Lecture 1: Introduction to Biomedical Imaging Technology

2/28/2024

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School of Biomedical Engineering

ShanghaiTech University

Lecture 1: Introduction to Biomedical Imaging Technology (BIT)

❑Who
- Instructor + TA
- You

❑What
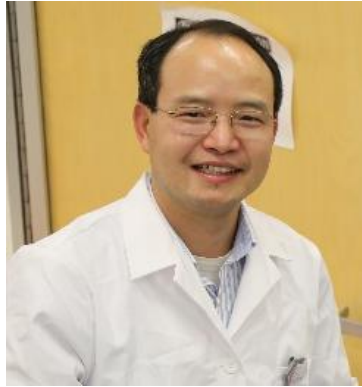- Lay-person Definition: Inner Vision
- Scientific Definition

❑Why
- Health knowledge for you and your loved ones
- A career with better pay

❑How
- Learning Goal
- Textbook + Syllabus
- Grading
- Foundation + MATLAB

Professor and TA(s)

Dr. Guohua Cao
曹国华

Miss. Jiayi Wu
吴嘉怡

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曹国华

生医工学院 2021年级

导师：---

研究兴趣：生物医学成像

- **背景信息**：
  - 本科 中国科大 化学物理专业
  - 博士 美国布朗大学(Brown University)
  - 2011-2021 Virginia Tech 教授、研究员
  - 2014 美国国家自然基金会杰出青年教授

性格特征：求真 务实 担当　　　**爱好**：旅游，阅读，音乐

You, Me, Us

• A slide about you

• Wechat group for this course

课前调查

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Mysterious Vision

Superman Vision

What is Biomedical Imaging?

Biomedical imaging is the science and technologies underlying the **acquisition**, **reconstruction**, **processing**, and **interpretation** of images of a biological object.

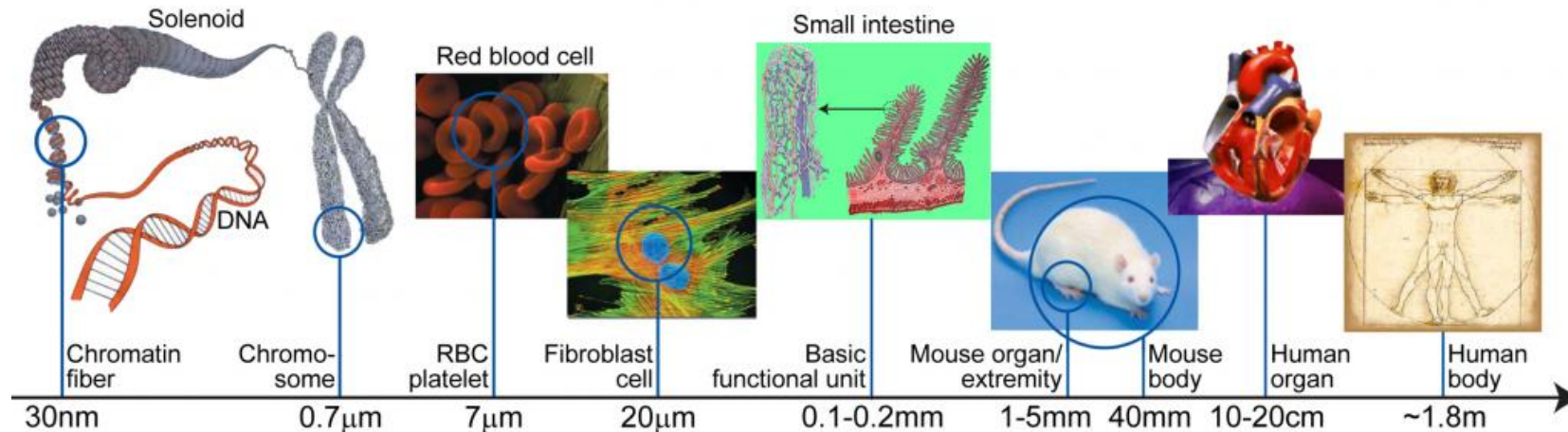Acquisition → Reconstruction & Processing → Interpretation
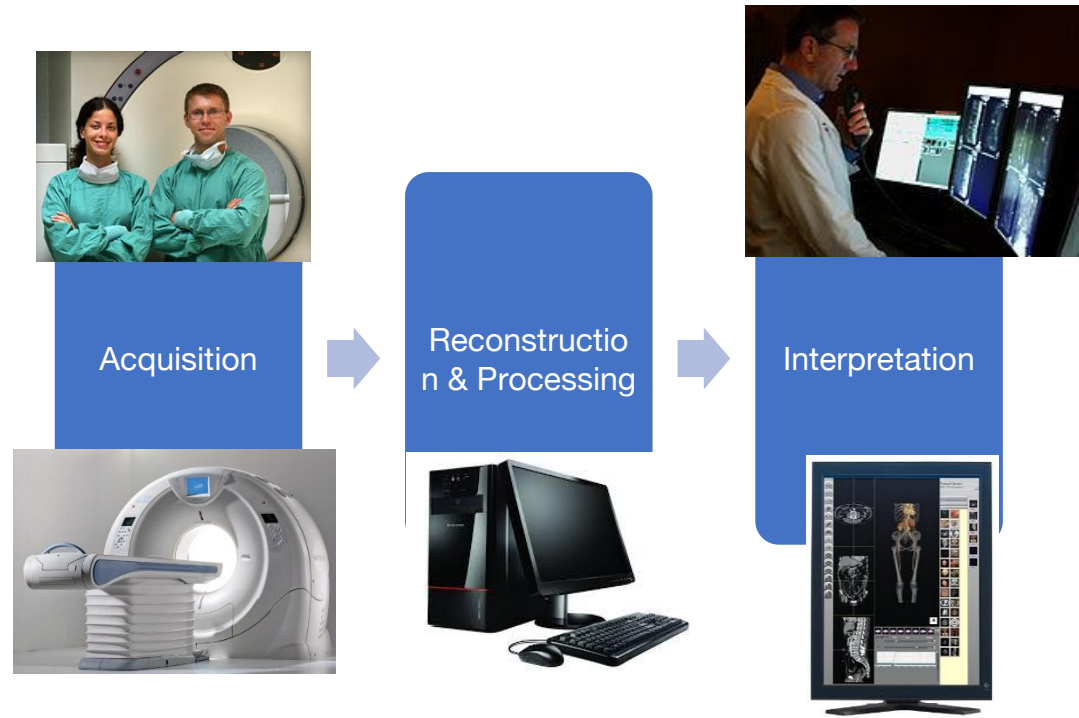
Biomedical Imaging vs. Medical Imaging

