35534805.101695 9287544.9818182 7406623.1304348 50086360762 1871928739 5036668690 12806873.102041 22782119.493333 17929766.259259 1370365.08 26488561.394737 14955943950 2642847678 80376412.222222

Combining like terms math lib answers pdf version

Like Terms – Example Three

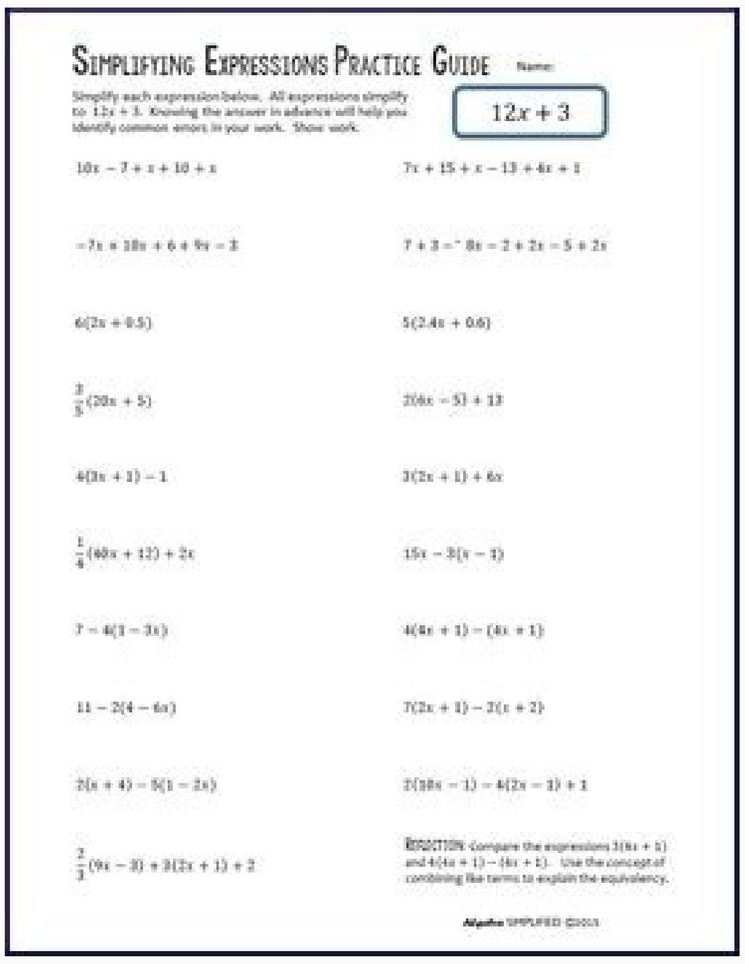
Simplify the expression: **4w + 3 + 2w - 1**

4w + 3 + 2w – 1 (Now Group Like Terms)

= 4w + 2w + 3 – 1 (Combine Like Terms)

= 6w + 2

= **6w + 2** ✓



Simplifying Expressions Practice Guide

Name:

Simplify each expression below. All expressions simplify to $12x + 3$. Knowing the answer in advance will help you identify common errors in your work. Show work.

