中国石油大学
CHINA UNIVERSITY OF PETROLEUM

JET 101

石油工程数值分析及数据可视化方法

王斌

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CUPB
厚积薄发，开物成物

Python科学计算

学习目标

学习目标	学习成果	效果考察	课程活动
应该掌握哪些知识？	应该能够做哪些事情？	怎么考察学生？	应该怎么学习？
1. 实战非线性方程解法 • 数学算法回顾 • Scipy库的使用 2. 中期Project答疑 3. 期末Project的Proposal	1. 能够针对数学算法自行编程求解 2. 可以找到对应的库进行求解计算	1. 测试学生是否能编程二分法解非线性方程 2. 测试学生能否寻找并使用scipy 3. 课堂测验简单问题 • 期末Proposal	1. 完成期中Project

Python科学计算

非线性方程（Root finding）解法

$$f(x)=0$$

PR气体状态方程 $f(x)=Z^3+(B-1)Z^2+(A-2B-3B^2)Z-AB+B^2+B^3$

Colebrook管流压耗摩阻系数 $\frac{1}{\sqrt{f}}=-2\log\left(\frac{\varepsilon}{3.7D_h}+\frac{2.51}{\mathrm{Re}\sqrt{f}}\right)$

- **Bisection method （二分法）**
- **Fixed-Point Iteration (不动点迭代法)**
- **Newton-Rapson Method (牛顿迭代法)**

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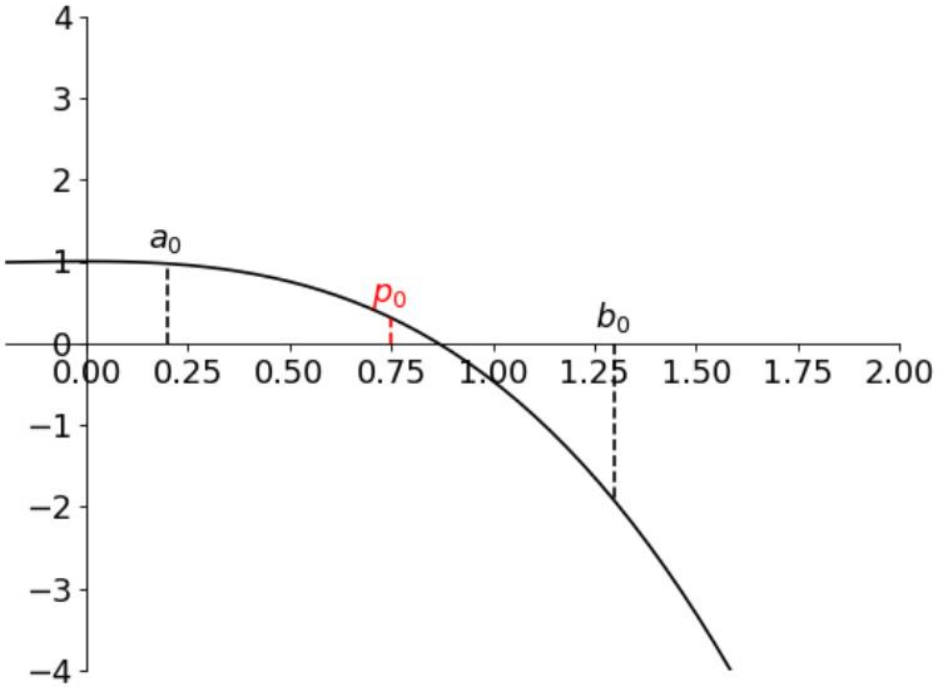
非线性方程（Root finding）解法 – 二分法

$$f(x)=\cos(x)-x^3$$

$$a_0=0.2,\quad b_0=1.3$$



INPUT endpoints a, b; tolerance TOL; maximum number of iterations N_0.

OUTPUT approximate solution p or message of failure.

Step 1 Set $i = 1$;
$FA = f(a)$.

Step 2 While $i \le N_0$ do Steps 3–6.