Biomedical imaging covers much **broader** topics. In addition to medical imaging, it includes topics in biological sciences and engineering.

Medical imaging: clinical domain
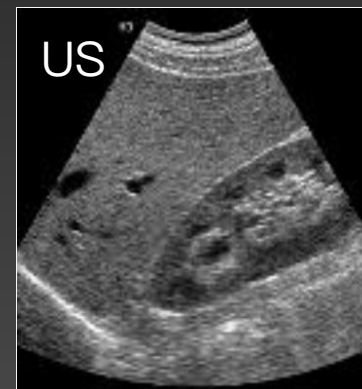**Biomedical imaging: research domain**
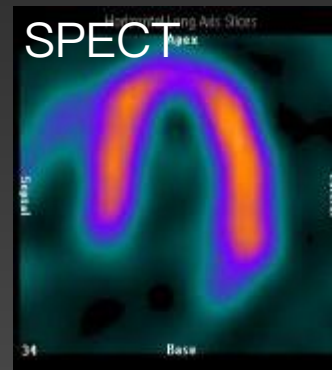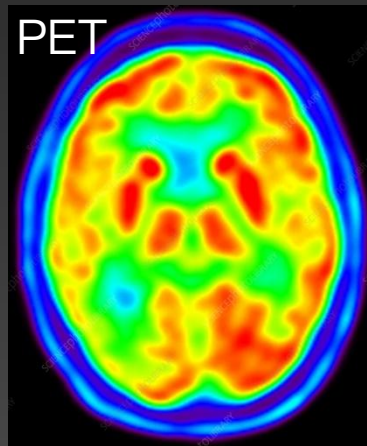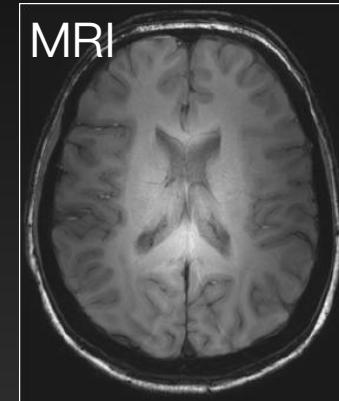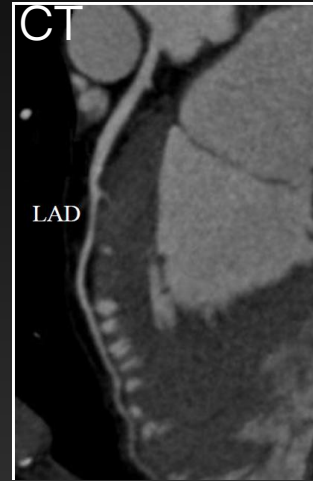
Medical Imaging Modalities

List of major medical imaging modalities:

- X-rays
- CT (Computed Tomography)
- MRI (Magnetic Resonance Imaging)
- US (Ultrasound)
- PET (Positron Emission Tomography)
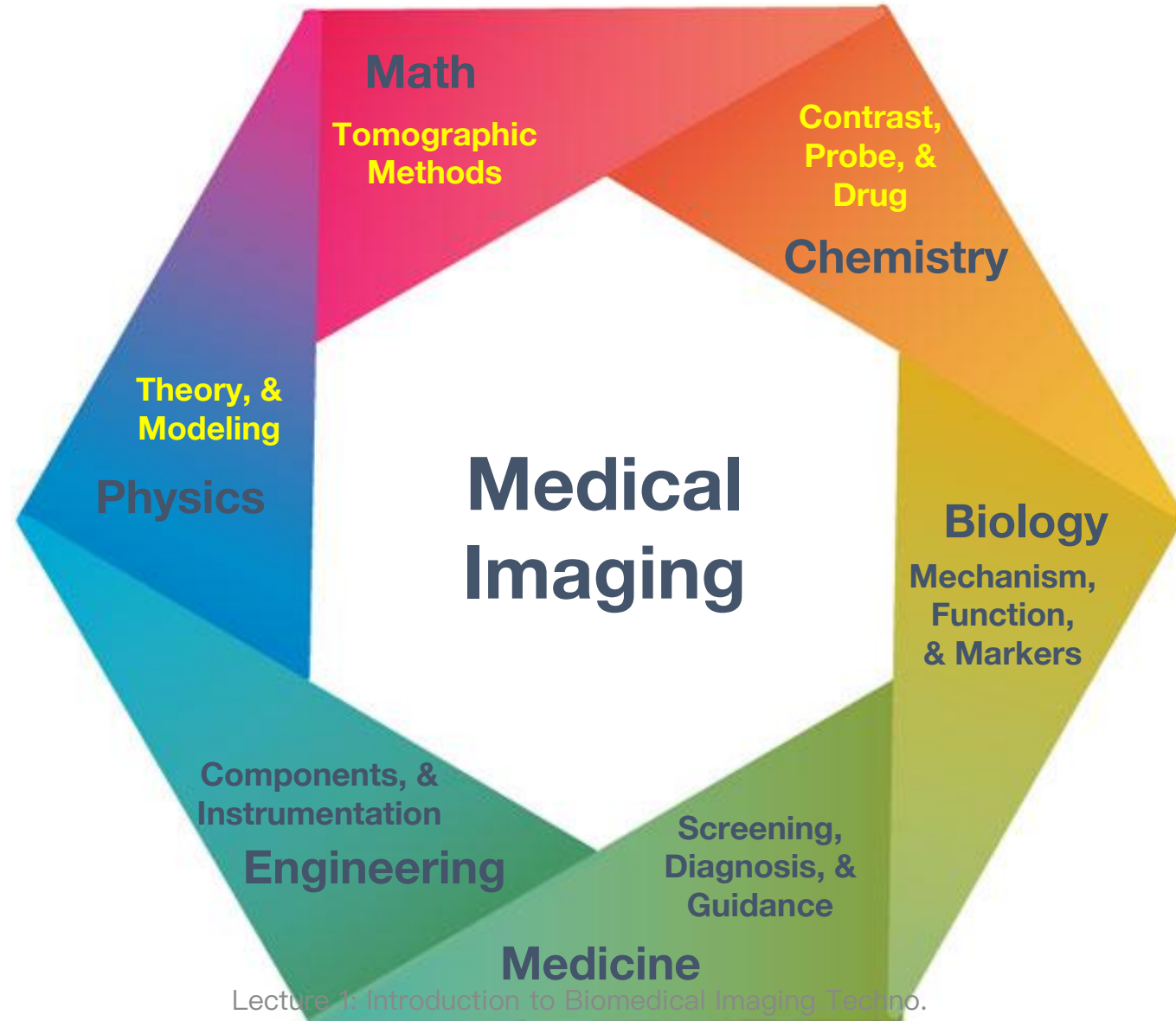- SPECT (Single-Photon Emission Computed Tomography)