$12x + 3$

$10x - 7 + x + 10 + x$

$7x + 15 + x - 13 + 4x + 1$

$-7x + 18x + 6 + 9x - 3$

$7 + 3 = 8x - 2 + 2x - 5 + 2x$

$6(2x + 0.5)$

$5(2.4x + 0.6)$

$\frac{3}{5}(20x + 5)$

$2(6x - 5) + 13$

$4(3x + 1) - 1$

$3(2x + 1) + 6x$

$\frac{1}{4}(40x + 12) + 2x$

$15x - 3(x - 1)$

$7 - 4(1 - 3x)$

$4(8x + 1) - (8x + 1)$

$11 - 2(4 - 6x)$

$7(2x + 1) - 2(x + 2)$

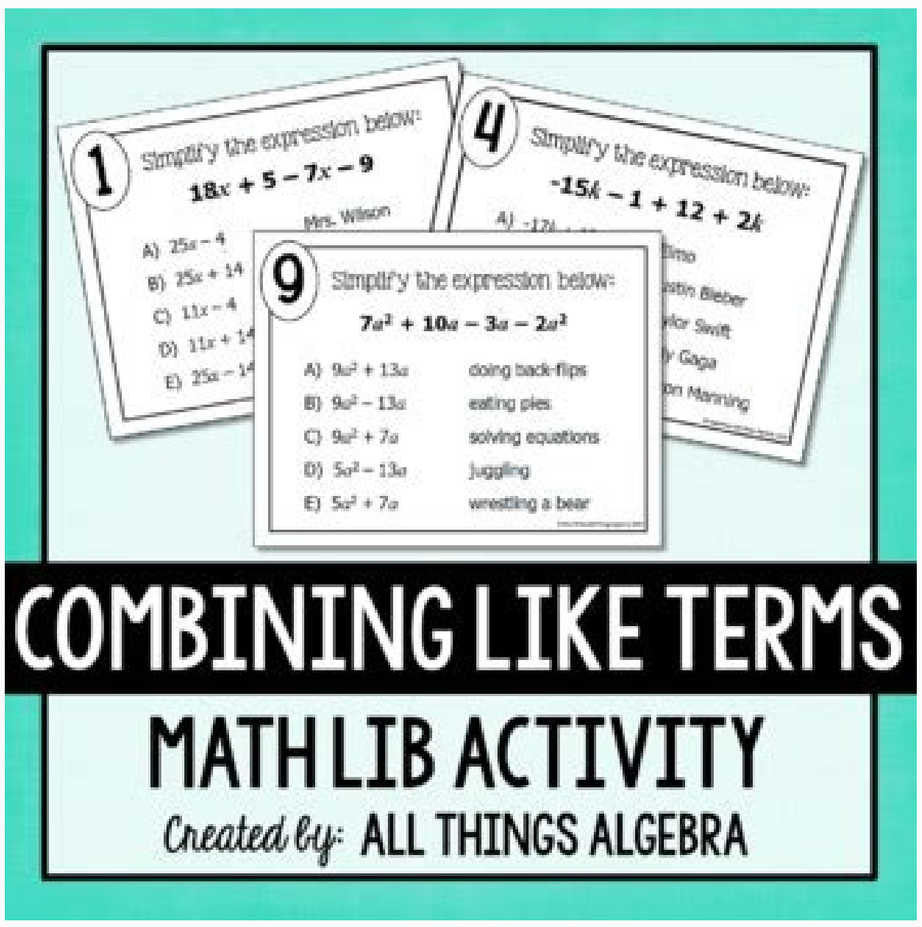
$2(x + 4) - 5(1 - 2x)$

$2(18x - 1) - 4(2x - 1) + 1$

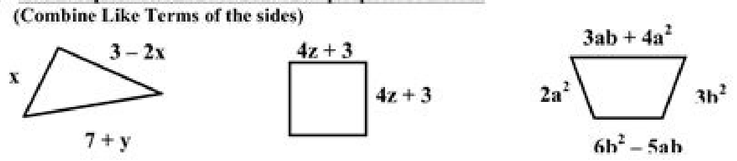
$\frac{2}{3}(9x - 3) + 3(2x + 1) + 2$

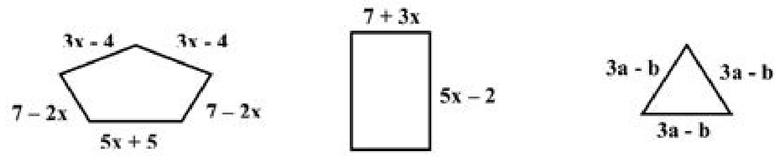
REFLECTION: Compare the expressions $3(8x + 1)$ and $4(5x + 1) - (8x + 1)$. Use the concept of combining like terms to explain the equivalency.

Algebra SIMPLIFIED ©2015



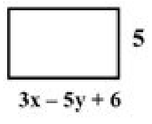
4) **Find the perimeter of each of the shapes pictured below:**
(Combine Like Terms of the sides)



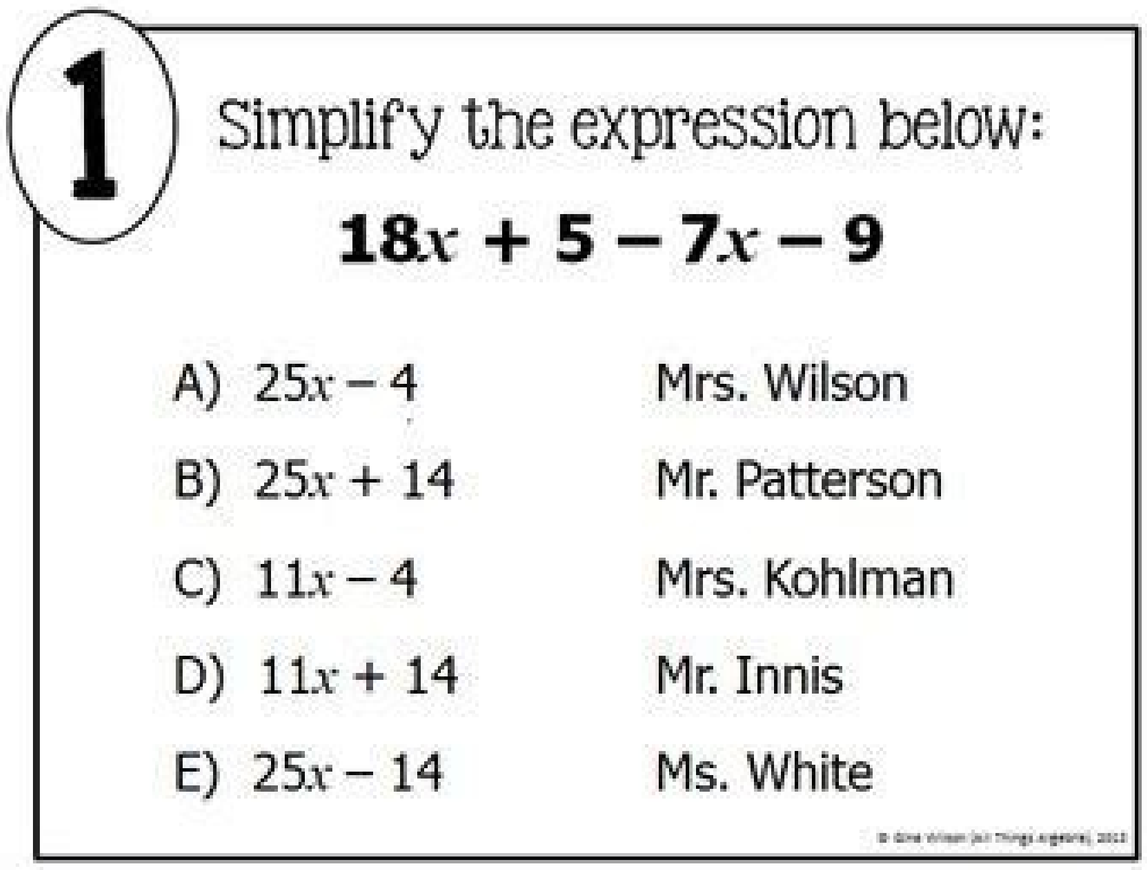


5) **FIND THE AREA OF THE GIVEN SHAPES:**
Equation #1: Area of Rectangle = Length * Width,
Equation #2: Area of Triangle = ½ *Base*Height