Step 3 Set $p = a + (b - a)/2$; (*Compute* p_i.)
$FP = f(p)$.

Step 4 If $FP = 0$ or $(b - a)/2 < TOL$ then
OUTPUT (p); (*Procedure completed successfully.*)
STOP.

Step 5 Set $i = i + 1$.

Step 6 If $FA \cdot FP > 0$ then set $a = p$; (*Compute* a_i, b_i.)
$FA = FP$
else set $b = p$.

Step 7 OUTPUT ('Method failed after N_0 iterations, N_0 =', N_0);
(*The procedure was unsuccessful.*)
STOP.

Python科学计算

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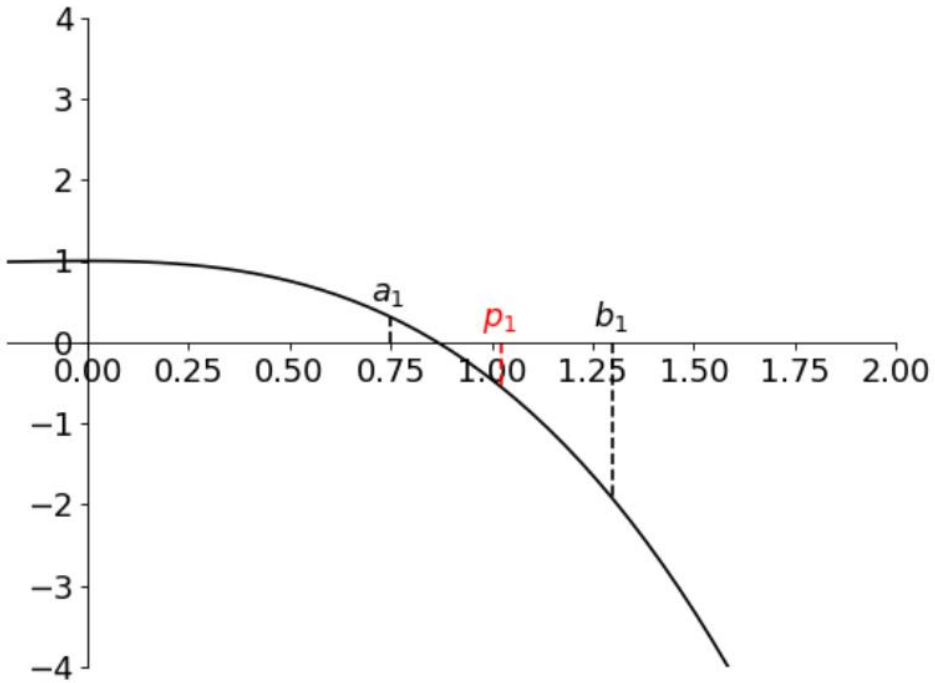

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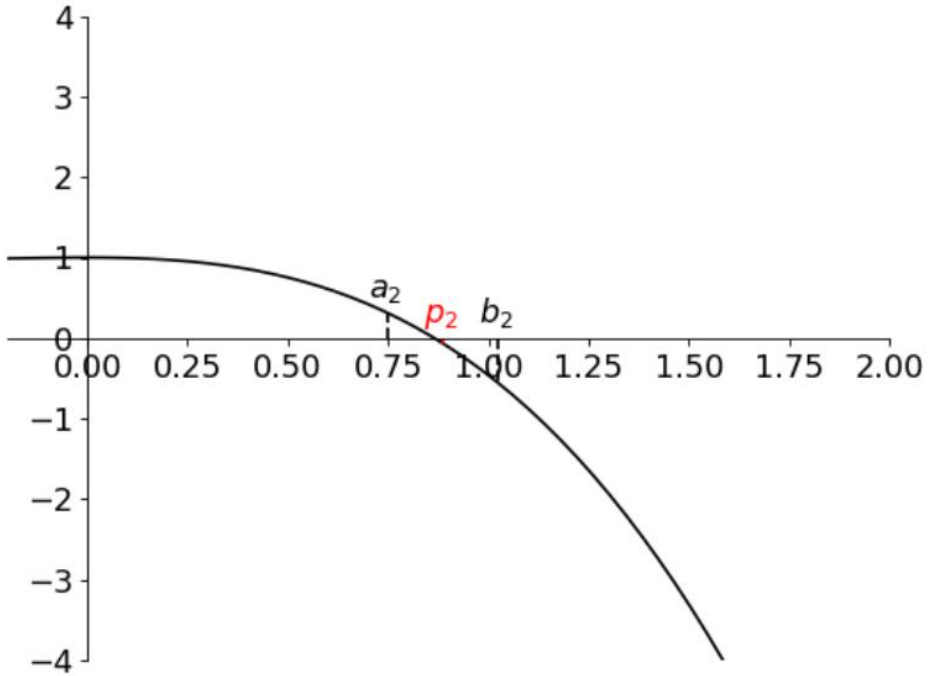

