#### Avizo class I

March 5, 2015

#### Aspirin Data Analysis copy from Dr. Butler's lecture

- Objective: Calculate the amount of aspirin in each pill.
- Formula:
  - The number of voxels in the 6 pill mask = 142,818 voxels
  - The average intensity for the 6 pills = 36,786.9
  - The aspirin mass =  $6 \times 81 \text{ mg} = 486 \text{ mg}$
  - Tomography scale factor = (486 mg)/(36,786.9 x 142,818) = 9.25 x 10-8
- Measuring the aspirin in one pill
  - The number of voxels in the pill #2 mask = 22,385 voxels
  - The average intensity for the pill = 35,163.9
  - The aspirin mass = (9.25 x 10–8 )(22,385)(35,163.9) = 72.8 mg

### Steps in Avizo

- Load Data (Raw)
- Binarize
- Separate Objects (streamlined combination of many computing steps)
- Label Analysis
- Analysis Filter
- Interactive object seeking

000

Avizo - aspirin.hx

START PROJECT SECREMATATION ANIMATION	
	Tables
Open Data	aspirin_v2-511x281x305-uint16.Label-Analysis O O aspirin_v2-511x281x305-uint16.Analysis-Filter O O
Animate Ports Caption Synchronize Ports	
□■aspirin_v2-511x281x305-uint16.raw ② + □□Ortho Slice 2 ③	Volume3d Area3d BaryCenterX BaryCenterY BaryCenterZ Mean index
	Mean 1.57090e+06 79101.5 149.194 145.969 252.631 35672.6 264.5
EDInteractive Thresholding ()	Min 1.48803e+06 77441.2 115.625 118.793 52.8263 34719.8 15
	Max 1.63091e+06 81814 194.653 172.229 456.372 36322.3 564
aspirin_v2-511x281x305-uint16.thresholded* ()	Median 1.59962e+06 78756 124.291 151.499 214.261 35626 161
Discounts Objects Ob	Variance 3.00988e+09 2.7072e+06 944.819 377.6 19281.1 316378 44789.6
Diseparate Objects Di	Kurtosis -1.43044 1.17954 -1.62583 -1.42356 -1.29109 0.240008 -1.57174
Emaspirin_v2-511x281x305-uint16.separate* 🕥 🚽 🖽 Ortho Slice 3 🕥	Skewness -0.542094 0.572173 0.242159 -0.0990975 0.018383 -0.518083 0.138532
	Volume3d Area3d BaryCenterX BaryCenterY BaryCenterZ Mean index
ELabel Analysis ()	1 1.48803e+06 78756 194.653 143.501 52.8263 34719.8 15
	2 1.59962e+06 78257 124.291 172.229 125.556 35626 31
aspirin_v2-511x281x305-uint16.label* ()	3         1.58766e+06         77441.2         120.067         164.877         214.261         36088.5         161           4         1.61541e+06         80796.2         127.08         124.014         201.016         35107.5         326
CIR asoldo v2-S11x281x205-ulot16 Label-Analysis* (0)	5 163091e+06 81814 115.625 151.499 375.757 36081.7 480
	6 1.5038e+06 77544.5 162.55 118.793 456.372 36322.3 564
□Analysis Filter ⊙	
□ aspirin_v2-511x281x305-uint16.label-filtering* ③	
Com Volume Rendering Settings	
DE Volume Rendering	
Consolida v2 Elliv291v205 vist16 Apphala Ellipt ()	
© © Properties	
Volume Rendering	
푸 Common Settings: Volume Rendering Settings 💠 🛋	
The selector: NO SOURCE :	
표 Colormap: 1 8 Edit.	
푸 Colormap Lookup: 🔵 alpha 🔄 luminance alpha 💿 rgba	
T Alpha Scale:	
auto-refresh Apply	
	Stop 🗈

#### Load Data

- hdf5 to raw data conversion
- big endian, x fastest
- data type and dimension

	R	aw Dat	a Paramete	rs			and the second
nput							
Data type:	16-bit unsigned	<b>+</b>	1	\$			4
Dimensions:	305	•	281	•	511		
Header:	0		bytes				
Requested:	87590510		bytes				
Filesize: Endianess	87590510		bytes				
💿 big end	ian i little end	lian					
Index order							
Index order	t 🔿 z fastest						
Index order	t 🔿 z fastest						
Index order • x fastes Resolution Define	t 🔿 z fastest						
Index order • x fastes Resolution Define • boundir	ng box		• voxe	size			
Index order • x fastes Resolution Define • boundir Min. coord:	ng box		• voxe	size	0	0	

## Binarize by Thresholding

- interactive thresholding
- tradeoff between coverage and noise
- this data relatively easy to threshold
- apply to generate binary data (.thresholded)