Multi-Modalities:
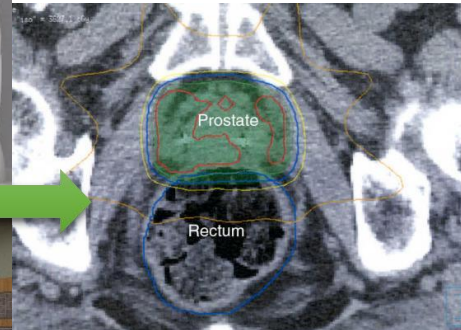
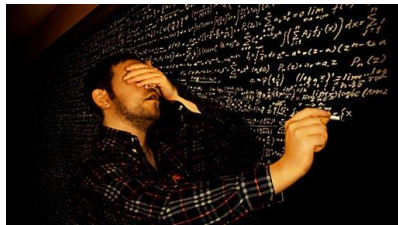- PET/CT
- SPECT/CT
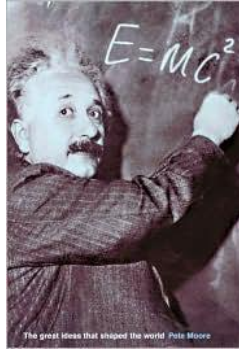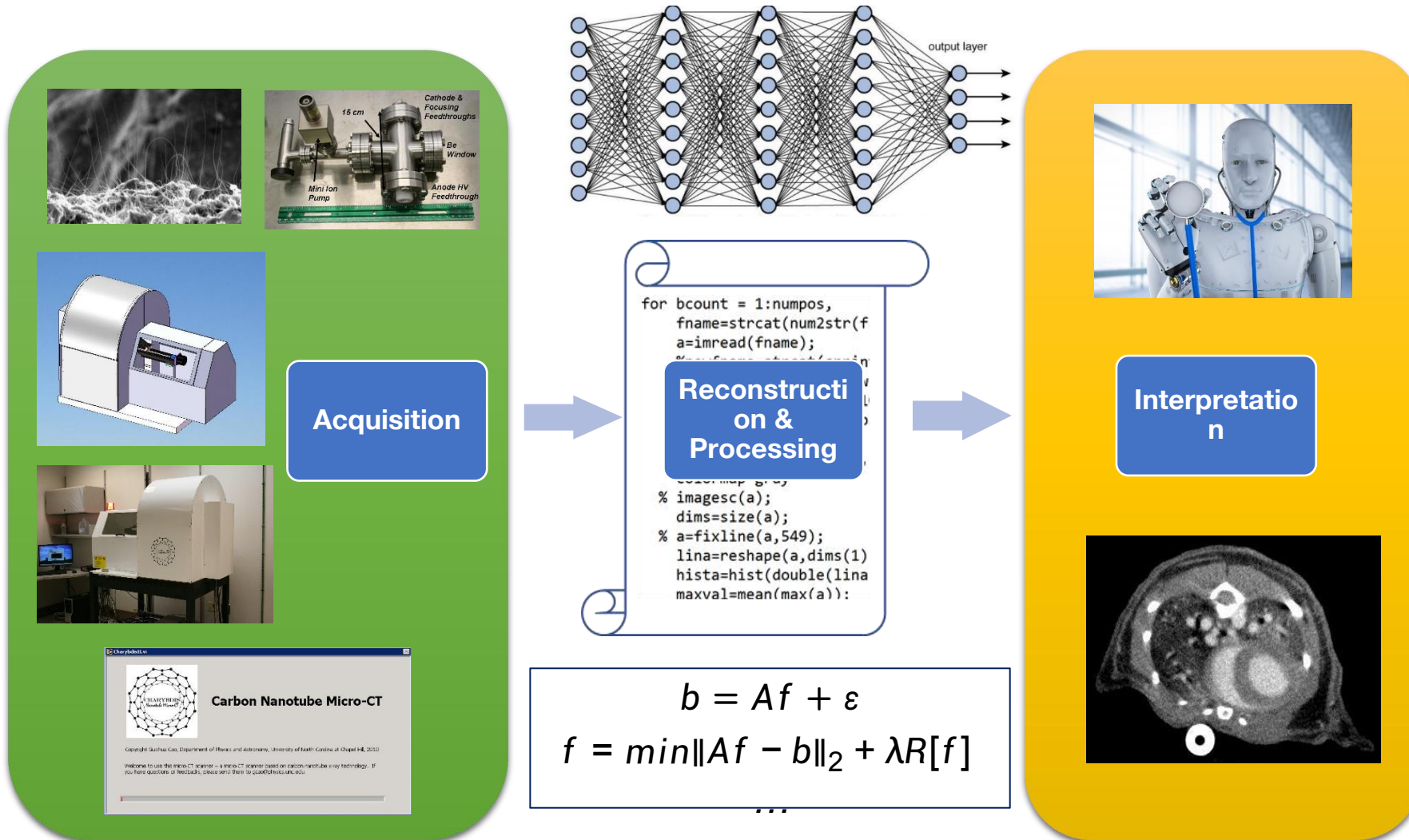- PET/MRI
- ...

