EMERSE Virtual Machine (VM)

For additional help, or to provide feedback regarding this manual, please contact David Hanauer, at: hanauer@umich.edu

Additional information about EMERSE: http://project-emerse.org

Example datasets for import: http://project-emerse.org/virtualmachine.html

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INTRODUCTION

EMERSE (Electronic Medical Record Search Engine) is provided on a virtual machine (VM) as a way for potential users to test the system and even load their own data on it for searching. The VM is also provided so that technical teams can try out a fully functional system and take a look “under the hood.” It should be noted at the outset that this virtual machine approach is intended primarily for light use as a demonstration and not for full production-level use in a large research or operational environment.

For large-scale implementations EMERSE should be installed on dedicated servers and be maintained by a professional IT team, and all security and regulatory considerations must be addressed. For such operational use we recommend a full-installation of EMERSE as described in our separate Technical Documentation. The current document (as opposed to the Technical Documentation) focuses primarily on the VM itself and not on a full-scale implementation). We do not recommend simply migrating the current EMERSE VM into a production environment, as we are currently not able to support such an approach. For example, we cannot currently support exporting the current EMERSE VirtualBox VM and importing it into a ESX VMware platform environment.

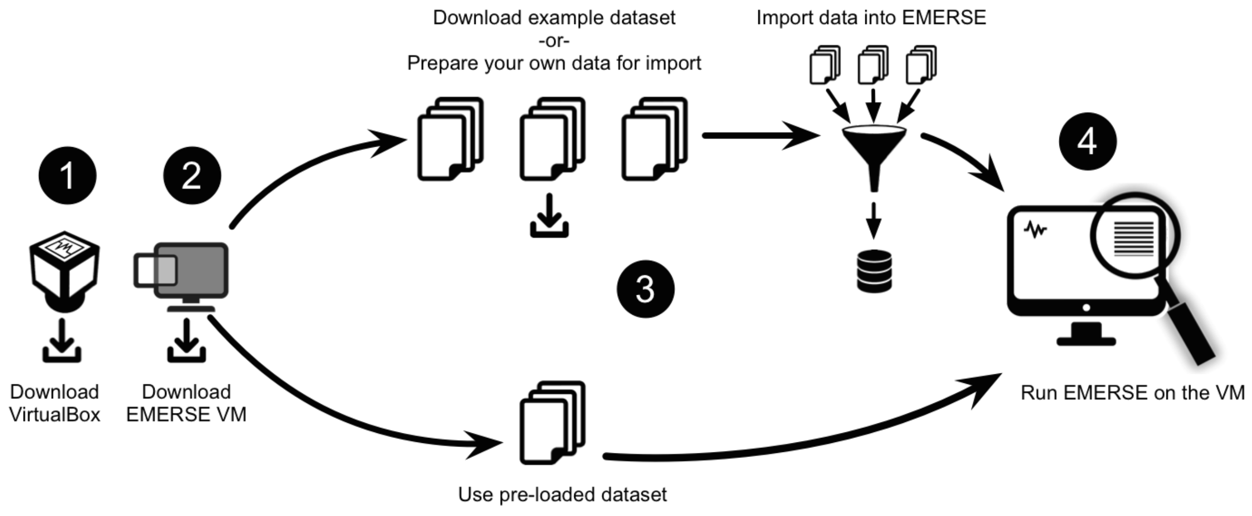
The following directions were created to help small groups pilot EMERSE on the VirtualBox VM, and the process for loading documents into EMERSE described below are not what we recommend for a full-scale installation of EMERSE. For more detailed technical directions on the full-scale implementation and integration, please see our separate Technical Manual.

This version of the VM comes preloaded with a demonstration dataset, so the system can be used right away for demonstrations and for testing. The dataset contains 1,750 patients (fake) and about 125,000 documents (PubMed abstracts are serving as a replacement for clinical documents here). It also has approximately 10,000 synonyms pre-loaded into the system, which is about 20% of the full synonym dataset. The full set is available by licensing it from the University of Michigan.

This demo version of EMERSE on the VM uses an Oracle database that is an *Express Edition*, which means that it is free to distribute but limited in its power. It can use only one CPU and has a maximum allowed size of 4 GB. However, that is more than enough for this demonstration system, and it is also worth noting that the majority of the data used by EMERSE (i.e., the documents) are stored in Solr files and not in the Oracle database.

The VM is currently being distributed via a link that we provide, so please contact us for the link to the VM.

There are 4 basic steps to get started with the EMERSE VM (see overview figure below), and for those wishing to learn more about importing your own data into the VM we are providing some example datasets (using PubMed abstracts in place of clinical documents), as well as instructions for preparing and loading the data.



This document covers four main sections, outlined below:

GETTING STARTED: Describes basics for how to download both the Virtual Box application and the EMERSE virtual machine, and how to launch EMERSE, along with other details about exploring the system.

IMPORTING YOUR OWN DATA: Describes the process for importing your own data into the EMERSE VM for further testing or, in some cases, for small studies in which institutional IT support is not possible.

SECURITY CONSIDERATIONS: For those that do choose to import data, some security considerations should be addressed to ensure that the data remain safe.

MAKING EMERSE AVAILABLE ON THE HOST MACHINE: For those who want to run the VM essentially as a background server and want to be able to access the EMERSE application web page from their host Machine (e.g., Mac or Windows) rather than using the Linux interface within the VM.

GETTING STARTED

The directions in this section are provided to allow for basic downloading and launching of the EMERSE virtual machine, and to launch EMERSE itself for testing with the data that are pre-loaded into the system. PubMed abstracts are being used in place of clinical patient documents in this demonstration version.

Downloading and importing the VM

Note: This only needs to be done once. After it has been imported, you can start the VM over and over again by following the directions in the next section (Launching the EMERSE VM).

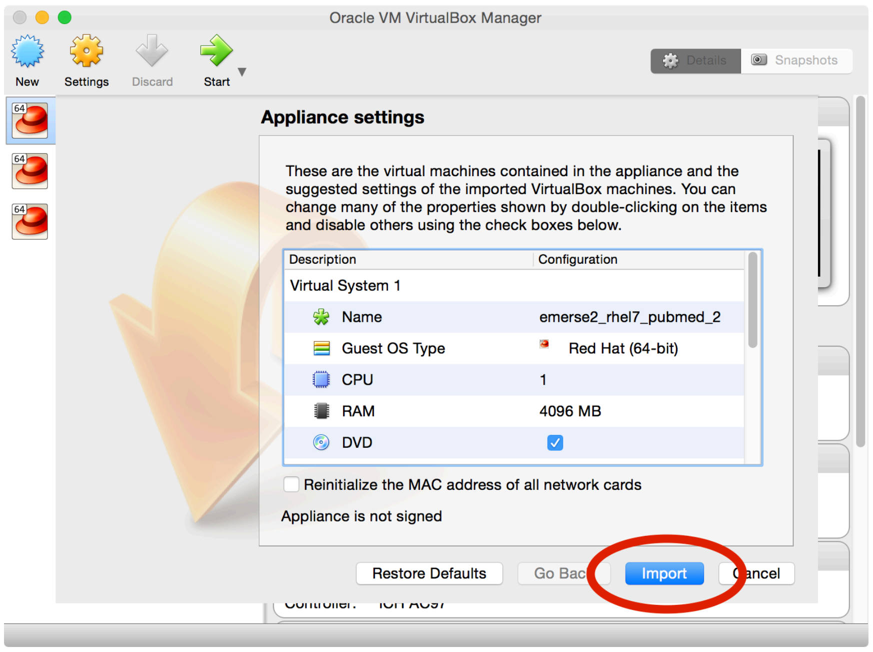
☐ Download and install the VirtualBox application, if not done already. You can find it at:

`https://www.virtualbox.org`

☐ Download the EMERSE virtual machine, which is packaged as an `.ova` file. Currently we are distributing this via a link that we will share with you, so feel free to contact us for the latest VM file. Contact David Hanauer at hanauer@umich.edu.

☐ Double click on the `.ova` file. This will launch the VirtualBox application.

☐ A window will open that is related to `Appliance Settings`. Click on the `Import` button.



Appliance settings

These are the virtual machines contained in the appliance and the suggested settings of the imported VirtualBox machines. You can change many of the properties shown by double-clicking on the items and disable others using the check boxes below.