a. **Find area of a rectangle with length of 5 and width of 3x – 5y + 6.**



b. **Find area of a rectangle with width of 7 and length of 6x – 7**



Combining like terms math lib answers. Combining like terms math lib answer key.

Google’s your friend :). Nothing special but if this goes through that means that you’re installation of SimpleITK probably worked :). I want to emphasize the 2nd option. The above holds for all image filters included in SimpleITK. Lifestyle | Daily Life | News | The Sydney Morning HeraldWe’re sorry, this feature is currently unavailable. Therefore, we need to first ‘rescale’ imgSmooth to the same integer range and then cast it so that the types of the two images, i.e., imgSmooth and imgWhiteMatter, match. You're Reading a Free Preview Pages 56 to 60 are not shown in this preview. Next, the reasonable thing to do would be to inspect the result of the segmentation. We could simply use sitk_show, passing imgWhiteMatter, but all we would see would be a white-color label in a black backdrop which doesn’t exactly give us much insight. The result of the label overlay with sitk_show can be seen below. – No pipeline! Those who read my previous posts on VTK, will be aware of that pipeline monstrosity VTK is built upon. – A fantastic SimpleITK.Image class which handles all image data and which includes overloads for all basic arithmetic (+ - * / // **) and binary (& | ^ ~) operators. However, as you can see in the commented code, an alternative would be to create a filter object, CurvatureFlowImageFilter in this case, and set the required parameters one-by-one through the corresponding methods before calling the Execute method. Here’s how we do that: imgSmooth = SimpleITK.CurvatureFlow(image1=imgOriginal, timeStep=0.125, numberOfIterations=5) # blurFilter = SimpleITK.CurvatureFlowImageFilter() # blurFilter.SetNumberOfIterations(5) # blurFilter.SetTimeStep(0.125) # imgSmooth = blurFilter.Execute(imgOriginal) sitk_show(imgSmooth) The CurvatureFlowImageFilter class “implements a curvature driven image denoising algorithm”. Options Once again, we’ll define a few options to keep the rest of the notebook ‘clean’ and allow you to make direct changes without perusing/amending the entire notebook. You might also want to check the GitHub repo of the above page which contains the demo-data and some extra notebooks. Lastly, there are many more examples on ITK than on SimpleITK and through those you can find out about many useful classes and algorithms implemented in ITK and which are wrapped in SimpleITK. As we can see, the majority of those regions should actually be part of the gray matter so let’s do exactly that: imgMask= imgWhiteMatterNoHoles/labelWhiteMatter * imgGrayMatterNoHoles/labelGrayMatter imgWhiteMatterNoHoles -= imgMask*labelWhiteMatter imgLabels = imgWhiteMatterNoHoles + imgGrayMatterNoHoles sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, imgLabels)) Firstly, we create imgMask which will be a ‘boolean’ image containing only the common regions of the two labels. You're Reading a Free Preview Pages 21 to 28 are not shown in this preview. It just works! SimpleITK Today, however, we won’t be dealing with ITK, but SimpleITK instead! SimpleITK is, as the name implies, a simplified layer/wrapper build on top of ITK, exposing the vast majority of ITK functionality through bindings in a variety of languages, greatly simplifying its usage. Image segmentation is mostly about trial-n-error so try away. Image Segmentation As always we’ll start with a few imports. Lastly, when you feed point indices to SimpleITK for different algorithms, as we’ll see later, these indices need to be in the SimpleITK order and not the NumPy order. Hence, combining the two label-fields is as easy as a simple OR operator (|): imgLabels = imgWhiteMatterNoHoles | imgGrayMatterNoHoles sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, imgLabels)) with the result being stored under imgLabels: However, note the cyan-colored label! Those are regions ‘claimed’ by both the white-matter and gray-matter labels due to our lazy segmentation. However, a process like this typically assumes a working knowledge of Git, CMake, and the structure of your non-vanilla Python distribution. Let me just say that the radius defines the pixel area/volume around a hole that is examined and the majorityThreshold is the number of pixels over 50% that need to be ‘on’ for that hole pixel to be turned ‘on’. You’ll find a fair number of links to SimpleITK material at the end of this post. For examples, regions might seem entirely disconnected when viewed on one cross-section but end up being connected further down the slices through some small structure. – SimpleITK Examples: A small number of basic examples in C++ and Python which showcases some of the SimpleITK functionality. You're Reading a Free Preview Pages 81 to 88 are not shown in this preview. Installation For better or for worse, SimpleITK isn’t written in pure Python but rather C++ which translates to you needing a compiled version of the library. What this filter does is simply “label pixels that are connected to a seed and lie within a range of values”. Once more, you can get the MRI dataset of my head under here whose contents you should extract next to today’s notebook. Segmentation with the ConnectedThreshold filter Initial segmentation of the white-matter For the purposes of this post we’ll be segmenting the white and gray matter through the ConnectedThresholdImageFilter class, or rather the ConnectedThreshold function which wraps the former. Depend on the kindness of strangers. I may demonstrate things like that in later posts. The opposite can be done through the GetImageFromArray function which just takes a numpy.ndarray and returns a SimpleITK.Image object. Note that we operate on imgSmooth and not imgOriginal. However!, there’s a serious catch to this conversion! Be careful! If you were to have a SimpleITK.Image object with a size/shape of 