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i	a	b	p
1	0.2	1.3	0.75
2	0.75	1.3	1.025
3	0.75	1.025	0.8875
..	..	..	
10	0.8649	0.8660	0.8654

INPUT endpoints a, b; tolerance TOL; maximum number of iterations N_0.

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Python科学计算

非线性方程（Root finding）解法 – 作业

The Peng-Robinson Equation of State

$$P = \frac{RT}{V_m - b} - \frac{a\alpha}{V_m^2 + 2bV_m - b^2}$$

$$a = \frac{0.45724R^2T_c^2}{P_c}$$

$$b = \frac{0.07780RT_c}{P_c}$$

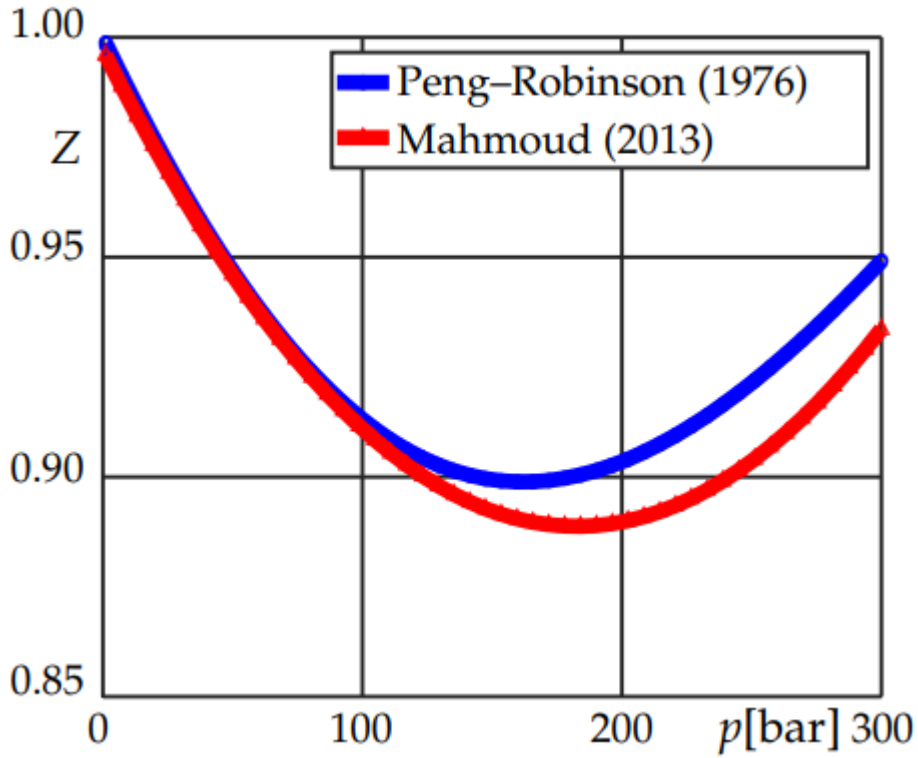
$$\alpha = \left(1 + \left(0.37464 + 1.54226\omega - 0.26992\omega^2\right)\left(1 - T_r^{0.5}\right)\right)^2$$

$$T_r = \frac{T}{T_c}$$

Where ω is the acentric factor for the species,
P_c is critical pressure,
T_c is critical temperature.