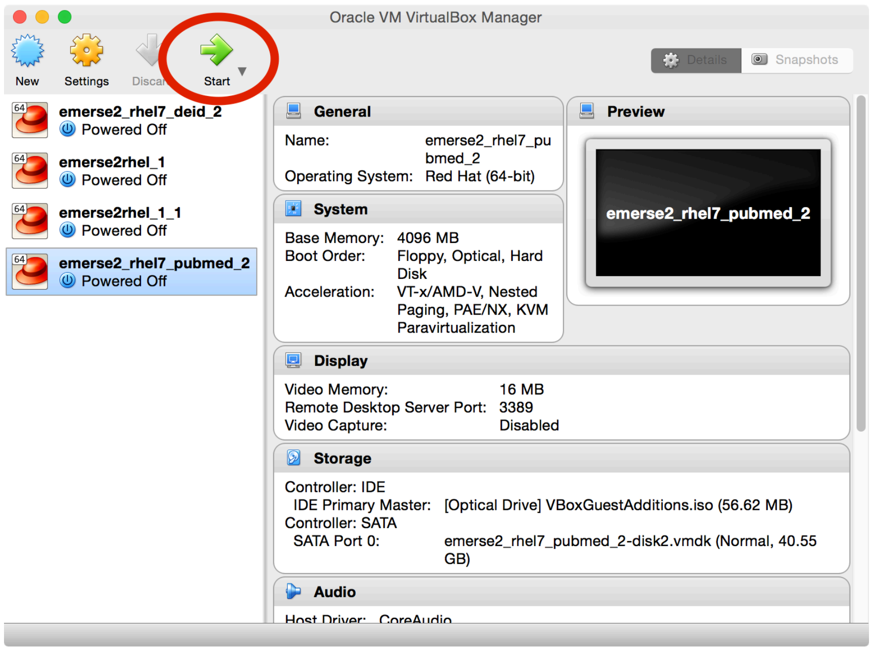
Description	Configuration
Virtual System 1	
Name	emerse2_rhel7_pubmed_2
Guest OS Type	Red Hat (64-bit)
CPU	1
RAM	4096 MB
DVD	✓

☐ Reinitialize the MAC address of all network cards

Appliance is not signed

Launching the EMERSE VM

☐ Once the VM is imported, make sure it is selected in the pane on the left in the main Virtual Box window, then press the green start arrow. This will launch the VM (a Linux operating system).



General
Name: emerse2_rhel7_pubmed_2
Operating System: Red Hat (64-bit)

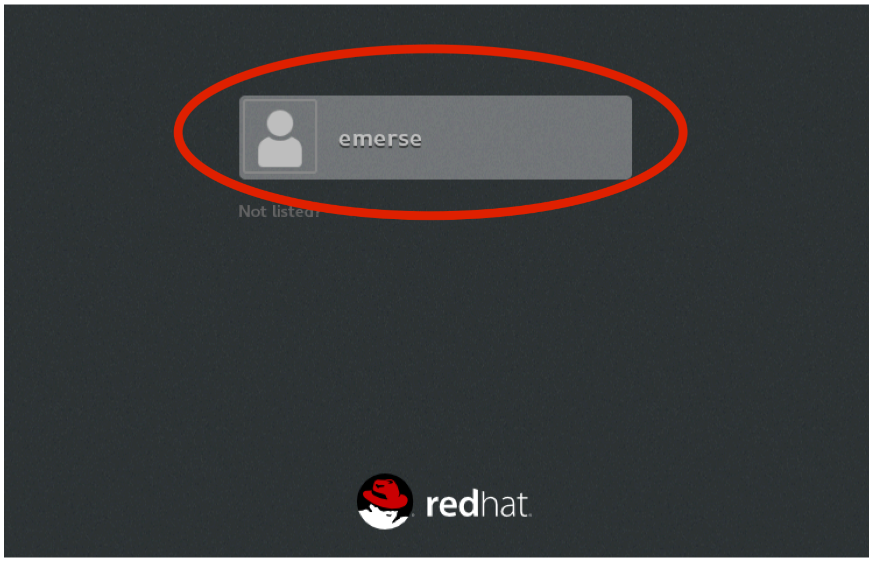
System
Base Memory: 4096 MB
Boot Order: Floppy, Optical, Hard Disk
Acceleration: VT-x/AMD-V, Nested Paging, PAE/NX, KVM Paravirtualization

Display
Video Memory: 16 MB
Remote Desktop Server Port: 3389
Video Capture: Disabled

Storage
Controller: IDE
IDE Primary Master: [Optical Drive] VBoxGuestAdditions.iso (56.62 MB)
Controller: SATA
SATA Port 0: emerse2_rhel7_pubmed_2-disk2.vmdk (Normal, 40.55 GB)

Audio
Host Driver: CoreAudio

☐ The default username for this Linux OS is `emerse` and the password is `demouser`. Once the OS loads you will see the login screen that says EMERSE. Click on where it says EMERSE, then enter the password on the next screen. This username and password is also the default for the EMERSE system on the VM (accessible via the web browser on the VM itself).



Launching EMERSE

Once the virtual machine (VM) is up and running, launching EMERSE should be simple. The servers that run EMERSE should already automatically start up, so all you need to do is launch the browser (preferably Chrome). This can be found on the Linux VM under `Applications` → `Internet` → `Chrome` or by double clicking on the Chrome icon on the Desktop. Then, simply go to the URL:

```
localhost:8090/emerse/login.html
```

username: `emerse`
password: `demouser`

This username and password combination are used throughout the VM, for the Linux OS, for the EMERSE application, for Oracle, etc.

Other useful things to explore on the VM

In addition to the main EMERSE interface that most users will interact with, there are other areas that may be worth exploring.

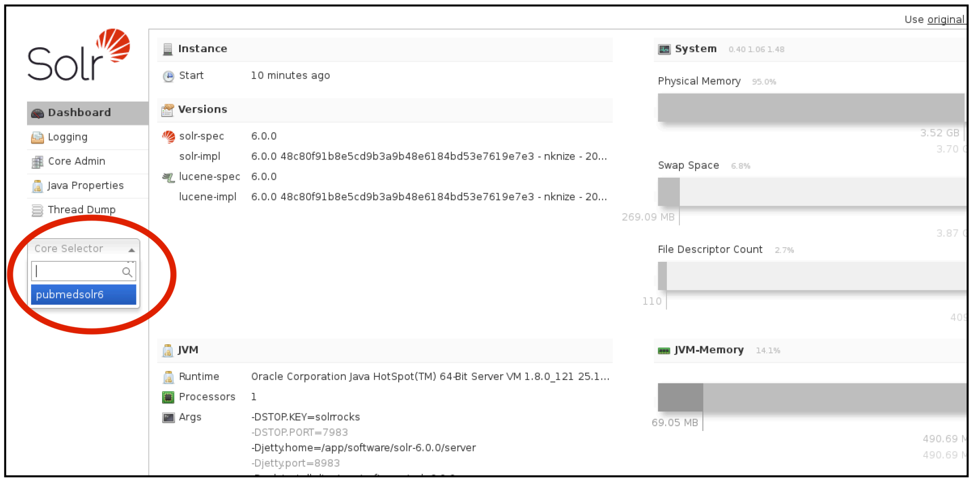
1. The EMERSE administrator page (for adding/managing users) can be found at:

```
localhost:8090/emerse/admin.html
```

2. For those wishing to try out the native Solr interface for submitting a query, visit this URL:

```
localhost:8983/solr/
```

To get to the proper area for running queries from this interface, click on the left pane where it says “Core Selector” and choose “pubmedsolr6”:



Instance
Start 10 minutes ago

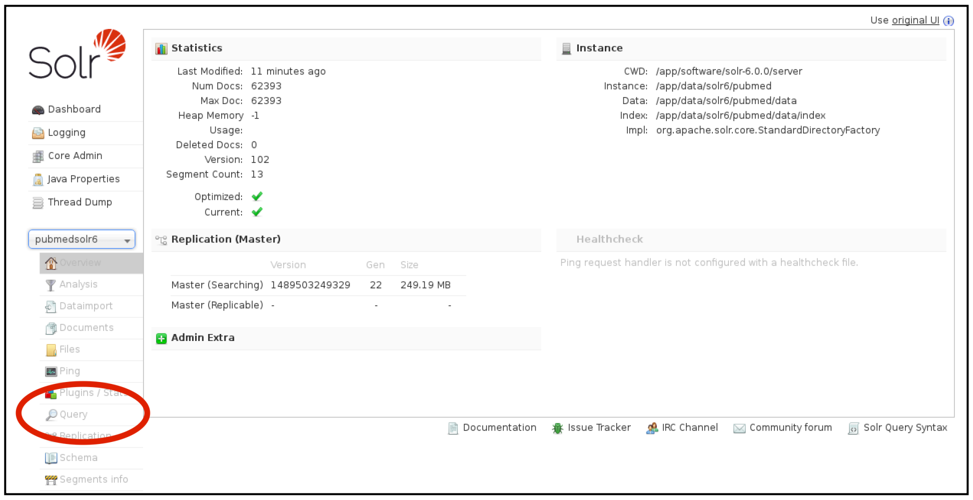
Versions
solr-spec 6.0.0
solr-impl 6.0.0 48c80f91b8e5cd9b3a9b48e6184bd53e7619e7e3 - nknize - 20...
lucene-spec 6.0.0
lucene-impl 6.0.0 48c80f91b8e5cd9b3a9b48e6184bd53e7619e7e3 - nknize - 20...

