograms of songs through a short-time Fourier transform
- 3 Remained points with high energy in spectrograms and constructed fingerprint for each song
- 4 Matched successfully using the features



(a) Spectrogram



(b) Fingerprint

linear inverse problem: ADMM

- ① Problem:

$$\begin{aligned} & \text{minimize} && \|Bx\|_1 \\ & \text{subject to} && Ax = b \end{aligned}$$

- ② Split and get a standard ADMM Form:

$$\begin{aligned} & \text{minimize} && f(x) + \|z\|_1 \\ & \text{subject to} && Bx - z = 0 \end{aligned}$$

f is an indicator function for set C , $C = \{x \in \mathbf{R}^n \mid Ax = b\}$.

- ③ Reformulation and iteration algorithm:

$$\begin{aligned} x^{k+1} &:= \underset{x}{\operatorname{argmin}} \left(f(x) + (\rho/2) \left\| Bx - (z^k - u^k) \right\|_2^2 \right) \\ z^{k+1} &:= \underset{z}{\operatorname{argmin}} \left(\|z\|_1 + (\rho/2) \left\| z - (Bx^{k+1} + u^k) \right\|_2^2 \right) \\ u^{k+1} &:= u^k + (Bx^{k+1} - z^{k+1}) \end{aligned}$$

Image inpainting

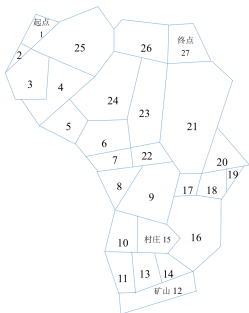


(c) resource

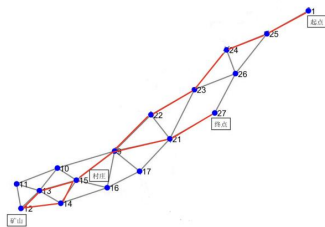


(d) after imainting

CUMCM:the game of Crossing the Desert(like monopoly)



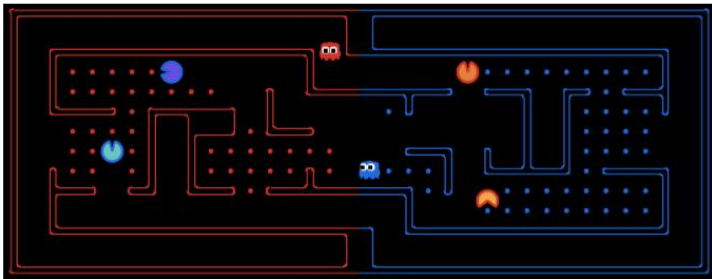
(e) Map



(f) Solution route

Contest: Pacman Capture the Flag

Version 1.002. Last Updated: 01/01/2015.



Enough of defense,
Onto enemy terrain.
Capture all their food!

Figure: <http://ai.berkeley.edu/contest.html>

Some favorite theorems and results:

Optimization

- ① Banach fixed point theorem: convergence!
- ② Implicit function theorem: used to prove lagrange multiplier theorem, KarushKuhnTucker conditions, so powerful!

Fourier Analysis

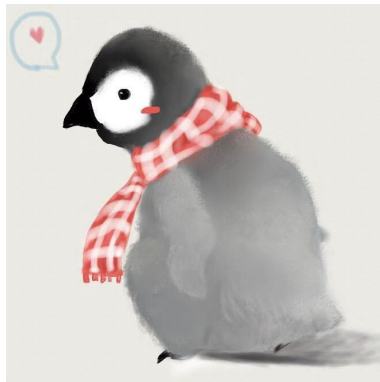
- ① Sampling theorem
- ② Various transforms: Fourier transform, Discrete Fourier transform and FFT algorithm, Randon transform, Z transform, etc.

.....

Overview

I am a student:

- 1 good at coding:
c++, Matlab,
Python, Latex, ...
- 2 love mathematics :)
- 3 enjoy thinking,
reading and doing
research
- 4 interesting! (with
hobbies like drawing,
basketball, travel, ...
so many)
- 5



self-portrait :D

Thanks!