Example Images

Highly Interdisciplinary Field

The Make of CT Scanner

Physical System

The Path from Science to Medicine
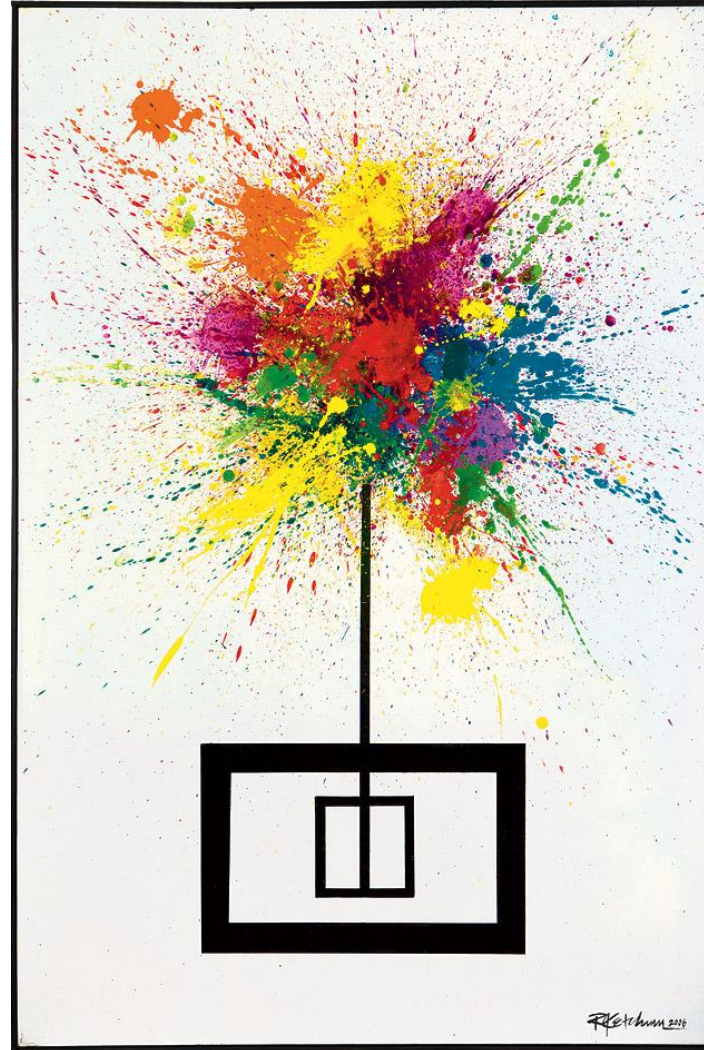
Acquisition

Reconstruction & Processing

Interpretation

$$b = Af + \varepsilon$$

$$f = min\|Af - b\|_2 + \lambda R[f]$$

Think Outside of Box

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Medical Vision — Good for Saving Life

Accidents are leading cause of death for people under 40!

Trauma Imaging

Contrast enhanced CT Scan of abdomen following motor vehicle collision (MVC) shows fluid in abdomen. The left kidney shows minimal linear area of non-enhancement in the medial cortex(arrow). This may represent a very small laceration or minor renal contusion: grade I or grade II.
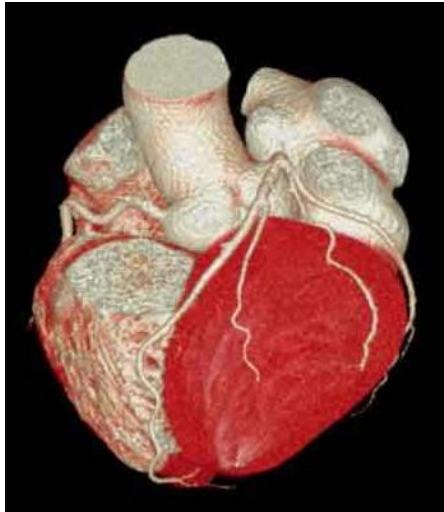