System 0.40 1.06 1.48
Physical Memory 95.0%
3.52 GB
Swap Space 6.8%
269.09 MB
File Descriptor Count 2.7%
110

JVM
Runtime Oracle Corporation Java HotSpot(TM) 64-Bit Server VM 1.8.0_121 25.1...
Processors 1
Args -DSTOP.KEY=solrrocks
-DSTOP.PORT=7983
-Djetty.home=/app/software/solr-6.0.0/server
-Djetty.port=8983

JVM-Memory 14.1%
69.05 MB
490.69
490.69

Then, click where it says “Query”:



Statistics
Last Modified: 11 minutes ago
Num Docs: 62393
Max Doc: 62393
Heap Memory Usage: -1
Deleted Docs: 0
Version: 102
Segment Count: 13
Optimized: ✓
Current: ✓

Instance
CWD: /app/software/solr-6.0.0/server
Instance: /app/data/solr6/pubmed
Data: /app/data/solr6/pubmed/data
Index: /app/data/solr6/pubmed/data/index
Impl: org.apache.solr.core.StandardDirectoryFactory

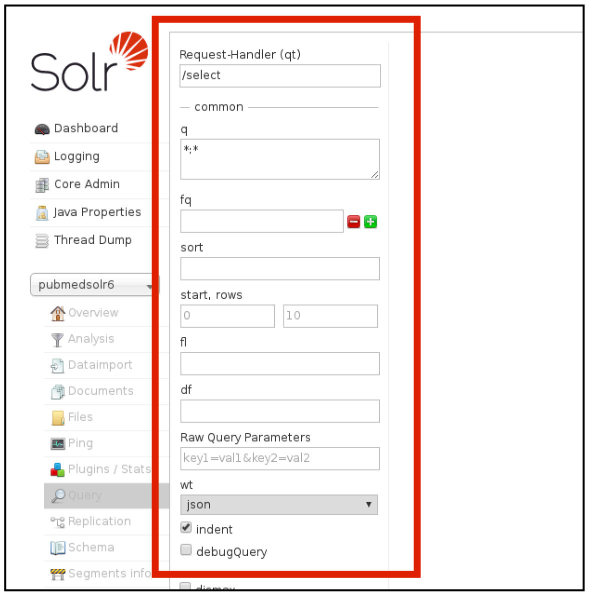
Replication (Master)

	Version	Gen	Size
Master (Searching)	1489503249329	22	249.19 MB
Master (Replicable)	-	-	-

Healthcheck
Ping request handler is not configured with a healthcheck file.

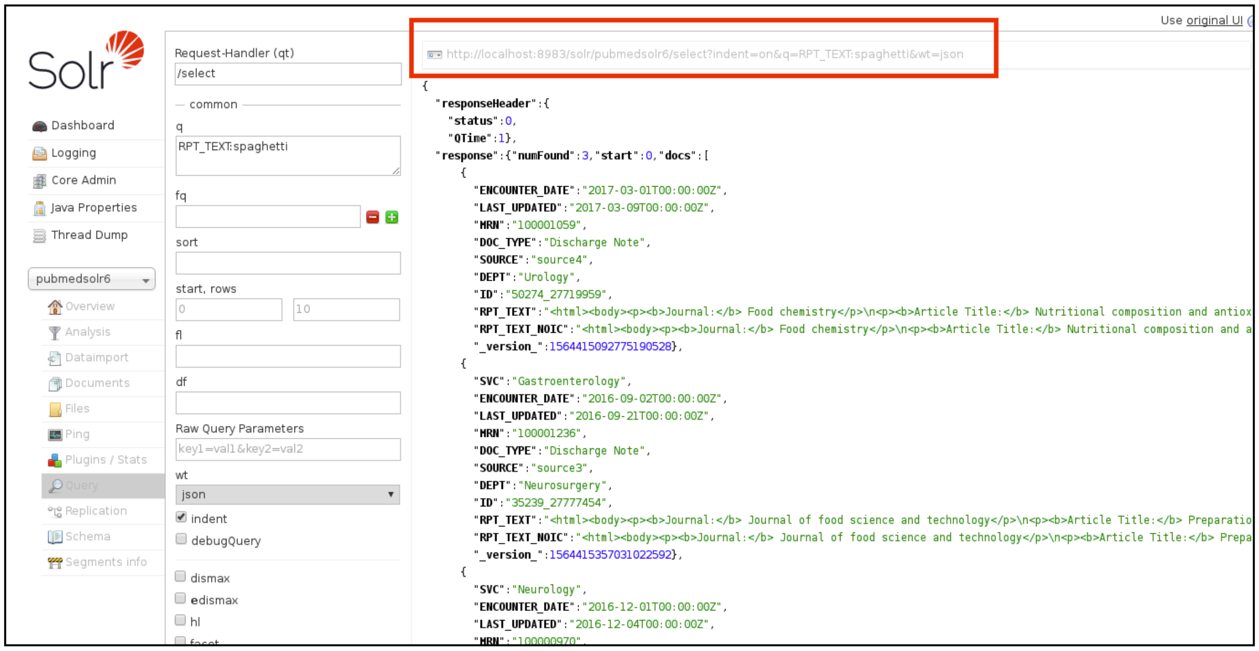
Admin Extra

You will then be at the page where Solr queries can be run, which can be useful for testing and troubleshooting queries:



```
Request-Handler (qt)
/select
common
q
*:*
fq
sort
start, rows
0    10
fl
df
Raw Query Parameters
key1=val1&key2=val2
wt
json
[✓] indent
[ ] debugQuery
[ ] dismax
```

This is the result from an example query for the word ‘spaghetti’:



```
Request-Handler (qt)
/select
common
q
RPT_TEXT:spaghetti
fq
sort
start, rows
0    10
fl
df
Raw Query Parameters
key1=val1&key2=val2
wt
json
[✓] indent
[ ] debugQuery
[ ] dismax
[ ] edismax
[ ] hl
[ ] facet
```

```
http://localhost:8983/solr/pubmedsolr6/select?indent=on&q=RPT_TEXT:spaghetti&wt=json
{
  "responseHeader":{
    "status":0,
    "QTime":1},
  "response":{"numFound":3,"start":0,"docs":[
      {
        "ENCOUNTER_DATE":"2017-03-01T00:00:00Z",
        "LAST_UPDATED":"2017-03-09T00:00:00Z",
        "MRN":"100001059",
        "DOC_TYPE":"Discharge Note",
        "SOURCE":"source4",
        "DEPT":"Urology",
        "ID":"50274_27719959",
        "RPT_TEXT":"<html><body><p><b>Journal:</b> Food chemistry</p>\n<p><b>Article Title:</b> Nutritional composition and antiox
        "RPT_TEXT_NOIC":"<html><body><p><b>Journal:</b> Food chemistry</p>\n<p><b>Article Title:</b> Nutritional composition and a
        "_version_":1564415092775190528},
      {
        "SVC":"Gastroenterology",
        "ENCOUNTER_DATE":"2016-09-02T00:00:00Z",
        "LAST_UPDATED":"2016-09-21T00:00:00Z",
        "MRN":"100001236",
        "DOC_TYPE":"Discharge Note",
        "SOURCE":"source3",
        "DEPT":"Neurosurgery",
        "ID":"35239_27777454",
        "RPT_TEXT":"<html><body><p><b>Journal:</b> Journal of food science and technology</p>\n<p><b>Article Title:</b> Preparatio
        "RPT_TEXT_NOIC":"<html><body><p><b>Journal:</b> Journal of food science and technology</p>\n<p><b>Article Title:</b> Prepa
        "_version_":1564415357031022592},
      {
        "SVC":"Neurology",
        "ENCOUNTER_DATE":"2016-12-01T00:00:00Z",
        "LAST_UPDATED":"2016-12-04T00:00:00Z",
        "MRN":"100000970",
```

