Homework1
A1
Acoustic wave equation finite diference simulator
声波方程有限差分模拟器
acoustic simulator 声学模拟器
velocity model, the source parameters, and simulation parameters
速度模型、源参数和 模拟参数
displays the "evolving" acoustic pressure field amplitude in a movie-like figure (snapshots)
程序显示“演变”的声压场振幅 电影般的人物（快照）中的百分比
define an optional set of receivers positions
用户可以定义一组可选的接收器位置
The program shows and outputs the pressure recorded at the receivers (seismic traces).
程序显示并输出接收器记录的压力（地震道）
The receivers that are out of the model are automatically rejected, and so the seismic traces can be less than the input receivers:
the output structure contains the actual position of the 'valid' receivers.
输出结构包含 “有效”接收者的实际位置
Vector of x grid coordinates x 网格坐标向量
matrix of velocity values 速度值矩阵
vector of x coordinates of receivers 接收器 x 坐标向量
max time sampling interval for seismic traces
地震道最大时间采样间隔
central frequency of source Ricker wavelet
source.f0: 震源 Ricker 子波的中心频率
time of source emission (referred to max peak of Ricker)
source.t0：源发射时间（指雷克最大峰值）
1 is Ricker, 2 is sinusoid at frequency source.f0
source.type: 1 为雷克波，2 为频率为 source.f0 的正弦波
multiplier of source amplitude
source.amp：源振幅乘数

max simulation time [s]
% simul.timeMax：最大模拟时间[s]
Absorbing boundaries (Yes:1, No:0)
% simul.borderAlg：吸收边界（是：1，否：0）
pressure map shown every printRatio comput. time steps
% simul.printRatio：每个 printRatio 计算时间步骤显示的压力图
colormap between -highVal and + highVal (from 0 to 1)
% simul.higVal：-highVal 和 + highVal 之间的颜色图（从 0 到 1）

values between -lowVal and +lowVal zeroed (from 0 to 1)
% simul.lowVal：-lowVal 和 +lowVal 之间的值归零（从 0 到 1）
velocity matrix as a "shadow" in the images (1:yes, 0:no)
% simul.bkgVel：速度矩阵作为图像中的“阴影”（1：是，0：否） %% 可选参数 %
simul.cmap：颜色表（默认“灰色”）

Acoustic simulator program call
声学模拟器程序调用
time axis of recorded signal
% recfield.time：记录信号的时间轴[s]，Nt 个元素
matrix of pressure at the receivers, (Nt,Nr1)
% recfield.data：接收器处的压力矩阵，（Nt，Nr1）
vector of x grid coordinates of receivers
% recfield.recx：接收器 x 网格坐标向量[m]，Nr1 个元素

Plotting seismic trace program call
绘制地震道程序调用

[fact]=seisplot2(datain,t,tr,scal,pltflg,scfact,colour,clip)
function for plotting seismic traces
绘制地震轨迹的函数

% INPUT
% datain - input matrix of seismic traces
% t - time axis
% tr - trace axis
% scal - 1 for global max, 0 for global ave, 2 for trace max
% pltflg - 1 plot only filled peaks, 0 plot wiggle traces and filled peaks,
% 2 plots wiggle traces only, 3 imagesc gray, 4 pcolor gray
% scfact - scaling factor
% colour - trace colour, default is black
% clip - clipping of amplitudes (if <1); default no clipping

Sampling interval for stability (computed automatically)
Courant-Friedrick-Levy (CFL) stability condition (display warning)

CONSTANT MODEL AND RECEIVERS ON A CIRCLE
常数模型和圆上的接收器

Plot receivers traces 绘制接收器轨迹

讲解代码

Model and grid 模型和网格
A uniform Cartesian grid 均匀笛卡尔网格
Nx = 1001, Nz = 501 grid points (note: number of *samples*, not meters).

velocity model assignement: constant velocity 得到速度 v
A constant **acoustic P-wave velocity** model (v = 2000 m/s) everywhere.
Since velocity is uniform, we expect a purely expanding circular

Source (If we provide vectors for these fields, the code will inject multiple sources**) source, (400, 250) 源**
The receiver circle (接收器的中心) is centered at (500, 250) (from model size)
Type 1 = Ricker wavelet, a common zero-phase impulse-like source in seismics.
主峰值频率 Dominant (peak) frequency f0 = 40 Hz ⇒ 主波长 dominant wavelength λ ≈ v/f0 = 2000/40 = **50 m**.
t0 is the time shift so the main lobe "peaks" at 0.04 s.