80		Properties
0	Interactive Threshold	ing
₽	Data:	aspirin_v2-511x281x305-uint16.raw
₽	Mask:	NO SOURCE
₽	Preview Type:	🗹 2D 🔲 3D
₽	Preview Orientation:	⊖xy ⊙xz ⊖yz
Ŧ	Colormap:	0 59464
₽	Preview Slice Number:	▲ ► 140 …
₽	Rendering:	🔵 transparent 💿 opaque
₽	Intensity Range:	20730 65535
Ŧ	Color Mask:	
	auto-refresh	Apply

# Separate Objects

- Used on binary data
- Encapsulated combination of:
  - distance map
  - markers by local maxima
  - hierarchical watershed
- Apply to create a new binary data (.separated)

0		Properties
0	Separate Objects	
Ŧ	Input Binary Image:	aspirin_v2-511x281x305-uint16.thresholded ‡
Ŧ	Method:	Chamfer - Conservative ‡
Ŧ	Interpretation:	● 3D ○ XY planes
Ŧ	Neighborhood:	○ 6 ○ 18 ● 26
Ŧ	Marker Extent:	1
Ŧ	Output Type:	split ‡
Ŧ	Algorithm Mode:	repeatable ‡
	auto-refresh	Apply

## Label Analysis

- From binary data to label data
- Measure statistics from label data and the original intensity data
- Two outputs: label image, and label-analysis spreadsheet

80		Properties
0	Label Analysis	?
臣	Data:	aspirin_v2-511x281x305-uint16.separate 🗘 🗧
포	Intensity Image:	aspirin_v2-511x281x305-uint16.raw 😫 🛋
臣	Interpretation:	• 3D OXY planes
포	Measures:	basic 🛟

## Analysis Filter

- remove noise
- identify features
- histogram helps



## Interactive Seeking

- Volume rendering with label colormap
- Individual seeking enabled by twoway connection

Q Z 🕃 A » 🖓 » 🕶 » 🔳 »	00			1	ables			
	aspirin_v2-5	11x281x305-u	int16.Label-Ana		aspirin_v2-5	11x281x305	-uint16.Analy	sis-Filter
	I P							
		Volume3d	Area3d	BaryCenterX	BaryCenterY	BaryCenterZ	Mean	index
l 🔶	Mean	1.41932e+06	80121.2	148.425	150.53	217.466	34717.1	305.714
	Min	172301	38486.9	115.563	118.795	5.41597	32636.7	3
	Max	1.69198e+06	117445	194.819	179.329	456.455	35723.9	714
	Median	1.63269e+06	80608.9	144.894	155.777	126.445	34651.4	59
	Variance	2.62272e+11	4.49327e+08	824.601	451.349	23995.9	990950	77729.1
	Kurtosis	2.05621	0.499341	-1.38729	-1.35493	-1.32647	-0.0675552	-1.6097
	Skewness	-1.99148	-0.301894	0.326911	-0.214664	0.125397	-1.02402	0.25118
		Volume3d	Area3d	BaryCenterX	BaryCenterY	BaryCenterZ	Mean	index
	1	172301	38486.9	144.894	179.329	5.41597	32636.7	3
	2	1.53846e+06	80142.1	194.819	143.389	52.8031	34172.9	12
ACCESSION AND A CONTRACTOR	3	1.67769e+06	117445	123.059	170.616	126.445	34805.4	59
	4	269e+06	80608.9	120.059	164.852	214.289	35598.6	241
and the second		.66807e+06	81973.5	178.139	124.811	291.078	34651.4	486
	6	1.69198e+06	83668.9	115.563	151.92	375,779	35430.9	625
	7	1.55403e+06	78523.2	162,438	118,795	456,455	35723.9	714

#### Avizo class II

March 10, 2015

#### Beads Data Analysis

Open Data		
Animate Ports Caption Synchronize Ports  Animate Ports Caption Synchronize Ports  Besult.Regions* O  Convert Image Type O  Convert I	ical Watershed ()	
O O Propertie		
Point Cloud View	D 8 ?	
표 Colorman		
두 Color: Id	s tary	
표 Options: ✓ plates _ filter ✓ opaque _ bond	s 🗆 scale plates	
₩ Sphere Scale: △ 0.0196078		
표 Action: Export Select Reset	Undo	
auto-refresh	Apply	

## Project Overview

- Load Data (Raw), Crop
- Image Processing
- Binarize threshold
- Separate Objects distance map, hierarchical watershed
- Label Analysis
- Analysis Filter
- Spreadsheet to point cloud