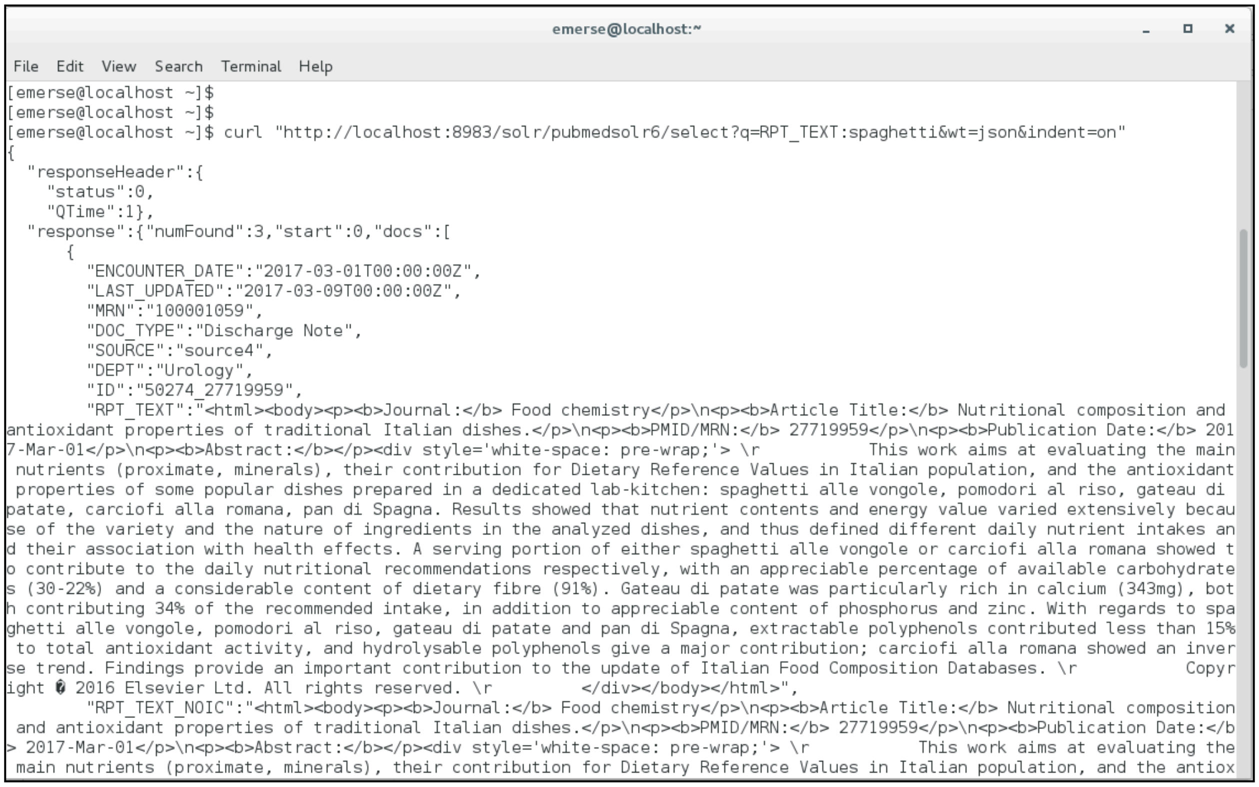
Note that the resulting URL in the red box above is an HTML version of the query that can be used for the Solr API using the `curl` command line program (described below).

3. The indexed data can also be accessed programmatically using the built-in Solr API via `curl`. This could be useful for additional processing or to build applications that can access the underlying indexes. Note that in this demonstration version we have not turned on a password for this access but in a production system it should be secured. While curl can be called from various programming languages (e.g., Perl, Python, Java, etc), the example here is for using `curl` directly from the command line:

Go to `Terminal`, and enter your query. You can get assistance for building queries by using the Solr interface (described in #2, above). To query the word ‘spaghetti’ with the results in JSON format, enter:

```
curl “http://localhost:8983/solr/pubmedsolr6/select?q=RPT_TEXT:spaghetti&wt=json&indent=on”
```

The results will come back in JSON format in the Terminal:



emerse@localhost:~

File Edit View Search Terminal Help

```
[emerse@localhost ~]$
[emerse@localhost ~]$
[emerse@localhost ~]$ curl "http://localhost:8983/solr/pubmedsolr6/select?q=RPT_TEXT:spaghetti&wt=json&indent=on"
{
  "responseHeader":{
    "status":0,
    "QTime":1},
  "response":{"numFound":3,"start":0,"docs":[
      {
        "ENCOUNTER_DATE":"2017-03-01T00:00:00Z",
        "LAST_UPDATED":"2017-03-09T00:00:00Z",
        "MRN":"100001059",
        "DOC_TYPE":"Discharge Note",
        "SOURCE":"source4",
        "DEPT":"Urology",
        "ID":"50274_27719959",
        "RPT_TEXT":"<html><body><p><b>Journal:</b> Food chemistry</p>\n<p><b>Article Title:</b> Nutritional composition and
antioxidant properties of traditional Italian dishes.</p>\n<p><b>PMID/MRN:</b> 27719959</p>\n<p><b>Publication Date:</b> 201
7-Mar-01</p>\n<p><b>Abstract:</b></p><div style='white-space: pre-wrap;'> \r          This work aims at evaluating the main
 nutrients (proximate, minerals), their contribution for Dietary Reference Values in Italian population, and the antioxidant
 properties of some popular dishes prepared in a dedicated lab-kitchen: spaghetti alle vongole, pomodori al riso, gateau di
patate, carciofi alla romana, pan di Spagna. Results showed that nutrient contents and energy value varied extensively becau
se of the variety and the nature of ingredients in the analyzed dishes, and thus defined different daily nutrient intakes an
d their association with health effects. A serving portion of either spaghetti alle vongole or carciofi alla romana showed t
o contribute to the daily nutritional recommendations respectively, with an appreciable percentage of available carbohydrate
s (30-22%) and a considerable content of dietary fibre (91%). Gateau di patate was particularly rich in calcium (343mg), bot
h contributing 34% of the recommended intake, in addition to appreciable content of phosphorus and zinc. With regards to spa
ghetti alle vongole, pomodori al riso, gateau di patate and pan di Spagna, extractable polyphenols contributed less than 15%
 to total antioxidant activity, and hydrolysable polyphenols give a major contribution; carciofi alla romana showed an inver
se trend. Findings provide an important contribution to the update of Italian Food Composition Databases. \r          Copyr
ight � 2016 Elsevier Ltd. All rights reserved. \r          </div></body></html>",
        "RPT_TEXT_NOIC":"<html><body><p><b>Journal:</b> Food chemistry</p>\n<p><b>Article Title:</b> Nutritional composition
 and antioxidant properties of traditional Italian dishes.</p>\n<p><b>PMID/MRN:</b> 27719959</p>\n<p><b>Publication Date:</b
> 2017-Mar-01</p>\n<p><b>Abstract:</b></p><div style='white-space: pre-wrap;'> \r          This work aims at evaluating the
 main nutrients (proximate, minerals), their contribution for Dietary Reference Values in Italian population, and the antiox
```

Many details about formulating queries can be found here:

https://lucene.apache.org/core/2_9_4/queryparsersyntax.html

4. It is also possible to access the Solr API through various programming languages. Below is a short Java program example showing how to query the system via a URL and get the result back as a String in JSON format. This example code takes a single word passed as an argument through the command line (‘spaghetti’ in the example below) and queries the system for that word, as in:

```
> java javaEMERSEexample spaghetti
```

```
// Simple code example showing how to query Solr using Java

// this was modified from code found at http://www.avajava.com/tutorials/lessons/how-do-i-connect-to-a-url-
using-basic-authentication.html

import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.net.MalformedURLException;
import java.net.URL;
import java.net.URLConnection;

//import org.apache.commons.codec.binary.Base64; //would be used to convert username and password to base64, if
usernames/passwords are turned on for access

public class javaEMERSEexample {

        public static void main(String[] args) {

                String wordToQuery = args[0]; //take the single word passed to the Java app at the command
line as the word for the query
                String   webPage =  "http://localhost:8983/solr/pubmedsolr6/select?q=RPT_TEXT:" + wordToQuery
+ "&wt=json&indent=on";
                String result = ""; //to hold the result of the Solr query.  In this case in json format.

                        /*
                        //this is how to deal with authentication if you need to convert the
username/password to the base 64 combination
                        String name = "emerse";
                        String password = "demouser";
                        String authString = name + ":" + password;
                        System.out.println("auth string: " + authString);
                        byte[] authEncBytes = Base64.encodeBase64(authString.getBytes());
                        String authStringEnc = new String(authEncBytes);
                        System.out.println("Base64 encoded auth string: " + authStringEnc);
                        */

                        try {
                        URL url = new URL(webPage);
                        URLConnection urlConnection = url.openConnection();
                        //urlConnection.setRequestProperty("Authorization", "Basic " + authStringEnc);
                        InputStream is = urlConnection.getInputStream();
                        InputStreamReader isr = new InputStreamReader(is);

                        int numCharsRead;
                        char[] charArray = new char[1024];
                        StringBuffer sb = new StringBuffer();
                        while ((numCharsRead = isr.read(charArray)) > 0) {
                                sb.append(charArray, 0, numCharsRead);
                        }
                         result = sb.toString();
                } catch (MalformedURLException e) {
                        e.printStackTrace();
                } catch (IOException e) {
                        e.printStackTrace();
                }
        System.out.println(result);
        }
}
```

The output of this code looks essentially like the output from the curl command in the prior example.

5. To explore the Oracle database, in the Linux VM menu bar go to `Applications` → `Developer` → `SQL Developer`.

Then in the `SQL Developer` application click on `Connections` → `Local XE as EMERSE`.

username: emerse
password: demouser

IMPORTING YOUR OWN DATA

The following directions are only needed if there is a desire to load your own data into EMERSE for searching your own documents. It is not required for the basic demonstration version of EMERSE. It is also not recommended as an institutional solution for supporting multiple users. In other words, this approach could be used for individual projects where you are not able to obtain institutional support to install EMERSE centrally. In such a case, it is still important to consider the privacy and security implications of running your own VM to host data if the system were to contain patient data with protected health information. Please consult your local IT support group for advice on the security aspects.

