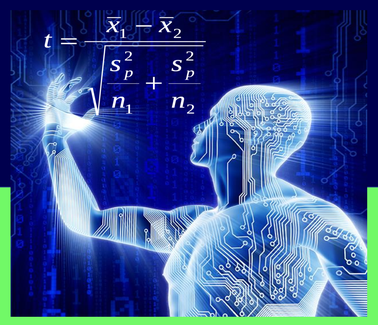


Statistical Applications in Computer Vision

Liberty High School, Kissimmee FL

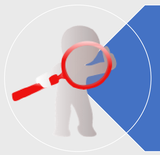
By: Carol Guthrie-Lewis, Ed.M.

UCF
CENTER FOR RESEARCH IN COMPUTER VISION

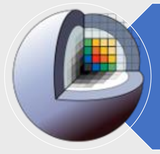
***Purpose*: To enrich students' understanding of inferential statistics using an interactive computer vision based lesson.**

Lesson Description

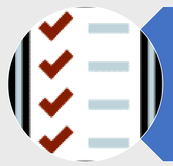
Anticipatory Sets
Familiarize students with the social, emotional, and physical effects of obesity



Day 1: Overview
Introduce computer vison applications in radiology and overview of lesson



Day 2: 3D Slicer Tutorial
Interactive program to familiarize students with basic 3D slicer functions



Day 3: Data Collection
3D Slicer to segmenting volume of visceral and subcutaneous fat

Day 4: Statistical Analysis
Identify the null/ alternative hypothesis, state assumptions/conditions, and conclusion decision based on p-value

Day 5: Exploration
Discussion of Neural Networking, Back Propagation, Edge Detection, and Python Coding

FL State Standards

MAFS.912.S-IC.1.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

MAFS.7.SP.2.4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

Statistical Application: Obesity Comparative Study

Overview

A retrospective analysis of patients with brown adipose tissue (BAT), detected by PET/CT images, to determined if oncology patients with detected BAT had less obesity then BMI matched control patients without detectable BAT.

Visceral Fat
Fat surrounding vital organs

Subcutaneous Fat
Fat that lies directly beneath the skin

BMI > 30 Obese

18.5 < BMI < 25 Normal Range

Quantitative Results (Two Sample T-Test)

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$$

Visceral fat and subcutaneous fat

	Brown fat patients	Control patients	*P*-value*
VF (cm^2)	124±71	145±84	0.09
SF (cm^2)	299±157	289±161	0.74
VF/(VF+SF)	0.30±0.10	0.34±0.12	0.03

SF, subcutaneous fat; VF, visceral fat.
**P*-value determined by a *t*-test.

Figure 1

Finding of Sample Study

The findings suggest that while there was no significant difference in amount of visceral fat or subcutaneous fat between BAT uptake oncology patients and the control group, the ratio of VF/(VF+SF) was lower in the BAT uptake oncology patients when compared to the control group.

Data Collection

- Students review CT scans segmented by an automated abdominal and thorax region detection algorithms and unsupervised learning methods developed at UCF. [2]
- Next, students find the volume of the pre-segmented tissue using 3D Slicer.
- Lastly, students compute a two sample t-test to measure the visceral fat (VF), subcutaneous fat (SF), and VF/(VF+SF) ratio of the BAT uptake cohort and control group.

Extension: Gaussian Smoother Filter

The Gaussian Smoother is often used in Medical Imaging Denoising

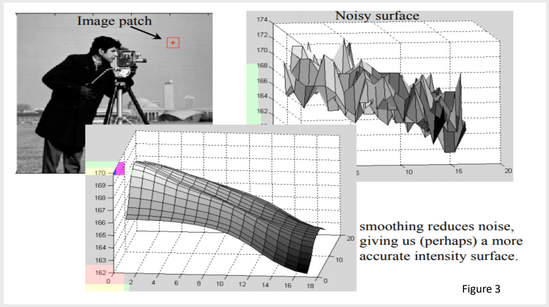


Figure 3

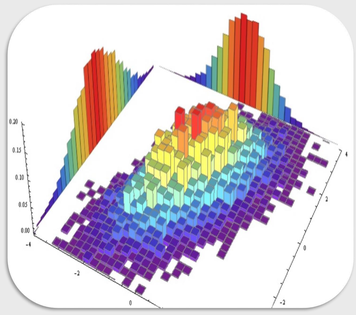
A balancing act to "clean up" the noise but not remove important image gradient

Figure 4

The standard deviation determines the amount of smoothing. $\pm 2.5\sigma = 98.76\%$ of the area

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

- The Gaussian formula creates a distribution of weighted values used to build a convolution matrix which is then applied to the original image.
- In medical image segmentation, the Gaussian smoothing filter is often used as a preprocessing step to remove noise, followed by the Canny edge detection algorithm to distinguish true edges from false edges.



Mission

To motivate AP Statistics students to purse advanced mathematics and explore career opportunities in computer vision

Educational Goals

1. Highlight obesity health factors
2. Provide AP Statistics students with a real world application for collecting and testing data
3. Recognize role of statistics when testing hypothesis
4. Use statistical inferences to drive and improve patient care
5. Recognize similarities between the Gaussian Distribution and Normal Distribution Density Curve

References

[1] Brown Adipose Tissue Detected by PET/CT Imaging Is Associated with Less Central Obesity." *Nuclear Medicine Communications*, vol. 38, no. 10, 2017, p. 883., doi:10.1097/mnm.00000000741.

[2] Hussein, Sarfaraz, et al. "Automatic Segmentation and Quantification of White and Brown Adipose Tissues from PET/CT Scans." *IEEE Transactions on Medical Imaging*, vol. 36, no. 3, 2017, pp. 734–744., doi:10.1109/tmi.2016.2636188.

[3,4] Robert Collins. CSE486 Computer Vision I." *A Collection of Well-Known Software Failures*, www.cse.psu.edu/~rtc12/CSE486/

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