## Open Data

- 16bit unsigned
- 615x581x512
- big endian
- x fastest

Input Data type: 16-bit unsigned \$ 1 \$ Dimensions: 615 \$ Dimension: 615				rs	a Paramete	Raw Dat	Ra	00
Data type: 16-bit unsigned ‡ 1 ‡ Dimensions: 615 \$ Header: 0 bytes Requested: 365890560 bytes Filesize: 365890560 bytes Endianess • big endian I little endian Index order • x fastest z fastest Resolution Define • bounding box • voxel size Min coord: 0 0 0 0								Input
Dimensions: 615 \$ 581 \$ 512 Header: 0 bytes Requested: 365890560 bytes Filesize: 365890560 bytes Endianess • big endian International Index order • x fastest z fastest Resolution Define • bounding box • voxel size Min. coord: 0 0 0	* *			\$	1	d ‡	16-bit unsigned	Data type:
Header: 0 bytes Requested: 365890560 bytes Filesize: 365890560 bytes Endianess	÷		512	•	581		615	Dimensions:
Requested: 365890560 bytes   Filesize: 365890560 bytes   Endianess • big endian   Index order • x fastest   • x fastest •   z fastest • z fastest   Resolution   Define •   • bounding box •   • voxel size					bytes		0	Header:
Filesize: 365890560 bytes   Endianess • big endian little endian   Index order • x fastest • z fastest   Resolution   Define   • bounding box • voxel size					bytes		365890560	Requested:
<ul> <li>big endian</li> <li>little endian</li> <li>Index order</li> <li>x fastest</li> <li>z fastest</li> </ul> Resolution Define Define i bounding box i voxel size Min_coord:					bytes		365890560	Filesize: Endianess
Index order						dian	ian i little endi	💿 big endi
<ul> <li>x fastest</li> <li>z fastest</li> <li>Resolution</li> <li>Define</li> <li>bounding box</li> <li>voxel size</li> </ul>								Index order
Resolution Define O bounding box O voxel size Min_coord: O 0 0						t	t 🔿 z fastest	• x fastes
Define       O bounding box     • voxel size								Resolution
<ul> <li>bounding box</li> <li>voxel size</li> </ul>								Define
Min coord:				size	💿 voxel		ng box	Oboundin
		0	0		0			Min. coord:
Voxel size: 1 1 1		1	1		1			Voxel size:
suppress file size warning							size warning	suppress file
ОК С	ancel	K	0					

#### ROI box

- Choose ROI
- Bounding box with green manipulators
- Change size in interactive mode

80		Properties	
*	ROI Box		<b>\$?</b>
至	Data:	beads-615x581x512-uint2.raw \$	
至	Minimum:	287.268 0 0	
포	Maximum:	614 262.819 511	
포	Options:	show box	
至	Draw:	restrict reset	
포	Size:	84.44 MB	

## Crop Editor

- Apply on data objects
- No un-crop
- Use ROI region info for minmax index values

000				
<b>A</b>	00 be:	1ds-615x581x512-	-uint2.raw [328 x 2	63 x 512]
START	Image crop			
0 0	Min index:	287	0	0
Open Data	Max index:	614	262	511
ROI Box Ortho Slic	Crop list:	Use ROI list	ROI Box ‡	
	Threshold:	24575	Auto crop	
Result.Label-Analys	Adjust:	8	Enlarge	Reduce
	Add mode:	Replicate	Pixel value:	0
EAnal	Resolution			
Result.Analysis-Fil	te Mode:	$\bigcirc$ bounding box	<ul> <li>voxel size</li> </ul>	
C Result.label-filterin	Min coord:	287	0	0
	Voxel size:	1	1	1
Result.Cloud* )	Flip and swap			
BB beads-615x581x5	1 flip	x 📃	flip y	flip z
	swap	ху	swap xz	swap yz
			C	ancel OK
				J
00		Properties		
beads-615x581x	c512-uint2.raw			¥ # # \$
표 Lattice info:	615 x 581 x 512,	uniform coordinate	s X	
표 Data info:	grayscale, 16-bit	unsigned, min-max	c: 065536, window	w: 2457565535, intens
표 Voxel size:	1 × 1 × 1			
至 Master:	NO SOURCE	•	6	
$\frac{\Pi}{T}$ Shared Colormap:	Edit			

## Image Processing

- Pre-processing to denoise, smooth, sharpen, detect edge, separate&fill, etc.
- Example: despeckle module in Image Processing ->Smoothing And Denoising

00		Properties
9	Despeckle	8 ?
포	Input Image:	beads-615x581x512-uint16.raw 🛟 🛋
포	Interpretation:	○ 3D
포	Kernel Size X [px]:	3
포	Kernel Size Y [px]:	3
포	Threshold Factor:	3