For importing data, we assume that you will have a way to obtain all of your documents that need to be imported into EMERSE, with each document saved as a separate file.

The general steps for importing data into EMERSE are shown in the table below.

Step	Description	Section(s) describing details in this document
1	Convert your documents for importing if they are not already in plain text or HTML formats.	Preparing documents for import: File Conversion
2	Creating metadata files that will define aspects of how the EMERSE system should display the documents, and define the patients with whom the documents will be associated.	Metadata files: Overview Metadata files: Document sources Metadata files: Document Source Metadata Metadata files: Document Metadata Metadata files: Patient Metadata
3	Creating a shared directory between your host computer and the guest virtual machine to copy the data from the host to the VM. This step, and the following step, is needed only if the data are created on the host machine. If the metadata files are created on the VM then there is no need to copy them.	Setting up a shared directory for copying data to the VM
4	Copy the files (metadata files and the actual documents for import) to the virtual machine.	Using the shared folder to copy the data files to the VM
5	Run the data loading scripts.	Using the scripts to load data into EMERSE
6	Directions for adding new data once existing data have already been loaded (this step is optional)	Incrementally adding new data

It is also possible to download an example dataset (containing PubMed abstracts) which can be used for importing into the EMERSE VM. Those datasets, or a set of blank templates, can be found here:

http://project-emerse.org/virtualmachine.html

Preparing documents for import: File Conversion (Mac directions only)

EMERSE uses Apache Solr for indexing documents. Solr can handle several file formats, but not all file formats are supported. If your documents are already plain text (.txt) or HTML (.html or .htm) then no additional conversion is required, and you can skip this section.

Files in other formats should be converted to either plain text or HTML. HTML is ideal for files with formatting (e.g., tables, bold text, etc) since HTML files can generally preserve that formatting whereas plain text files will not.

If file conversion is needed because the documents are not already in plain text (`.txt`) or HTML (`.html` or `.htm`) format, there are various ways to convert files, including several commercial options. The following directions were made for the Mac, using tools already provided with the Mac to perform file conversions. Other file conversions options are available for Windows machines. On Mac OS X there is a file converter built into the operating system. This can convert Microsoft Word documents (`.doc` or `.docx`) into HTML files which can then be imported into EMERSE. This file converter can also transform RTF documents into HTML. The following directions describe a simple approach for converting Word documents into HTML. Similar steps would be needed for converting RTF into HTML.

☐ Create a directory/folder on the Mac. It can have any name, but in this example you can name it `documentstoconvert` and it will be located on the Desktop.

☐ Copy all of the documents that need converting to this folder.

☐ Open a `Terminal` window. Navigate to `Applications` → `Utilites` → `Terminal` and double click the `Terminal` application to open it.

☐ At the `Terminal` command line, navigate to the proper directory, by typing:

```
cd ~/Desktop/documentstoconvert/
```

☐ Next, at the command line, convert the documents by typing:

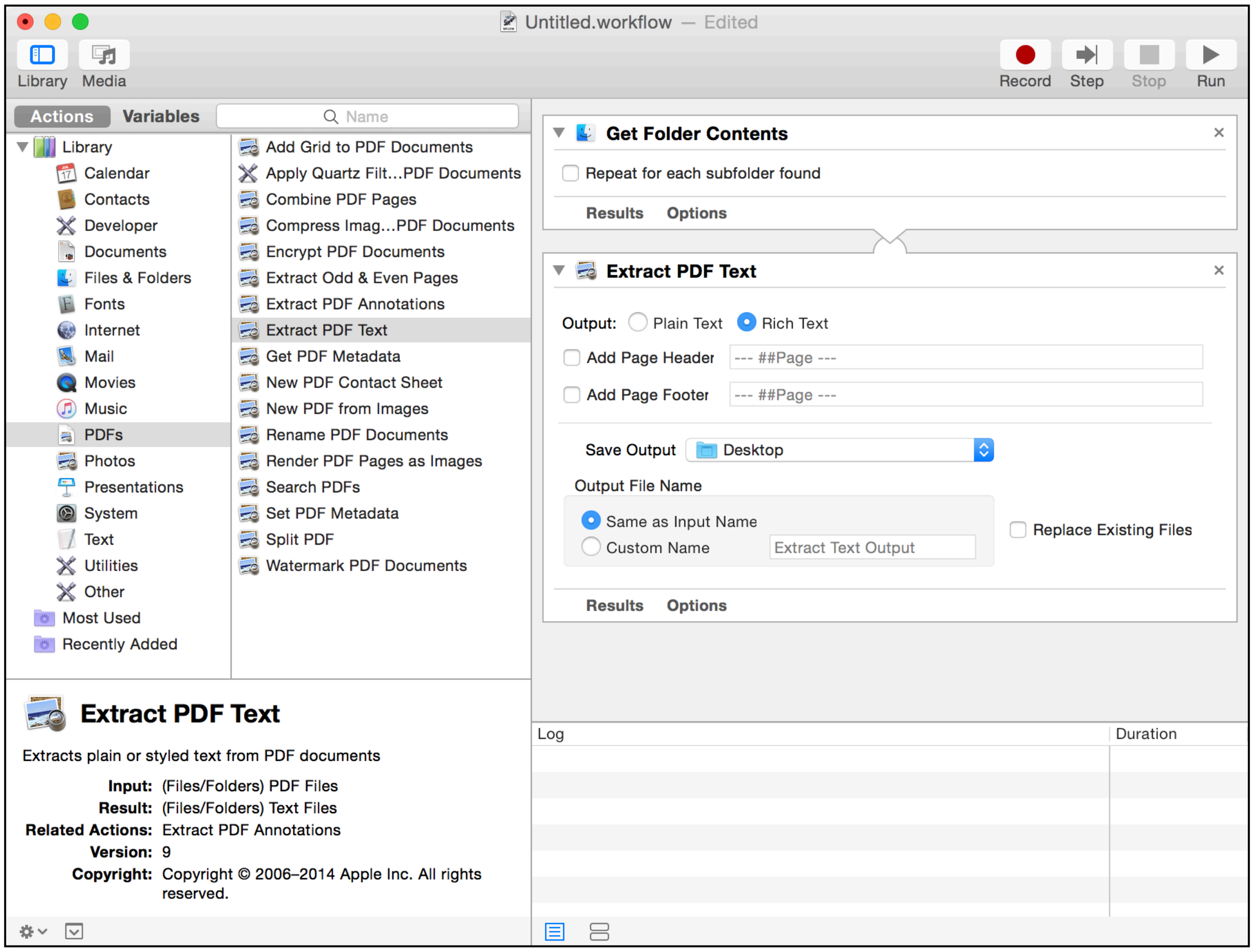
```
textutil -convert html *.docx *.doc
```

Note that this will convert all `.docx` and `.doc` files into HTML format. To also include RTF files, simply add that part of the command, such as:

```
textutil -convert html *.docx *.doc *.rtf
```

The converted files should all have a `.html` extension. You can now either delete or remove the original files, or simply copy the new HTML files to a new folder to separate them out. Note that you can sort the folder by `Kind` to get all of the HTML files together in the list, which makes it easier to just select that file type.

Note: On the Mac it is also possible to convert PDF files, but the process is a bit more involved. This can be done using the `Automator` app, and developing a workflow. The PDF conversion component in the `Automator` app can be found under the `PDFs` → `Extract PDF Text` *workflow. One can use this Automator workflow save the files in RTF format, and then follow the directions about using the* `textutil` *app to convert RTF to HTML.*



Get Folder Contents

☐ Repeat for each subfolder found

Extract PDF Text

Output: Plain Text [✓ Rich Text]

☐ Add Page Header --- ##Page ---

☐ Add Page Footer --- ##Page ---

Save Output: Desktop

Output File Name: [✓ Same as Input Name] Custom Name (Extract Text Output)

☐ Replace Existing Files

Extract PDF Text

Extracts plain or styled text from PDF documents

Input: (Files/Folders) PDF Files
Result: (Files/Folders) Text Files
Related Actions: Extract PDF Annotations
Version: 9
Copyright: Copyright © 2006–2014 Apple Inc. All rights reserved.

Figure. Screen shot of the Mac OS X Automator app Worfklow for converting PDFs into RTF.

Metadata files: Overview

EMERSE was designed to incorporate data from electronic health records. As such, it was designed to include documents that are connected to patients via a medical record number (MRN). Documents can have various sources (e.g., Radiology, Pathology, Epic, etc), and each document might have different metadata depending on the source (e.g., date, author, document type, clinical service, authoring clinician, etc). EMERSE also expects to have a list of all patients for which documents are loaded.