Values applied for 100% methane (CH_4):
ω = 0.0115
T_c = 191.15 K
P_c = 4.641 MPa.

The ideal gas constant R = 8.314413 J/mol-K

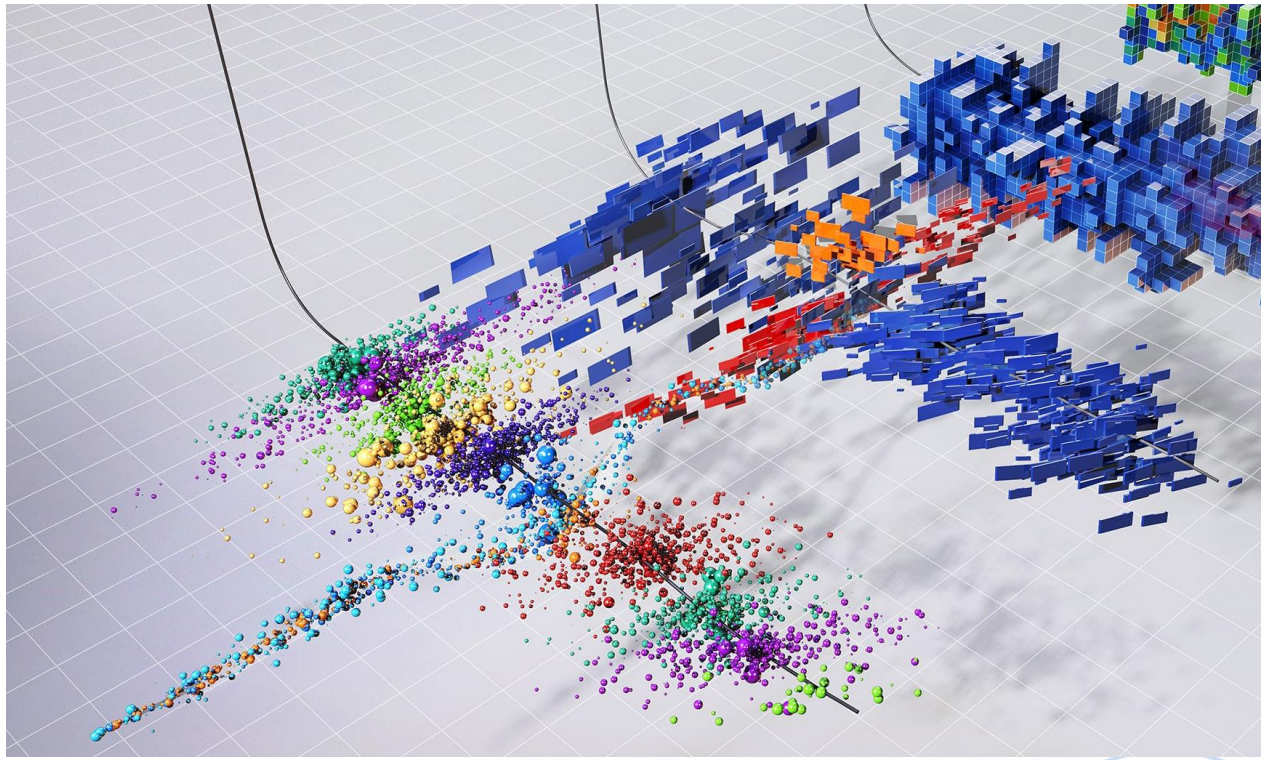


Wang, B. and Fidelibus, C., 2021. An Open-Source Code for Fluid Flow Simulations in Unconventional Fractured Reservoirs. Geosciences, 11(2), p.106.