车祸导致肾脏破裂

Stroke Imaging

CT provides fast and much more information and allows for non–operative management.
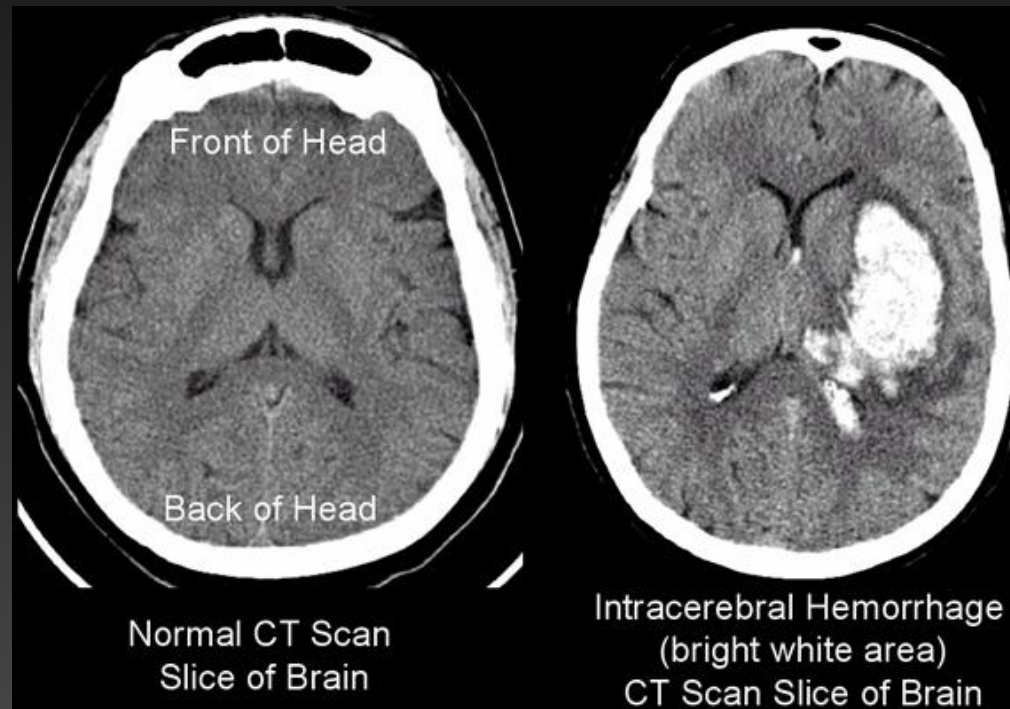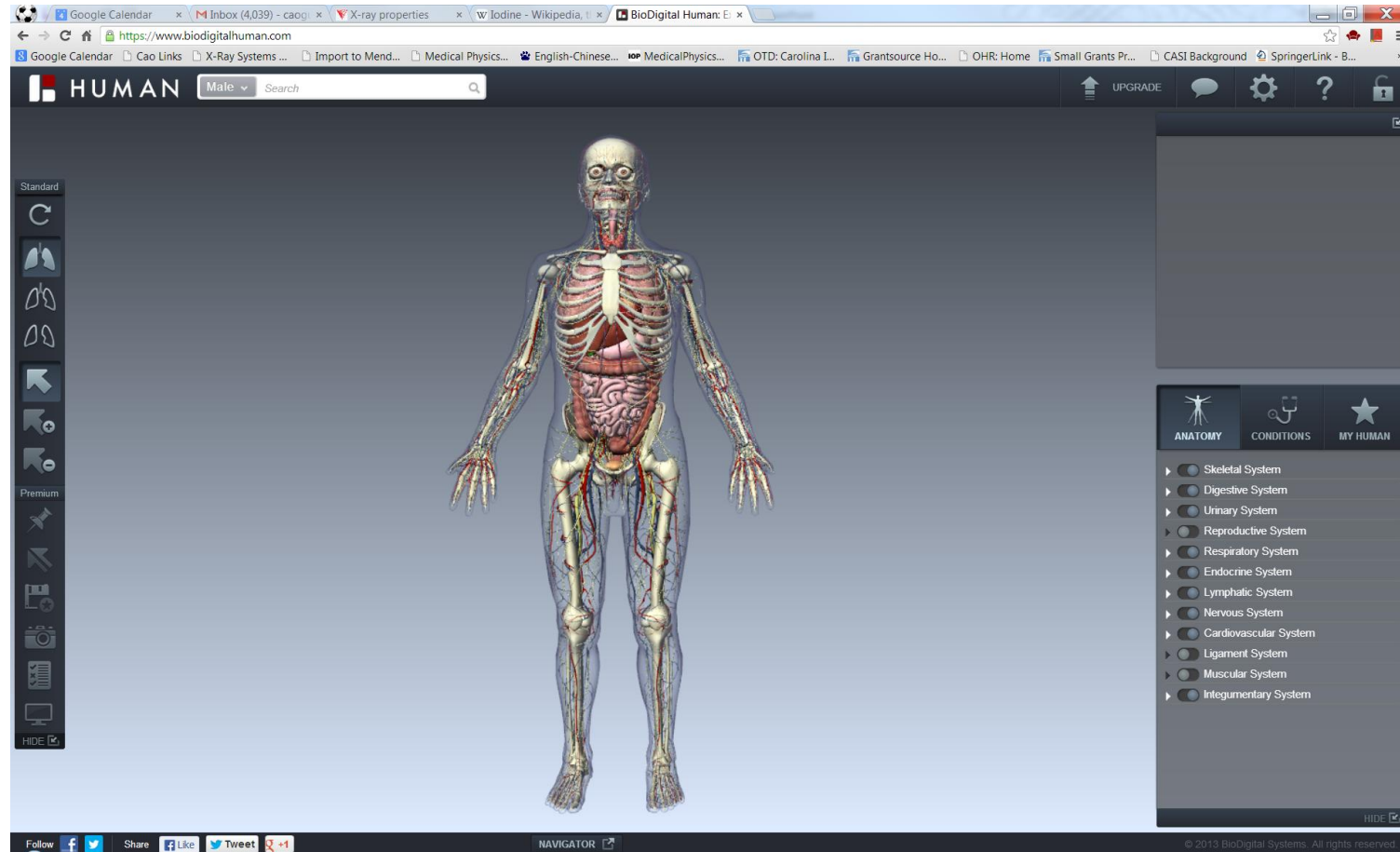
Good for Health & Happiness

Human Anatomy

www.biodigitalhuman.com

Good for Art

Good for Job

The Ten Fastest-Growing Jobs You Should Go to School for Today
Expected Growth from 2008 to 2018 and Mean Average Salary

+72% Biomedical Engineers — $81,120 — Bachelor's degree needed

+53% Network Systems and Data Communications Analysts — $73,830 — Bachelor's degree needed