While this was the intended use, it is still possible to include documents even if they are not actually tied to a known patient. In such a case, when setting up the data import you will need to essentially create a fake "patient" MRN to connect to the document as well as filler data about the patient name, date of birth, gender, etc. This should not affect the performance of the system.

Following are details about the data files needed to import your own data into the VM, their expected structure, and contents. Four files in Microsoft Excel (.xlsx) are required to define the metadata, and a separate folder (simply called `documents`) is required to hold the actual documents that will be indexed.

It is probably easiest to create these Excel files on your own (host) computer and then move them to the virtual machine (details for moving the files are provided within this document). However, if there is a desire to create, open, or edit Microsoft Excel xlsx files on the Linux virtual machine, this can be done using a free program called OpenOffice, which has been pre-installed on the virtual machine being distributed with EMERSE.

There are four components for which you need to provide data: the document source names, the metadata about the document sources, the document metadata, and the patient data. These four files are called:

```
documentMetadata.xlsx
patientMetadata.xlsx
sourceMetadata.xlsx
documentSources.xlsx
```

A fifth file is required by the loading scripts, but does not require any editing. It is called `solrmap.xlsx` and it should already be located on the virtual machine in `/app/data/emerse_pdi_job/`. In the event that it is missing or deleted, it can simply be re-created by pasting the table below into an Excel spreadsheet and naming it `solrmap.xlsx`

The contents of the `solrmap.xlsx` file:

SOLR Field	**Excel field**
ID	documentId
LAST_UPDATED	documentLastUpdatedDate
ENCOUNTER_DATE	documentServiceDate
ADMIT_DATE	admitDate
DISCHARGE_DATE	dischargeDate
CASE_ACCN_NBR	accessionNumber
DOC_TYPE	documentType
SVC	service
CSN	encounterNumber
DEPT	department
CLINICIAN	providerName
STATUS	status
DESC	description

Note: Because of the way that the import scripts were written, they will only work if the column headers in the Excel files are not modified in any way. That is, the header names should remain the same and the order of all of the columns should remain the same. Changing the column order will break the import scripts.

Also note that all dates should ideally be in the MM/DD/YYYY format to ensure there is no ambiguity when importing the dates, especially around any 2-digit year abbreviation.

Metadata files: Document sources

The first file to define is related to the document sources. In EMERSE, documents are displayed according to source system which helps distinguish where a document came from. In general, a source can be thought of as a source system, such as a radiology system, a pathology system, or the EHR itself. You can include just one source, or you can have multiple sources. These sources are defined in the file called:

`documentSources.xlsx`

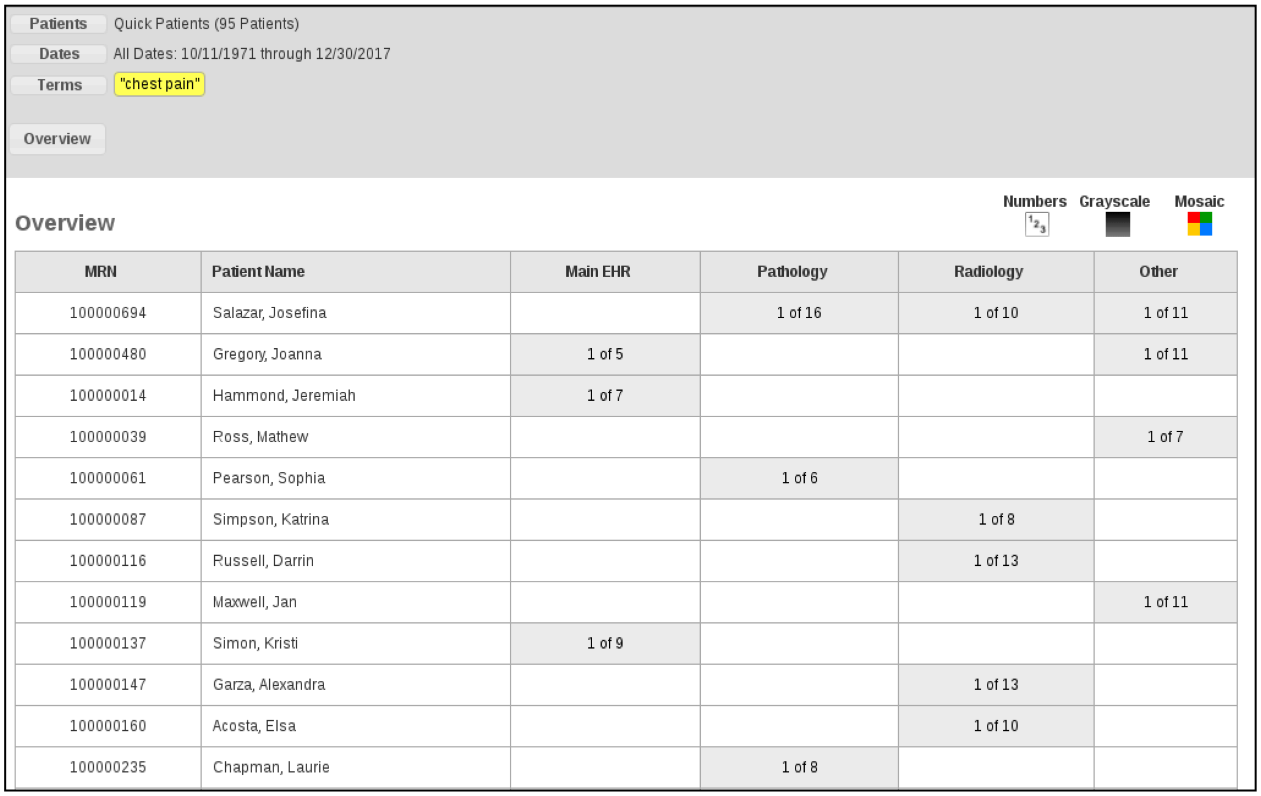
There are 2 columns where the metadata about the document sources should be defined. Each is explained below. The order in which the sources are displayed in the EMERSE "Overview" section (from left to right) are defined by the order in which they are listed in this spreadsheet (from top to bottom).

`Source Key`	This is used internally to link data between this `documentSources.xlsx` spreadsheet and the `sourceMetadata.xlsx` and `documentMetadata.xlsx` spreadsheets. The elements in this column can have any name, but there can be no spaces in the name provided, and each row must be unique.
`Source Display`	This is the name of the source as it will be displayed in EMERSE. This can have spaces in it, and would likely include things such as "Pathology", "Radiology", etc. (but without the quotes).

Example `documentSources.xlsx` spreadsheet:

Source Key	**Source Display**
source1	Main EHR
source2	Pathology
source3	Radiology
source4	Other

Example of how the mapping in the table above matches the appearance within EMERSE for the "Overview" section within EMERSE:



Patients	Quick Patients (95 Patients)
Dates	All Dates: 10/11/1971 through 12/30/2017
Terms	"chest pain"

MRN	Patient Name	Main EHR	Pathology	Radiology	Other
100000694	Salazar, Josefina		1 of 16	1 of 10	1 of 11
100000480	Gregory, Joanna	1 of 5			1 of 11
100000014	Hammond, Jeremiah	1 of 7			
100000039	Ross, Mathew				1 of 7
100000061	Pearson, Sophia		1 of 6		
100000087	Simpson, Katrina			1 of 8	
100000116	Russell, Darrin			1 of 13	
100000119	Maxwell, Jan				1 of 11
100000137	Simon, Kristi	1 of 9			
100000147	Garza, Alexandra			1 of 13	
100000160	Acosta, Elsa			1 of 10	
100000235	Chapman, Laurie		1 of 8		

Metadata files: Document Source Metadata

For every document source there are, at a minimum, two required metadata fields (other than the text of the document itself). These are the date in which the clinical encounter occurred (often called the service date or encounter date), and the date when the document was last updated. However, each document source may have additional metadata that could be displayed for the users and can include items such as the clinical department, the clinician's name who authored the document, or even the document/note type (e.g., progress report, discharge note, etc.). The types of metadata are defined in this Excel spreadsheet which is called:

`sourceMetadata.xlsx`

This file contains 3 columns, described below. The order in which these elements are listed (top to bottom) are the order in which they will appear in EMERSE (from left to right), with the caveat that the text snippet showing any text found for a note will always appear on the left, and, the order is only considered within each document source.

`Source Key`	This is the same source that should be listed in the `documentSources.xlsx file` file and the `documentMetadata.xlsx` file. The names cannot contain any spaces, and is only used internally to link between the files.
`nameFromDocumentSheet`	This provides a linking/map between the `sourceMetadata.xlsx` and the names of some of the column headers in the `documentMetadata.xlsx` file. It basically represents the various metadata elements that can be incorporated for each document source. (The names are fixed and cannot be changed, although this could potentially be changed by a developer who modified the underlying Solr schema.)
`displayName`	This is the name of the metadata element as it should be displayed in EMERSE. Often these will be names such as "Clinician", "Department", "Note Type", etc., but they can be anything.