课程大作业

期中大作业

- 组队或者单人（不超过3人）
- OnePetro阅读文献，从一个角度
- xlwings读单井数据Excel
- Matplotlib画2D井眼轨迹
- Matplotlib微地震散点图
- PyVista三维画图（奖励任务）

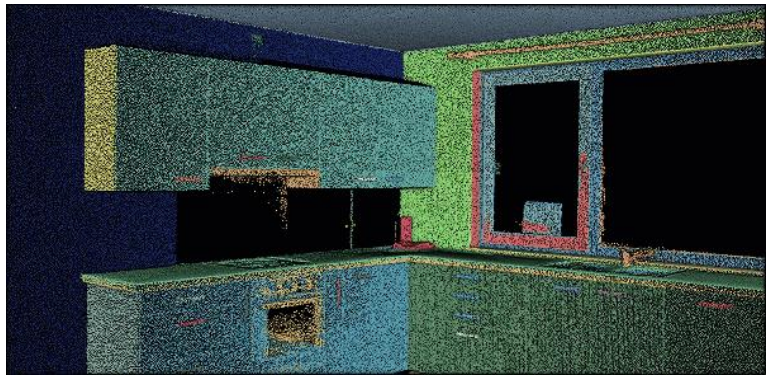


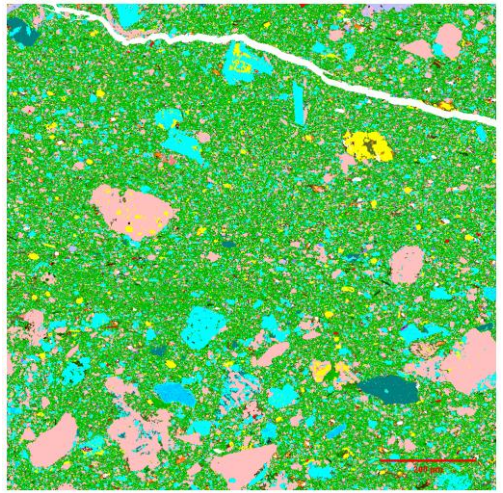
https://edx.netl.doe.gov/dataset/hfts-1-phase-1-microseismic-data-and-results

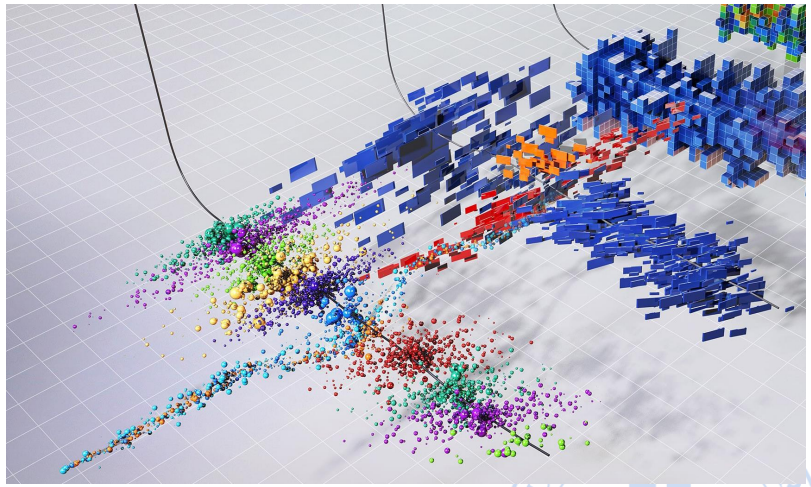
课程大作业

期末大作业选题

- QEMSCAN数字岩心矿物分割与分析
- 3D裂缝地层COMSOL网格转换
- 3D井眼轨迹与微地震数据可视化
- 3D微地震点云裂缝网重构*
- 超临界CO2状态SW方程求解
- …..







*https://www.freehowtos.com/how-to-automate-3d-point-cloud-segmentation-and-clustering-with-python/

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