200x100x50, then upon conversion to a numpy.ndarray that object would exhibit a shape of 50x100x200, i.e., the axes would be backwards. This is the way we’re calling it above. The code is pretty much entirely matplotlib but there’s one point you should pay attention to so here’s the code: def sitk_show(img, title=None, margin=0.05, dpi=40): nda = SimpleITK.GetArrayFromImage(img) spacing = img.GetSpacing() figsize = (1 + margin) * nda.shape[0] / dpi, (1 + margin) * nda.shape[1] / dpi extent = (0, nda.shape[1]*spacing[1], nda.shape[0]*spacing[0], 0) fig = plt.figure(figsize=figsize, dpi=dpi) ax = fig.add_axes([margin, margin, 1 - 2*margin, 1 - 2*margin]) plt.set_cmap("gray") ax.imshow(nda,extent=extent,interpolation=None) if title: plt.title(title) plt.show() As you can see in the first line of the function we convert the SimpleITK.Image object to a numpy.ndarray through the GetArrayFromImage function which resides directly under the SimpleITK module. Its quite a good introduction and you can find the presentation as a .pdf here. 0%(1)0% found this document useful (1 vote)441K views7,794 pages, active You're Reading a Free Preview Pages 12 to 17 are not shown in this preview. Regardless of the calling-paradigm, we end up with a imgSmooth image which contains the results of the smoothing. Hence, today I’ll do a little demonstration of some of SimpleITK’s functionality, and use it to semi-automatically segment the brain-matter (white and gray) off an MRI dataset of my own head (of which I first spoke in this past post about DICOM in Python). The first way is to directly call a function, CurvatureFlow in this case, which nicely wraps all required filter parameters as function arguments (while also exposing optional arguments). reader = SimpleITK.ImageSeriesReader() filenamesDICOM = reader.GetGDCMSeriesFileNames(pathDicom) reader.SetFileNames(filenamesDICOM) imgOriginal = reader.Execute() Reading the entirety of the DICOM file series goes as follows: We start by creating a new ImageSeriesReader object under the name reader. – SimpleITK Tutorial for MICCAI 2011: A GitHub repo containing the material for a SimpleITK tutorial presented at MICCAI 2011. I should stress that the code I’ll be presenting is entirely applicable to the full 3D image but the parameters used in the function calls, e.g. seed-point indices, won’t be. As you can see the operation wasn’t wildly successful but many of the smaller holes were indeed filled. That was the whole point of de-noising imgOriginal anyway right? To my knowledge you have one of three options: Compile the code yourself against the Python interpreter and dynamic library you’re using.That of course includes checking out the code, ensuring you already have (or even worse compile from source) whatever dependencies that package has, and build the whole thing yourself. The reason? We’re working to restore it. As I mentioned in the Introduction, the SimpleITK.Image class overloads and supports all binary and arithmetic operators. All this means is that we should’ve imposed looser criteria, e.g., a larger radius. Also, upon inspection of the slice, an inspection I performed while viewing the data in Osirix, I could see that the white-matter pixels exhibited values, roughly, between lower=130 and upper=190 which we’ll be setting as the threshold limits. However, I didn’t find the time to package SimpleITK on Binstar hence .egg files it is for now :). While slicing in SimpleITK is not as powerful as NumPy, its still pretty darn impressive (not to mention invaluable)! – Built-in support for two-way conversion between SimpleITK.Image object and numpy.ndarray (there’s a catch though, more on that later as well). Unfortunately, SimpleITK doesn’t come pre-compiled with any of the major alternative Python distros I know so if you’re using Anaconda Python, Enthought Python, Enthought Canopy, or even the OSX MacPorts or Homebrew Python, installing it is a lil’ hairier than normal. You're Reading a Free Preview Pages 115 to 168 are not shown in this preview. Hole-filling is a very standard procedure in image segmentation, especially when employing region-growing algorithms. Then we just multiply those common regions by labelWhiteMatter to switch its values back to those of the white-matter label, and subtract the result from imgWhiteMatterNoHoles (therefore letting imgGrayMatterNoHoles keep those regions). You're Reading a Free Preview Pages 329 to 352 are not shown in this preview. It turns out that the SimpleITK.Image class doesn’t exactly have a bracket ([and]) operator but instead uses the GetPixel method which takes in a pixel index in a (x, y, z) order, i.e., the internal array is stored in an ‘x-fastest’ fashion. It includes a whole bunch of goodies including routines for the segmentation, registration, and interpolation of multi-dimensional image data. Links & Resources Material Here’s the material used in this post: See also Check out these past posts which were used and referenced today or are relevant to this post: SimpleITK If you want to read up on SimpleITK then check out the following resources: – The Design of SimpleITK: A freely available article by Bradley Lowekamp on SimpleITK and a rather good starting point. As a result you get the axes backwards! Now, what does that mean for you? Subsequently, we ‘cast’ the image to the same type as imgWhiteMatter by using the CastImageFilter and the GetPixelID method of the SimpleITK.Image class. It also means that the result of the sitk_show helper-function, which uses the GetArrayFromImage method we’re discussing, shows you the numpy view of the array and needs to be taken with a grain of salt. If you’re lucky, the source-code will come with CMake’s Superbuild and the process will just take a couple hours of tinkering. One such filter is the VotingBinaryHoleFillingImageFilter which in a nutshell “Fills in holes and cavities by applying a voting operation on each pixel”. Google bruker informasjonskapsler og data for ålevere