+41% Financial Examiners — $78,180 — Bachelor's degree needed

+40% Medical Scientists — $81,870 — Doctoral degree needed

+39% Physician's Assistants — $81,610 — Master's degree needed

+38% Skin Care Specialists — $32,040 — Postsecondary Vocational Award needed

+37% Biochemists & Biophysicists — $81,120 — Bachelor's degree needed

+37% Athletic Trainers — $41,620 — Bachelor's degree needed

+36% Physical Therapist Aides — $24,770 — Associate degree needed
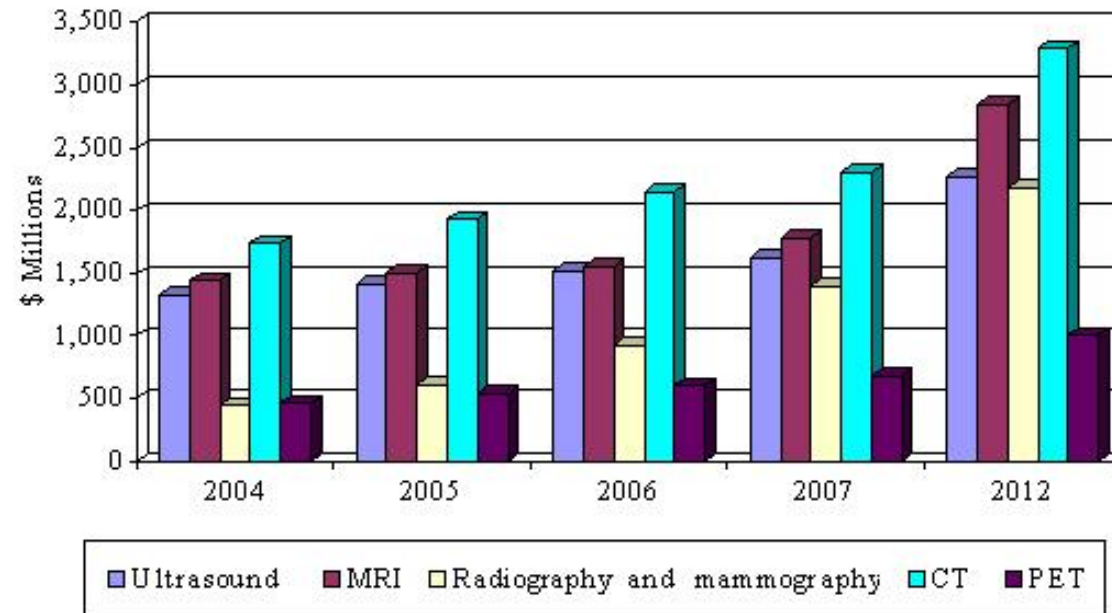
+36% Dental Hygienists — $66,950 — Associate degree needed

Jump start your education with our comprehensive **Open Education Library**, featuring the all the free educational resources on the web.