## Thresholding

- Interactive Thresholding
- Multi-thresholding
- Hysteresis Thresholding

80	)	Properties	
0	Hysteresis Thresholding	2	?
포	Input Image:	beads-615x581x512-uint16.filtered 🛟 🔿	
포	Interpretation:	● 3D ○ XY planes	
포	Thresholds (Low/High):	17000 22000	
Ξ	Length [px]:	1	

#### Distance Map

- Apply on binary data
- float value computed as distance of foreground voxels to closest background voxels

80		Properties	
9	Distance Map		38?
포	Data:	beads-615x581x512-uint16.binary 🛟 🛋	
포	Туре:	Euclid Ochamfer SingleSeeded	
포	Chamfer Weights:	○ 1-2-3 ○ 3-4-5 ● float	
포	Region:	Inside \$	

#### Arithmetic

- Do simple math, click ? for syntax help
- Example: negate distancefield data and bring min value to 0

80		Properties		
9	Arithmetic			8 ?
포	Input A:	beads-615x581x512-uint16.DistField	\$ 4	
포	Input B:	NO SOURCE	\$ 4	
포	Input C:	NO SOURCE	\$ 4	
포	Result Channels:	like input A	\$ )	
至	Expr:	-A + 21.66		
포	Result Type:	💿 input A i regular		
₽	Options:	ignore errors		

## Hierarchical Watershed

- Flood a hierarchy of catchment basins
- Input threshold doesn't do much here (observation)
- update with different minimal depth is relatively fast, can us auto fresh
- Smaller minimal depth means more separation
- output to 16bit data to allow more than 255 objects

6	3 0	)		Properties	
	<b>Q</b>	Hierarchical Wat	ershed		8
	포	Data:	Result		\$
	포	Input Threshold:	$\Box$	1.5	
	포	Minimal Depth:	Δ	7	
S	Ξ	Output Type:	Unsigned short (16 bit)	\$	

### Color wash to Ortho slice

- Blend two slices to view together
- orthoslice to grayscale data
- add color wash to orthoslice
- label blending

00		Properties
0	Color Wash	8 ?
포	Data:	Result.Regions 💠 🔿
至	Module:	Ortho Slice 2 🗘 🖘
至	Colormap:	1 8 Edit <sub>y</sub>
至	Fusion Method:	Label Blending \$
至	Transparency:	△ 0.699346
포	Options:	Color exterior 🗹 Use colormap when material color not defined

# Convert Image Type

- Example: convert grayscale image to label image
- both 16bit unsigned data type, but some operation must apply on label data

80			Properties		
9	Convert Ima	ge Type			2
포	Data:	Result.Region	s 🛟 🛋		
포	Info:	16-bit unsigne	d (0288) -> 16-bit unsigned (0288)		
포	Output Type:	16-bit label	*		
포	Options:	🗹 clean labels			
포	Colormap:	0	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	288	Edit

## Label Analysis

- Apply to binary data for component analysis, or to label data directly for measurements
- Intensity Image required to calculate certain measurements
- Here use 'standdard shape analysis' measure group, instead of 'basic' group

80		Properties
Q	Label Analysis	
Ξ	Data:	Result.to-labelfield-16_bits ‡
포	Intensity Image:	beads-615x581x512-uint16.raw 🗘 🖨
Ξ	Interpretation:	● 3D ○ XY planes
푸	Measures:	Standard Shape Analysis 💲

## Analysis Filter

- Use &&, || for and or
- Comparison: < > == !=
- Negate: !
- math: + \* /

80		Properties	
9	Analysis Filter		2
포	Label Analysis:	Result.Label-Analysis 💠 🛋	
포	Image:	Result.to-labelfield-16_bits 🗘 🖨	
Ŧ	Filter:	Anisotropy < 0.25 && Elongation > 0.9 && Flatness > 0.9 Formula is valid Volume3d BaryCenterX BaryCenterZ Anisotropy Elongation Flatness EigenVal1         Image: Constant of the second	Label Image Connect a label image. T will remove labels whose do not fulfill the filter for (Optional)
	auto-refresh		Apply

#### Speadsheet to Point Cloud

 Apply to analysis result

?

#### Point cloud view

- Show each point as drawing primitive
- Here use sphere to represent beads

3 0		Properties	
<ul> <li></li></ul>	Point Cloud	View	3
포	Data:	Result.Cloud \$	
玊	Colormap:	1	8 Edit
포	Color:	ld \$	
₽	Options:	🗹 plates 🗌 filter 🗹 opaque 🗌 bonds 🗌 scale plates	
Ξ	Sphere Scale:		
₽	Action:	Export Select Reset Undo	