og opprettholde tjenester, slik som sporing av tjenesteavbrudd og beskyttelse mot nettsøppel, svindel og uriktig brukmåle brukerengasjement og statistikk om nettstedet for å forstå hvordan tjenestene våre brukesHvis du samtykker, bruker vi også informasjonskapsler og data for åforbedre kvaliteten på tjenestene våre og utvikle nye tjenesterlevere og måle effektiviteten av annonservise personlig tilpasset innhold, avhengig av innstillingene dinevise personlig tilpassede eller generiske annonser, avhengig av innstillingene dine, på Google og på nettetFor innhold og annonser som ikke er personlig tilpasset, kan det du ser, være påvirket av blant annet innholdet du ser på, og posisjonen din (annonselevering er basert på den generelle posisjonen). – Slicing capability akin to that seen in numpy.ndarray objects allowing you to extract parts of the image, crop it, tile it, flip it, etc etc. Loading the DICOM files Now let’s move onto reading the DICOM files. Let’s see how it’s done: lstSeeds = [(150,75)] imgWhiteMatter = SimpleITK.ConnectedThreshold(image1=imgSmooth, seedList=lstSeeds, lower=130, upper=190, replaceValue=labelWhiteMatter) So, we start by create a list of tuple objects with the 2D indices of the seed points. While the usage of ITK would require incessant usage of templates and result in code like this: // Setup image types. Hole-filling As you can see from the above figure, our initial segmentation is subpar at best. Thankfully, SimpleITK provides us with an arsenal of filters to ameliorate such issues. Using the sitk_show helper function we get the next figure. Just like VTK, ITK exhibits the same mind-boggling design paradigms and near-inexistent documentation (apart from this one book and some little tidbits like the Doxygen docs, a couple presentations, and webinars). However, the array within SimpleITK is what it is and unless you just want to use SimpleITK to load data and then play around with NumPy there’s little point to it. If you’re using Anaconda Python the you simply need to download the appropriate .egg and install it through easy_install . Alternative Python distros like the Anaconda Python, Enthought Python, Enthought Canopy, or even the OSX MacPorts and Homebrew Python, have their own version of the Python interpreters and dynamic libraries. These operators just wrap the corresponding ITK filter and operate on a pixel-by-pixel basis thus allowing you to work directly on the image data without long function calls and filter configuration. Lastly, we configure the filter to set a value of labelWhiteMatter to all pixels belonging to the white-matter tissue (while the rest of the image will be set to a value of 0). In this post I will demonstrate SimpleITK, an abstraction layer over the ITK library, to segment/label the white and gray matter from an MRI dataset. Therefore, and since I’ll only be using 2D visualization, I wanted to keep things clear. A point I’d like to make here is that all of the image filters in SimpleITK can be called in one of two ways. There are many, more appropriate, filters in SimpleITK to do the above but I just wanted you to see how easy it is to play around with your images. Nonetheless, its the best resource out there. The point of this post, however, was to introduce you to SimpleITK, a truly simplified interface to a very powerful library. There you will find many custom-built packages such as OpenCV, PETSc, etc but I’ll get back to Binstar at a later post. Through the previous figure we spot a good seed-point in the white-matter (inner structure of the brain) at an x index of 150 and a y index of 75. import os import numpy import SimpleITK import matplotlib.pyplot as plt %pylab inline Helper-Functions There’s only going to be a single ‘helper-function’ today: sitk_show(img, title=None, margin=0.05, dpi=40): This function uses matplotlib.pyplot to quickly visualize a 2D SimpleITK.Image object under the img parameter. We’ll be using imgSmoothInt for all subsequent label overlays but won’t repeat the rescaling/recasting. This last one is exactly the case today. In addition, there’s a whole treasure-trove of functionality one just can’t find elsewhere. Please try again later. The reason for this is not because the process would become too computationally expensive (clearly slower but not by much) but rather for the sake of clarity. Some very notable features are: – Super-simple IO of multi-dimensional image data supporting most image file formats (including DICOM through the infamous Grassroots DICOM library (GDCM), more on that later). As I explain in the comments, I’m going to be limiting the segmentation to a single 2D slice of the DICOM dataset. Today I’ll be branching off and talking about its cousin, the Insight Segmentation and Registration Toolkit (ITK), a library created by the same fine folk as VTK, i.e., Kitware, but which focuses on image processing. You're Reading a Free Preview Pages 391 to 408 are not shown in this preview. The reason behind this is briefly outlined in this SimpleITK notebook by the SimpleITK author. Otherwise, pip will be called through the root Anaconda environment and be installed in that environment instead. Nonetheless, just like VTK, ITK offers some amazing functionality one just can’t overlook in good conscience. As a result we get an integer version of imgSmooth dubbed imgSmoothInt. Also, make sure that environment contains pip and setuptools before installing the .egg. Image segmentation is inherently interactive and repetitive, which is why there are dozens of applications out there neatly wrapping functionality such as what we saw today in a GUI. The math behind this filter are based on a finite-differences algorithm and are quite convoluted. Du kan også gå til g.co/privacytools når som helst. You're Reading a Free Preview Pages 273 to 310 are not shown in this preview. However, the aforementioned SimpleITK wheels and eggs are all compiled and linked against vanilla Python interpreters, and should