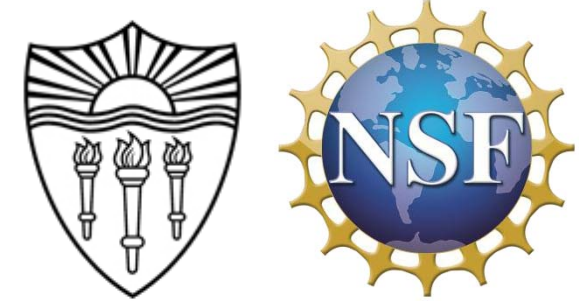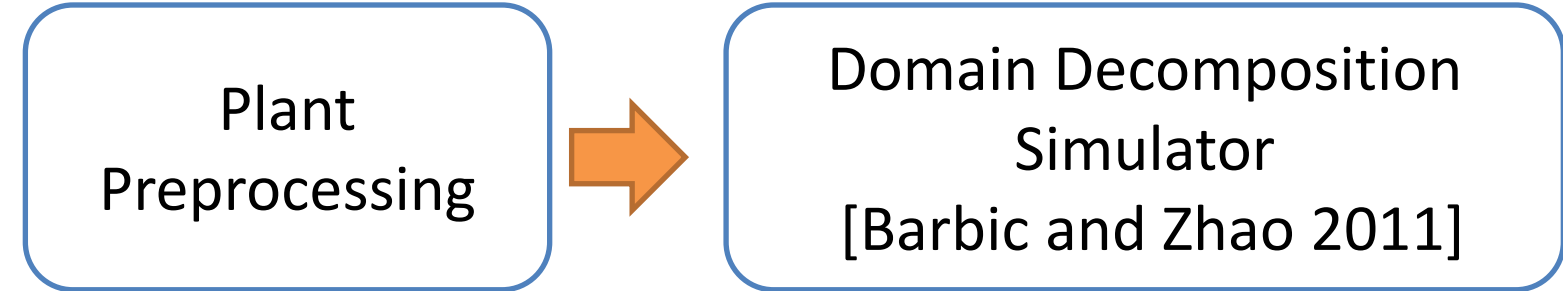# Interactive Simulation of Plant Motion

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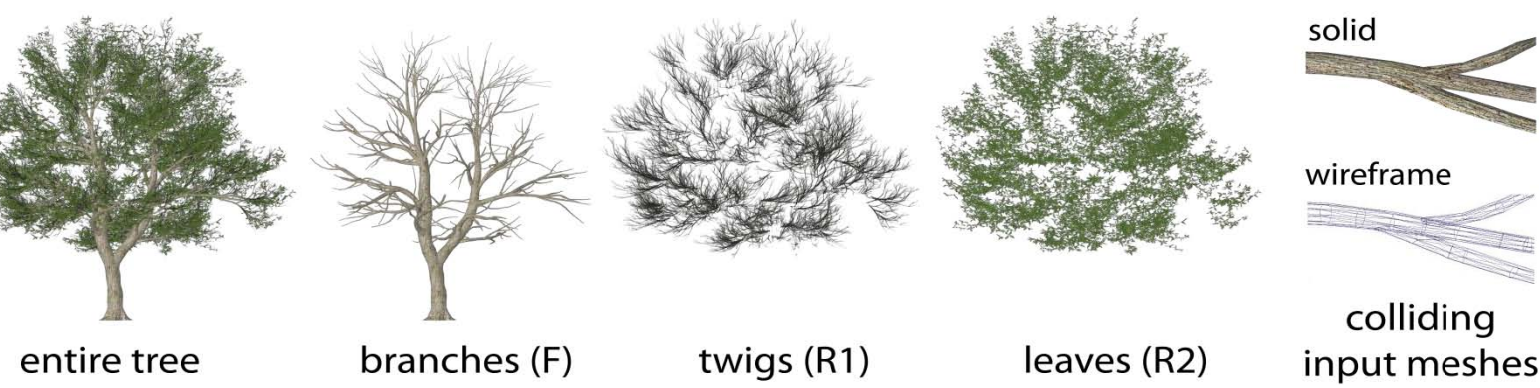
Goal:

Fast simulation of plants undergoing large deformations
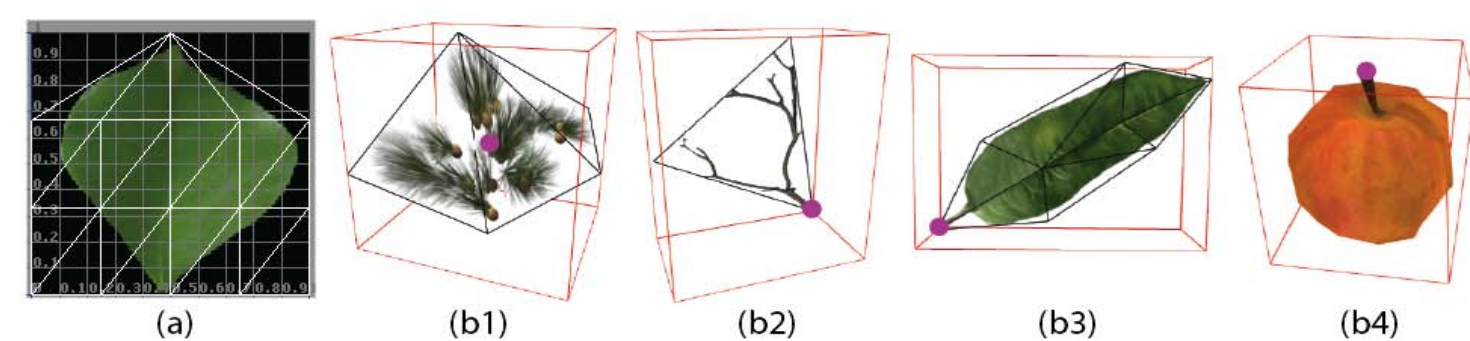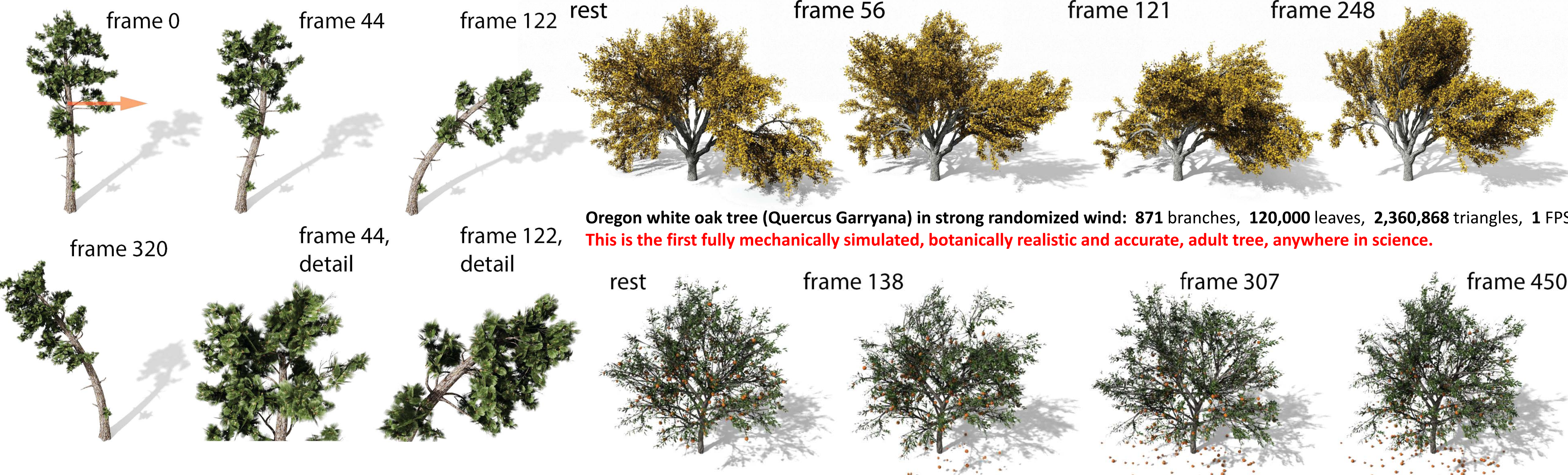
Plant Preprocessing → Domain Decomposition Simulator [Barbic and Zhao 2011]

Plant Preprocessing

Step 1: (U) Organize mesh into domains

entire tree | branches (F) | twigs (R1) | leaves (R2)

solid / wireframe / colliding input meshes

Step 2: (U) Instancing

(a) (b1) (b2) (b3) (b4)

Step 3: (AU) Recover **F** tree hierarchy

A
B
incorrect cycle-breaking graph edge / correct edge to break the cycle
C (1) add root (2) cycle (3)
(4) root
D

Step 4: (A) Add **Rx** to tree hierarchy

F root R1 R2

q_{11} ... (a) (b) (c) (d) (e)