Note: There are two `nameFromDocumentSheet` *elements that are required for each document source, although the display names are customizable. These two required fields are:*
`documentServiceDate`
`documentLastUpdatedDate`

By Default EMERSE will sort data based on `documentServiceDate`.

The full list of elements for the `nameFromDocumentSheet` are defined in the table below. Note that these names are essentially placeholders, so even if a name appears to have a specific intended use, it can be overridden simply by providing a new display name. There are also two data types supported, `date` and `text`. Note that the table below is just for information to define what the elements are, it is not meant to be a spreadsheet used for importing data into EMERSE.

Table. Metadata elements that can be included in the `sourceMetadata.xlsx` sheet.

nameFromDocumentSheet	**Solr field name***	**Required?**	**Type**	**Original intended use**
`documentServiceDate`	ENCOUNTER_DATE	Yes	Date	The data of the clinical service that the document relates to
`documentLastUpdatedDate`	LAST_UPDATED	Yes	Date	The date the document was last updated
`documentType`	DOC_TYPE	No	Text	The type of document, such as progress note or admission note
`department`	DEPT	No	Text	The clinical department, such as pediatrics, or internal medicine
`encounterNumber`	CSN	No	Text	The encounter number to which the document belongs
`providerName`	CLINICIAN	No	Text	The name of the clinician who authored the document
`admitDate`	ADMIT_DATE	No	Date	The admission date for the encounter to which the document belongs
`dischargeDate`	DISCHARGE_DATE	No	Date	The discharge date for the encounter to which the document belongs
`accessionNumber`	CASE_ACCN_NBR	No	Text	A field for a case accession number, used by the pathology department
`status`	STATUS	No	Text	The status of the document, such as Signed, Preliminary, etc.
`service`	SVC	No	Text	The clinical service, such as rheumatology or cardiology
`description`	DESC	No	Text	Any additional information that might be relevant about the ddocuments

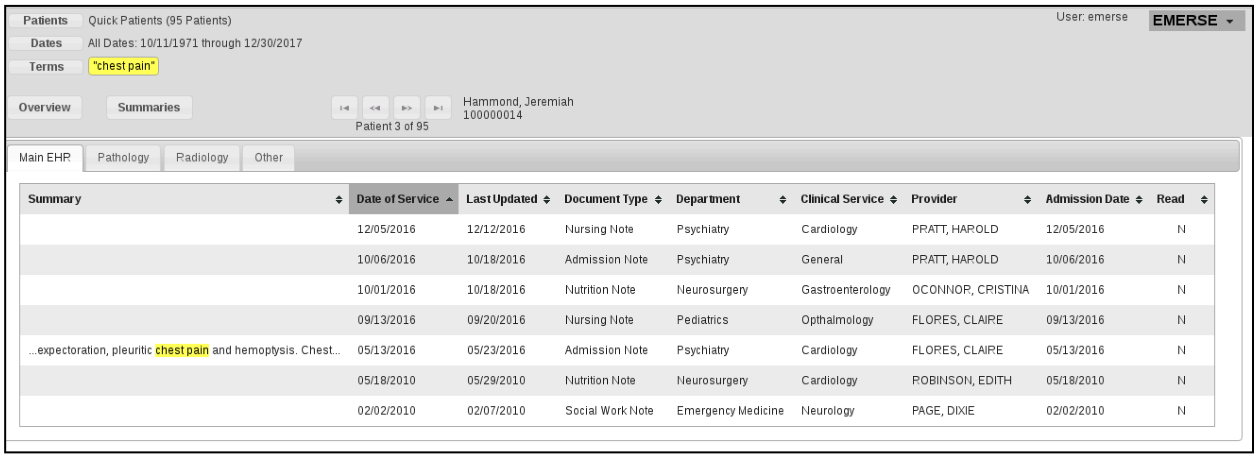
* This is only provided for those wishing to look deeper into the underlying Solr configuration to understand how the fields are being mapped.

Example `sourceMetadata.xlsx` spreadsheet:

Source Key	**nameFromDocumentSheet**	**displayName**
source1	documentServiceDate	Date of Service
source1	documentLastUpdatedDate	Last Updated
source1	documentType	Document Type
source1	department	Department
source1	service	Clinical Service
source1	providerName	Provider
source1	admitDate	Admission Date
source2	documentServiceDate	Date of Service
source2	documentLastUpdatedDate	Last Updated
source2	documentType	Document Type
source2	department	Department
source2	service	Clinical Service
source2	providerName	Provider
source3	documentServiceDate	Date of Service
source3	documentLastUpdatedDate	Last Updated
source3	documentType	Document Type
source3	department	Department
source3	service	Clinical Service
source4	documentServiceDate	Date of Service
source4	documentLastUpdatedDate	Last Updated
source4	documentType	Document Type
source4	department	Department

Note: `documentServiceDate` *and* `documentLastUpdatedDate` *are required fields for each data source. The others are optional.*

Example of how the mapping of `source1` in the table above matches the appearance within EMERSE for the "Summaries" section within EMERSE:



Quick Patients (95 Patients)
All Dates: 10/11/1971 through 12/30/2017
"chest pain"
Hammond, Jeremiah
100000014
Patient 3 of 95

Summary	Date of Service	Last Updated	Document Type	Department	Clinical Service	Provider	Admission Date	Read
	12/05/2016	12/12/2016	Nursing Note	Psychiatry	Cardiology	PRATT, HAROLD	12/05/2016	N
	10/06/2016	10/18/2016	Admission Note	Psychiatry	General	PRATT, HAROLD	10/06/2016	N
	10/01/2016	10/18/2016	Nutrition Note	Neurosurgery	Gastroenterology	OCONNOR, CRISTINA	10/01/2016	N
	09/13/2016	09/20/2016	Nursing Note	Pediatrics	Opthalmology	FLORES, CLAIRE	09/13/2016	N
...expectoration, pleuritic chest pain and hemoptysis. Chest...	05/13/2016	05/23/2016	Admission Note	Psychiatry	Cardiology	FLORES, CLAIRE	05/13/2016	N
	05/18/2010	05/29/2010	Nutrition Note	Neurosurgery	Cardiology	ROBINSON, EDITH	05/18/2010	N
	02/02/2010	02/07/2010	Social Work Note	Emergency Medicine	Neurology	PAGE, DIXIE	02/02/2010	N

Metadata files: Document Metadata

Every document indexed will have its own metadata which relates to the types defined in the `sourceMetadata.xlsx` sheet. For example, if `service` is defined in the `sourceMetadata.xlsx` sheet, then the specific metadata elements for a document could be 'cardiology', 'pulmonology', 'rheumatology', etc.

The file in which these document-specific metadata are defined is called:

`documentMetadata.xlsx`

Every row in this spreadsheet represents a single document to be indexed. Every document must have a unique identifier, and must be connected to a patient through a medical record number. The filename of the document to be loaded (from the `documents` folder) must also be specified here. For the metadata elements related to the documents that will be displayed in EMERSE, each element has its own column in the spreadsheet, regardless of whether or not any metadata for that element actually exists for the documents. The specific cells related to those columns should be left blank if no metadata exists. The following table details the elements present in this spreadsheet.

Column Header Name	Column Order	Column Required?	Data Required?	Description
`fileName`	A	Yes	Yes	The name of the document, located in the `documents` folder, including the file extension.
`source`	B	Yes	Yes	The source that the document belongs do, which would be one of the elements listed under `Source Key` in the `documentSources.xlsx` file
`patientMRN`	C	Yes	Yes	The patient medical record number, which must match a MRN in `patientMetadata.xlsx`
`documentID`	D	Yes	Yes	A unique identifier for each document. This can be anything, but must be unique for each document
`documentServiceDate`	E	Yes	Yes	See definitions in the table describing the metadata in the `sourceMetadata.xlsx` file
`documentLastUpdatedDate`	F	Yes	Yes	
`documentType`	G	Yes	No	
`department`	H	Yes	No	
`encounterNumber`	I	Yes	No	
`providerName`	J	Yes	No	
`admitDate`	K	Yes	No	
`dischargeDate`	L	Yes	No	
`accessionNumber`	M	Yes	No	
`status`	N	Yes	No	
`service`	O	Yes	No	
`description`	P	Yes	No	

Example `documentMetadata.xlsx` spreadsheet:

fileName	source	patientMRN	documentID	documentServiceDate	documentLastUpdatedDate	documentType	department	…*	description
abc.txt	source1	1000000056	abc12345	12/26/16	1/8/17	Nursing Note	Orthopedics		
def.txt	source3	1000000045	def43454	12/26/16	1/8/17	Discharge Note			clinical trial subject
ghi.txt	source1	1000000034	ddd33433	12/26/16	1/11/17	Nutrition Note	Emergency Medicine		
jkl.txt	source2	1000000056	12323abc	9/21/16	10/6/16		Pediatrics		
mno.txt	source2	1000000056	231325f3	10/7/16	10/17/16		Urology		
pqr.html	source1	1000000045	ddsf4543	9/21/16	10/8/16	Discharge Note	Neurosurgery		
stu.html	source3	1000000045	hhjuy654	9/21/16	10/11/16	Nursing Note			clinical trial subject
vwx.html	source2	1000000023	ddfdfdf12	12/12/16	12/13/16		Neurosurgery		

* Other columns should appear, as defined elsewhere in the previous table, but are not shown here due to space limitations. In addition, the order of the columns should not change, and all columns must be in this spreadsheet even if no metadata exists for them.