you make the very common mistake of installing one of those in a non-vanilla environment, then upon importing that package you’ll most likely get the following infamous error: Fatal Python error: PyThreadState_Get: no current thread This issue, however, isn’t exclusive to SimpleITK. Far from it actually as the gray matter unjustly claimed regions of white matter in nooks and crannies. That’s exactly why you have packages like VTK all built and ready with those distros. Well, SimpleITK does away with that and all operations are immediate (a much more pythonic paradigm). In the interest of # simplicity, segmentation will be limited to a single 2D # image but all processes are entirely applicable to the 3D image idxSlice = 50 # int labels to assign to the segmented white and gray matter. Label-field mathematics Lastly, we want to combine the two label-fields, i.e., the white and gray matter. Therefore, we’ll instead view this newly acquired label overlaid with imgSmooth, i.e., the input-image we used for the segmentation, using the SimpleITK.LabelOverlayImageFilter class: # Rescale 'imgSmooth' and cast it to an integer type to match that of 'imgWhiteMatter' imgSmoothInt = SimpleITK.Cast(SimpleITK.RescaleIntensity(imgSmooth), imgWhiteMatter.GetPixelID()) # Use 'LabelOverlay' to overlay 'imgSmooth' and 'imgWhiteMatter' sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, imgWhiteMatter)) Here I want to stress the following point: the result of the de-noising, i.e., imgSmooth, comprises pixels with float values while the result of the segmentation is of int type. To that end, before we start the segmentation, we smoothen the image with the CurvatureFlowImageFilter. Installing them is performed through pip install --use-wheel but you must have first installed the wheel package through pip install wheel. As a final treat lets visualize the two labels as edge-only contours using the LabelContourImageFilter class. Segmentation of the gray-matter Next we’ll repeat the process we just saw but this time for the gray matter. Don’t let that throw you off :). However, since we’ll be applying region-growing and thresholding segmentation algorithms we need a smoother, more homogeneous pixel distribution. SimpleITK falls under the latter category. You're Reading a Free Preview Page 387 is not shown in this preview. If you get a dead kernel here then please do check the console output. The process will include loading the series of DICOM files into a single SimpleITK.Image object, smoothing that image to reduce noise, segmenting the tissues using region-growing techniques, filling holes in the resulting tissue-labels, while I’ll also show you a few visualization tricks that come with SimpleITK. If you’re using an Anaconda environment, e.g. named py27 environment as instructed in this past post, then you need to activate that environment prior to installing the package through activate py27 (Windows) or source activate py27 (Linux/OSX). You're Reading a Free Preview Pages 412 to 416 are not shown in this preview. Here’s the code: lstSeeds = [(119, 83), (198, 80), (185, 102), (164, 43)] imgGrayMatter = SimpleITK.ConnectedThreshold(image1=imgSmooth, seedList=lstSeeds, lower=150, upper=270, replaceValue=labelGrayMatter) imgGrayMatterNoHoles = SimpleITK.VotingBinaryHoleFilling(image1=imgGrayMatter, radius=[2]*3, majorityThreshold=1, backgroundValue=0, foregroundValue=labelGrayMatter) sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, imgGrayMatterNoHoles)) As you can see, apart from defining four different seeds and changing the thresholds and label index, the process is entirely the same, i.e., segmentation and hole-filling. Henceforth I will be using the direct function calls in the code but I’ll be referencing the filter class as there’s no docs for the former. Personally, when I started this blog I intended to only address challenging yet IMHO interesting topics that I once found hard to tackle, and powerful tools that either suffered from poor/insufficient documentation or were not as prominent in the community as they deserve to be. Finally, by calling Execute we retrieve the entire 3D image under imgOriginal. Keep the name in mind. You can get the .egg files here (hosted on the blog’s BitBucket repo): Here I should note that the above, i.e., people distributing their own builds to save other people the trouble of doing so themselves, is not that uncommon. Innhold og annonser som er personlig tilpasset, inkluderer blant annet mer relevante søk og anbefalinger, en tilpasset YouTube-startside og annonser som er skreddersydd til interessene dine.Klikk på «Tilpass» for å gjennomgå alternativer, inkludert kontroller for å avvise bruken av informasjonskapsler for personlig tilpasning og informasjon om kontroller på nettlesernivå for å avvise noen eller alle informasjonskapsler for andre bruksområder. If you want to perform ‘proper’ segmentations of medical image data then take a look at applications like TurtleSeg, ITK-SNAP, MITK, etc etc. As I mentioned in the Helper-Functions section, these indices need to abide by the order expected by SimpleITK i.e., (x, y, z). Wait patiently till the devs of your non-vanilla Python distro build the package for you and give you a convenient way of installing it.Companies like Continuum Analytics (creators of Anaconda Python) and Enthought often do the work for you. To prove that point, I repeated the process in today’s notebook in an ‘alternative notebook’ where I used different techniques to achieve similar results (feel free to take a look cause I won’t be going over this ‘alternative notebook’ today). Its actually the primary reason behind the creation of Binstar, a package distribution system by the creators of Anaconda Python, principally targeting that distro, meant to allow users to redistribute binary builds of packages and permitting them to be installed through conda. However, a perfect segmentation wasn’t the point of this post. Summary The purpose of