Step 5: (A) Build simulation meshes

Step 6: (A) Prepare reduced dynamics models

Step 7: (A) Tune Young's modulus

z-displacement of vertex 4422
— Multidomain dynamics
— Multidomain dynamics with adjusted frequencies
--- Full space simulation

frame 0, frame 400, frame 1,200, frame 1,800

timestep: 0, 200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000

Accuracy Comparison

Results

frame 0, frame 44, frame 122

frame 320, frame 44 detail, frame 122 detail

rest, frame 56, frame 121, frame 248

Oregon white oak tree (Quercus Garryana) in strong randomized wind: 871 branches, **120,000** leaves, **2,360,868** triangles, **1** FPS
This is the first fully mechanically simulated, botanically realistic and accurate, adult tree, anywhere in science.
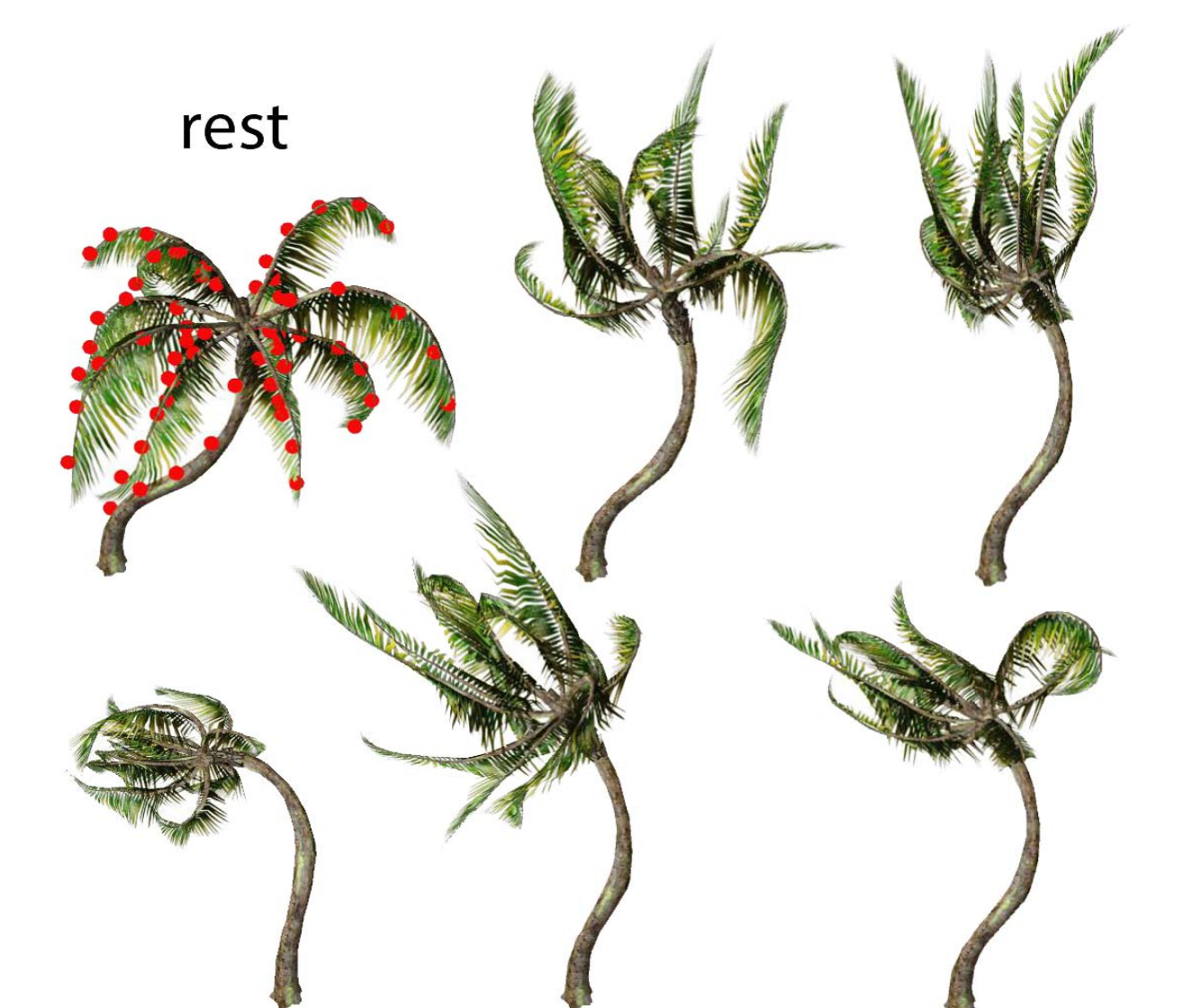
rest, frame 138, frame 307, frame 450

Rich secondary motion: instantaneous force followed by free vibration

Peaches fall from the tree swaying in the randomized wind: 237 branches, **3,556** twigs, **18,536** leaves, **330** fruits, **2,950** DOFs, **20** FPS

The tea bush (Camellia Sinensis) under gravity

rest

Real-time fracture: Leaves are shaken from bush by user-applied force

Palm: wind samples (red). Each leaf is skinned to 1 branch

Interactive editing of plant shape using Inverse Kinematics

Selected subset of simulated plants: variety of **types** (broadleaf, conifer, flower, bush, shrub, vegetable), **geographic locations**, **seasons** (spring, summer, autumn), **climates** (desert, ocean, meadow, forest)