Receivers on a circle 圆形接收器
We place 100 receivers on a circle of radius 200 m centered approximately at (x=500, z=250)（接收器的中心，根据模型大小来算得的，X, Z 除以 2）. With the model 0–1000 by 0–500, this circle（接收器） lies safely inside the domain (x: 300–700, z: 50–450). 接收器成功匹配这个模型网格

model.dtrec = 0.004;
Traces will be recorded/saved with max sampling interval 4 ms (250 Hz Nyquist). Your source has most energy < ~2.5 f0 ≈ 100 Hz (Ricker's effective bandwidth), so 4 ms is adequate.

Simulation controls 模拟控制
simul.borderAlg = 1;
Use absorbing boundaries (sponge/PML-style), reducing reflections from model edges. Keep this **ON** unless you want to study boundary effects.
simul.timeMax = 0.5;
Run for 0.5 s total. With v=2000 m/s, the wave can traverse up(传播) to ~1000 m one

way in 0.5 s, so you’ll see the wave reach the far side.

Display options:显示选项：
simul.printRatio = 10;
show snapshots every 10 time steps.
每 10 个时间步显示一次快照。

simul.higVal = .1; simul.lowVal = 0.01;
clamp/cut low amplitudes and cap the color scale (±highVal). **Helps contrast.**
钳制/切断低振幅并限制色阶 (±highVal)。有助于对比。

simul.bkgVel = 1;
plot velocity as a faint background “shadow” behind the pressure field.simul.bkgVel = 1;
将速度绘制为压力场后面的微弱背景“阴影”。

simul.cmap = 'gray';
colormap for snapshots.simul.cmap = 'gray'; 快照的色彩图。

Core call 核心调用
recfield = acu2Dpro(model,source,simul);
This runs a 2D finite-difference time-domain (FDTD) acoustic solver and returns:这将运行二维有限差分时域 (FDTD) 声学求解器并返回：

recfield.time (Nt×1) sampled time axis for recorded traces,recfield.time （Nt×1）记录轨迹的采样时间轴，

recfield.data (Nt×Nr1) pressures at valid receivers (Nr1 can be < Nr if some receivers fell outside the grid after rounding),
recfield.data (Nt×Nr1) 有效接收器处的压力（如果一些接收器在四舍五入后落在网格之外，则 Nr1 可以是 ＜Nr），

recfield.recx,
recfield.recz (actual receiver coordinates used).
（实际使用的接收器坐标）。

Plot receivers traces 绘制轨迹 seismic traces 地震图
scale each trace by its own max (equal visual amplitude across traces).
scal=2 → 根据每个轨迹的最大值对其进行缩放（轨迹间的视觉振幅相等）。

wiggle + filled peaks (classic seismic look).
pltflg=0 → 摆动 + 填充峰（经典地震外观）。
apply an extra scaling factor of 1 (i.e., none).s
cfact=1 → 应用额外的缩放因子 1（即无）。
(default black).
colour='' （默认黑色）。
(no additional clipping).
clip=1 （无额外剪辑）。You'll get a **gather** with trace index on x-axis and time on y-axis.

代码在做什么？
Finite differences (FDTD)有限差分（FDTD）

Stability (CFL) and sampling 稳定性（CFL）和采样

结果图？
This is a synthetic seismic **shot gather**: 100 traces (x-axis = receiver index; y-axis = two-way time). The dark, arch-shaped band that "bows up" in the middle is a **reflection hyperbola**.
100 条道（x 轴 = 接收器索引；y 轴 = 双程时间）。中间向上"弓起"的暗拱形带是**反射双曲线**。

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总结：
It's a 2-D **acoustic finite-difference** forward model: inject a **Ricker** source into a **constant-velocity** grid, record pressure at **100 receivers on a circle**, and plot the synthetic **seismogram** (wiggle gather) plus movie snapshots of the wavefield.

结果解释：
same first-arrival time (a flat line in the gather).
horizontal arrival in the wiggle(微狗)plot