today’s post was to introduce you to SimpleITK, show you how to install it, and give you a taste of its image-processing prowess. When it comes to image segmentation, and especially when using algorithms based on region-growing and pixel-connectivity, application to the full 3D image might yield non-intuitive results. I will start with an intro on what SimpleITK is, what it can do, and how to install it. # Directory where the DICOM files are being stored (in this # case the 'MyHead' folder). However, I find the existing documentation lacking and perhaps its due to the fact that people don’t know of its existence. Essentially, this filter operates on the input image starting from a series of given ‘seed points’. Remember you have to extract the contents of the MRI dataset, i.e., my head, alongside today’s notebook. Vanilla Python If you’re using a vanilla Python interpreter, i.e., a Python distro downloaded straight from python.org, or the ‘system Python’ that comes pre-installed with most Linux and OSX distros, then you’re in luck! You can simply install the SimpleITK package hosted on PyPI through pip as such: pip install SimpleITK Alternatively, you can install it by using easy_install and one of the Python eggs (.egg), or pip and one of the Python wheels (.whl) provided at the SimpleITK download page as such: easy_install or pip install --use-wheel In case you’ve missed the news, Python wheels (.whl) are meant to replace Python eggs (.egg) in the distribution of binary Python packages. GDCM is actually the most comprehensive DICOM library I know of so you should be able to handle pretty much any DICOM file :). We then use the GetGDCMSeriesFileNames static method of the ImageSeriesReader to retrieve a list of all .dcm filenames which we store under filenamesDICOM and which we then pass back to the reader through the SetFileNames method. Solution? Mixing the two won’t work, or will at least have unforeseen results. We do that by first using the RescaleIntensityImageFilter with its range to the default values of 0 and 255. If my crummy explanation above wasn’t sufficient then off to the VotingBinaryHoleFillingImageFilter docs. Here’s how that’s done: imgWhiteMatterNoHoles = SimpleITK.VotingBinaryHoleFilling(image1=imgWhiteMatter, radius=[2]*3, majorityThreshold=1, backgroundValue=0, foregroundValue=labelWhiteMatter) sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, imgWhiteMatterNoHoles)) As you can see we once more skip the whole ‘initialize filter-configure filter-execute filter’ process and run the wrapper straight away. As a result of all this we get the imgWhiteMatter image. You can download that dataset here and you should extract its contents alongside today’s notebook. Both approaches, however, wrap the same filters and which one to use is a matter of preference. Well for one it means you need to be careful with your indices depending on whether you’re addressing the SimpleITK.Image or a numpy.ndarray derivative. If not, you can spend days trying to get the thing to compile without errors, repeating the same bloody procedure over and over and harassing people online for answers.In the case of SimpleITK there are instructions on how to do so under the ‘Building using SuperBuild’ on their Getting Started page. Its no coincidence ITK is being heavily employed in image processing software like ParaView, MeVisLab and 3DSlicer. Before I close, I’d like to note that going from a label-field, such as the one we saw above, to a 3D surface is rather easy. Finally, we overlay imgSmoothInt and imgWhiteMatter through the SimpleITK.LabelOverlayImageFilter class which creates a nice basic-color RGB depiction of the otherwise monochrome 2nd image. The result of the hole-filling operation is stored under imgWhiteMatterNoHoles and we once more overlay this new label with imgSmoothInt getting the next figure. Smoothing/Denoising As you can see from the above figure, the original image data exhibits quite a bit of ‘noise’ which is very typical of MRI datasets. Using sitk_show we get the following figure: I should mention that image-smoothing is a very typical first step in the medical image data segmentation process, ‘required’ by the majority of segmentation algorithms. However, keep in mind that the presented functionality is the mere tip of a massive iceberg and that SimpleITK offers a lot more. A very important point I want to stress here is that SimpleITK uses the Grassroots DICOM library (GDCM) to load DICOM files. – SimpleITK Notebooks: A collection of IPython Notebooks showcasing different features of SimpleITK. – Should the above not prove sufficient, your best bet is to read about ITK itself. Innhold og annonser som er personlig tilpasset, kan også være basert på disse tingene samt aktiviteten din, for eksempel Google-søk og videoer du ser på YouTube. sitk_show(SimpleITK.LabelOverlay(imgSmoothInt, SimpleITK.LabelContour(imgLabels))) Outro As you can see, my segmentation was by no means perfect. Anaconda Python Unfortunately, here’s where the trouble starts. Loading PreviewSorry, preview is currently unavailable. In addition, and as I mentioned in the intro, SimpleITK comes with a lot of classes tailored to image registration, interpolation, etc etc. It might well be that you forgot to extract the DICOM files out of their .zip or that you’ve placed them under a different directory to the one under pathDicom. However, numpy internally stores its arrays in a ‘z-fastest’ fashion and takes an index in a (z, y, x) order. Background Insight Toolkit (ITK) ITK was originally built to support the ‘Visible Human’ project, which we used in this past post about surface extraction. The filter class itself typically has an ImageFilter suffix while the corresponding wrapper function maintains the same name minus that suffix. I suggest you check the filter docs for details on the actual implementation but in layman’s terms what this filter does is check every ‘off’ pixel, i.e., a pixel with a