Online Colleges — The Source for Online Education Information

Medical Imaging Equipment Market
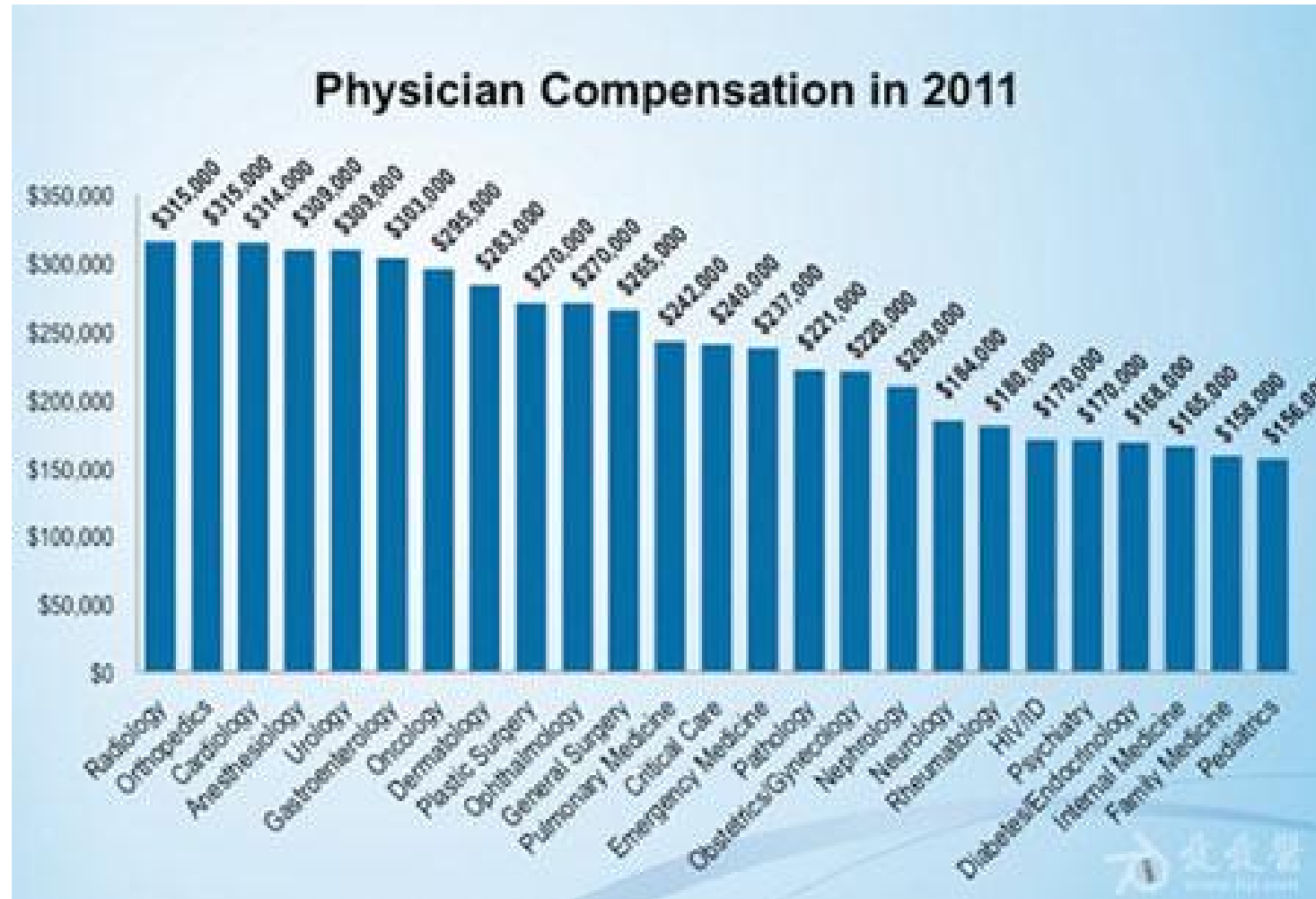

Number of scans each year in the U.S.,

CT: ~80m
MRI: ~40m
PET+SPECT: 15-20m (~75% SPECT)

中国每百万人口**CT**机拥有率为美国的**1/2**，日本的**1/5** 。

How much $$$ radiologists make?

AI probably will never replace human readers.

急需研究型、复合型医学影像人才

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Learning Goal

- **Teaching Objectives:**
  - 知识认知能力：通过本课程的学习与训练，学生能掌握X射线成像、CT、MRI、核医学成像、超声成像等医学影像模态的成像物理原理和方法，了解各种医学影像技术的临床应用，同时能开展医学影像科研领域的相关研究。

  - 综合素质能力：能对相关行业的发展现状有客观的认识，能理解医学影像职业道德和规范，具备科学精神和工程师的基本素养，具备科技报国的家国情怀和使命担当；通过对医学影像交叉学科知识的学习，能进行团队协作，具备合作精神和人际沟通能力。

- **建议先修知识:**
  - 高等数学，线性代数，基础物理，光学，傅里叶变换，信号处理，生物医学影像导论
  - MATLAB （本课堂会教一些）

Textbooks & Tools

<u>Textbook:</u>

- 康雁，《医学成像技术与系统》，清华大学出版社，1st edition （2014）
- Andrew G. Webb, **"Introduction to Biomedical Imaging"**, Wiley – IEEE Press (2003)
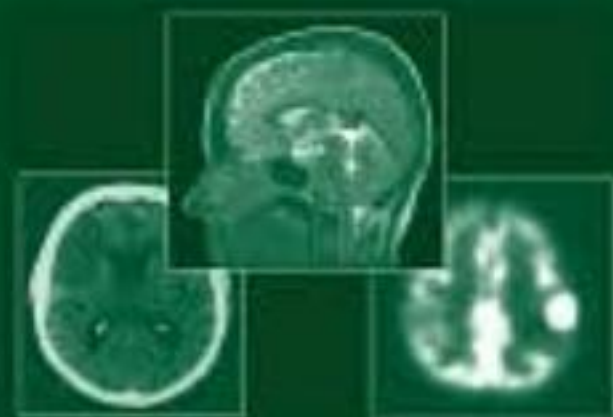
<u>Good to have in class:</u>

- **Laptop**
- **ImageJ**

医学成像技术与系统

康 雁 主编

Introduction to Biomedical Imaging

ANDREW WEBB

Grading

Weighting Factors:

- 作业（~5次）： 30%
- 阶段考核测试（2次）： 30% （期中20% + 期末10%）
- 课程报告：30%
- 随堂考核：10%
- 课程表现：+10%

Letter Grades:

等级	A+	A	A-	B+	B	B-	C+	C	C-	F	P	NP	N
绩点	4.0	4.0	3.7	3.3	3.0	2.7	2.3	2	1.7	0	N/A	N/A	N/A
参考百分制换算关系	95-100	90-94	85-89	80-84	75-79	70-74	67-69	63-66	60-62	0 -59	≥60	<60	未有成绩记录

学术诚信

本课程高度重视学术诚信，严禁抄袭、作弊等行为。

在学习、科研、实习实践等活动中，学生应恪守学术道德，坚守学术诚信，保护知识产权，坚持勇于创新、求真务实的科学精神，努力培养自己严谨求实、诚实自律、真诚协作的科学态度，成为良好学术风气的维护者、严谨治学的力行者、优良学术道德的传承者。