backgroundValue, and sets it to a foregroundValue if the majority of the pixels around it also have a foregroundValue. I compiled the latest SimpleITK release (v0.8.0) against an x64 Anaconda Python with Python 2.7 under Mac OSX 10.9.5, Windows 8.1, and Linux Mint 17 and I’m gonna give you the .egg files you need to install the package. Lastly, note labelWhiteMatter and labelGrayMatter. Not only did we ‘eat into’ the gray matter, with which we’ll deal later, but in addition there are numerous ‘holes’ in the white-matter label. As I said in the intro, I barely scraped the surface here and there’s still a lot of very interesting functionality to explore. Should you feel like it, you can read more about the algorithm in the class’ docs. Often enough, other users of non-vanilla Python distros will do the work described in (1) and, should they feel like it, distribute the built package for other users of the same distro. It then starts ‘growing’ a region around those points and keeps adding the neighboring points as long as their values fall within given thresholds. You're Reading a Free Preview Pages 187 to 240 are not shown in this preview. The number of demonstrated classes, however, is rather small. However, in the case of less-popular packages, SimpleITK being one, you might be waiting for some time till enough people request it and the devs take time to do so. You can download the paper by clicking the button above. We achieve that by firstly dividing the respective labels by their label index value, therefore switching their values to 1s and 0s. Any package containing Python-bound C/C++ code compiled against a vanilla Python will most likely result in an error if used in a different interpreter. You're Reading a Free Preview Pages 364 to 383 are not shown in this preview. I should state here that one can easily use numpy.transpose to bring the axes in the derivative numpy.ndarray in their ‘proper’ order. Introduction I think that by this point you may’ve had enough of VTK and its obscure, bordering on the occult, inner-workings. All one would need to do is segment the full 3D image data and then use a surface extraction algorithm on each label much like what I presented in this past post about surface extraction. However, information and examples on the former can be found with relative ease and I’ve posted a few such links in this early post about IPython & VTK. # These need to be different integers but their values themselves # don't matter labelWhiteMatter = 1 labelGrayMatter = 2 First of all we define the path where the .dcm files are under, i.e., pathDicom. You're Reading a Free Preview Pages 40 to 52 are not shown in this preview. Uninstalling it is as easy as pip uninstall simpleitk. As a result, those pesky JPEG compressed DICOM files, e.g., the ones found in the Osirix Datasets page, which we couldn’t load with either PyDICOM or VTK in the past post about Python and DICOM, are no longer a deterrence. I admit that the topics I covered so far were not that much about visualization but mostly about ‘secondary’ functionality of VTK. Another nice IPython Notebook entitled ‘SimpleITK Image Filtering Tutorial’ can be found here. Well often enough regions of the tissue exhibit pixel values outside the defined thresholds either due to excessive noise in the image or the nature of the tissue itself in the given region. These are simply two integer values, which will act as label indices in the segmentation as we want the different tissues to be characterized by a different index. The tutorial will include loading a DICOM file-series, image smoothing/denoising, region-growing image filters, binary hole filling, as well as visualization tricks. Let’s start by rectifying this. typedef float InputPixelType; typedef float OutputPixelType; typedef itk::Image InputImageType; typedef itk::Image OutputImageType; // Filter type typedef itk::DiscreteGaussianImageFilter FilterType; // Create a filter FilterType::Pointer filter = FilterType::New(); // Create the pipeline filter−>SetInput(reader−>GetOutput()); filter−>SetVariance(1.0); filter−>SetMaximumKernelWidth(5); filter−>Update(); OutputImageType::Pointer blurred = filter−>GetOutput(); SimpleITK hides all that characteristically un-pythonic-code and yields something like this: import SimpleITK imgInput = SimpleITK.ReadImage(filename) imgOutput = SimpleITK.DiscreteGaussianFilter(imgInput, 1.0, 5) However, the power of SimpleITK, doesn’t end in allowing for succinct ITK calls. Then, as I mentioned in the Options section, we limit ourselves to a single 2D slice of the 3D volume. The 4th edition of the two ‘ITK Software Guide’ books, namely ‘The ITK Software Guide Book 1: Introduction and Development Guidelines’ and ‘The ITK Software Guide Book 2: Design and Functionality’, are actually freely available as `.pdf` files and provide a rather in-depth overview of the library. You're Reading a Free Preview Pages 74 to 77 are not shown in this preview. We do so by using the basic slicing offered by the SimpleITK.Image class: imgOriginal = imgOriginal[:,:,idxSlice] Finally, we use the sitk_show helper-function to visualize that 2D image which we will be segmenting: sitk_show(imgOriginal) which yields the next figure. Note that, ironically, the white-matter (inner structure) appears as gray in the MR image while the gray-matter (outer structure) appears as white. Finally, we recreate imgLabels by adding imgWhiteMatterNoHoles and imgGrayMatterNoHoles and the result of sitk_show can be seen below: The above code was mostly meant to show you the power of the overloaded operators and their effect on image data. I find the package to be as easy and Pythonic as a Python-bound C++ package can be. However, keep in mind that some of the code, particularly that dealing with fancy IPython widget functionality, won’t work straight out. Its as simple as that. pathDicom = "./MyHead/" # Z slice of the DICOM files to process.

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