Note: The documents themselves (as defined under the `fileName` header column) should all be located within a directory called `documents`. This folder of documents should be in the same directory as the other metadata files when importing them into EMERSE.

Metadata files: Patient Metadata

Every document that is imported must be associated with a patient through a medical record number. A patient can have one or (more likely) many associated documents. Patients are defined in a simple Excel spreadsheet called:

`patientMetadata.xlsx`

In this spreadsheet every patient is listed in a row with some additional metadata about them including date of birth, race, gender, and, most importantly, medical record number (MRN). Currently race and gender are free text fields and there is no constraint on what can be entered for them.

Example `patientMetadata.xlsx` spreadsheet:

LastName	FirstName	patientMRN	DOB	gender	race
CURRY	CODY	100000001	02/23/2004	male	Black
RICE	CHAD	100000002	12/22/1985	male	Other
DURAN	DEVIN	100000003	05/05/2006	male	Other
SANCHEZ	EARNEST	100000004	03/11/1980	male	Other
COLE	JONATHON	100000005	12/16/1931	male	White
RILEY	SALLY	100000006	10/01/1977	female	Other
HENDERSON	LEONARD	100000007	05/16/1984	male	Black
ALEXANDER	LELA	100000008	07/08/1967	female	Other
FIELDS	REX	100000009	10/03/2000	male	Black
HINES	ROSIE	100000010	01/13/1999	female	Black
SIMS	DARNELL	100000011	07/31/1980	male	Asian

Setting up a shared directory for copying data to the VM

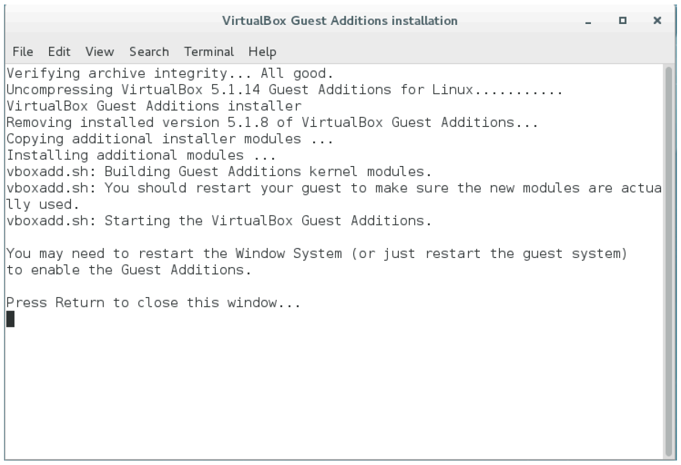
Note: The following directions were created for a Mac, but the process should be very similar for Windows. The directions below were based on those found at helpdeskgeek.com

http://helpdeskgeek.com/virtualization/virtualbox-share-folder-host-guest/

The virtual machine is essentially another computer (operating system) running on your computer. The VM is often called the *guest* and the main operating system on your computer is called the *host*. As such the *guest* OS has it's own disk space and can't "see" the files on your main (*host)* computer unless you set it up so that they can communicate. Once this is set up you can then copy files from the host OS to the guest VM. In these directions, the term "folder" and "directory" are used essentially interchangeably.

There are several ways to moves files to the VM for data import into EMERSE, and the directions below describe only one such approach. Depending on your setup, the default VM environment may not able to connect to the outside Internet, so using services connected to the internet for moving files may not be possible. There are ways to configure the VM to allow for internet connections, but this is not described here. Further, if the data destined for import contains sensitive patient information, it might not be ideal to move them via the internet anyway.

☐ In the Virtual Box Application (not the Linux VM), go to the menu bar at the top of the screen and choose `Devices → Insert Guest Additions CD image…`
Then choose `Run` at the prompt. Enter the password `demouser`.
You will see a window with text about the installation. After it is complete it will show a message `Press Return to close this window…`, so press `Return`.

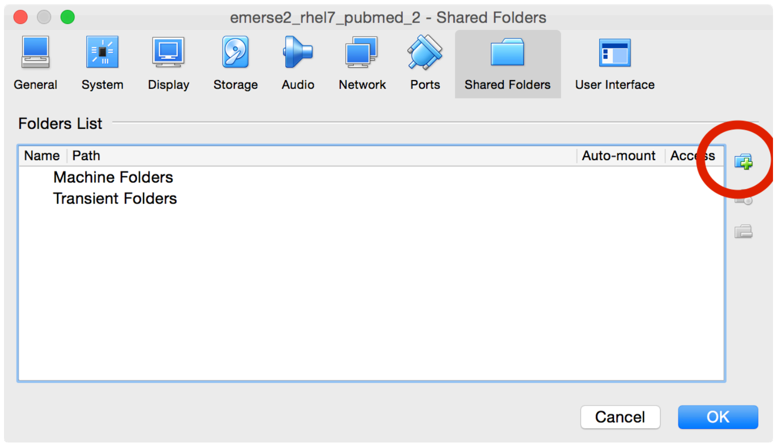

VirtualBox Guest Additions installation
File Edit View Search Terminal Help

```
Verifying archive integrity... All good.
Uncompressing VirtualBox 5.1.14 Guest Additions for Linux...........
VirtualBox Guest Additions installer
Removing installed version 5.1.8 of VirtualBox Guest Additions...
Copying additional installer modules ...
Installing additional modules ...
vboxadd.sh: Building Guest Additions kernel modules.
vboxadd.sh: You should restart your guest to make sure the new modules are actua
lly used.
vboxadd.sh: Starting the VirtualBox Guest Additions.

You may need to restart the Window System (or just restart the guest system)
to enable the Guest Additions.

Press Return to close this window...
```

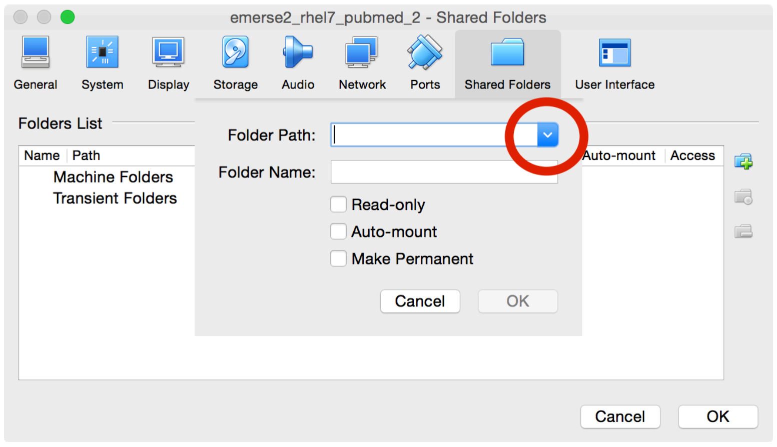
☐ On the Mac Desktop create a folder where you will put all of the files that should be moved over to the VM. You can give it any name, but in this case call it: `vboxsharedfolder`

☐ Go back to the VirtualBox Mac App and in the menu bar across the top of the screen choose `Devices → Shared Folders → Shared Folders Settings…`

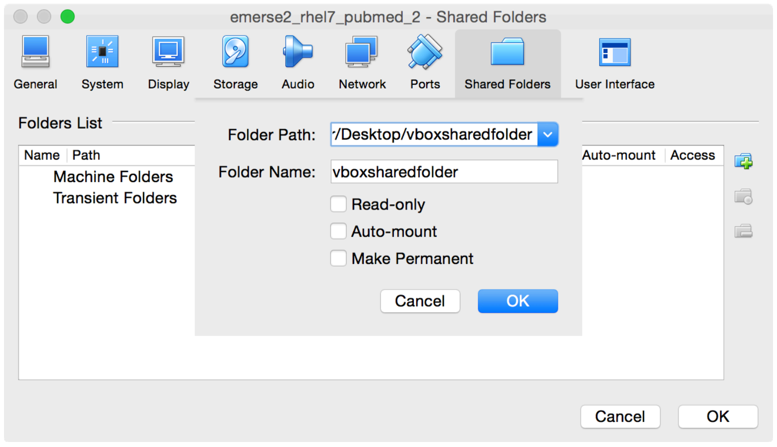
☐ A window will open up, and then click on the folder icon with a plus sign



☐ Under `Folder Path` click on the down arrow and select `Other…`

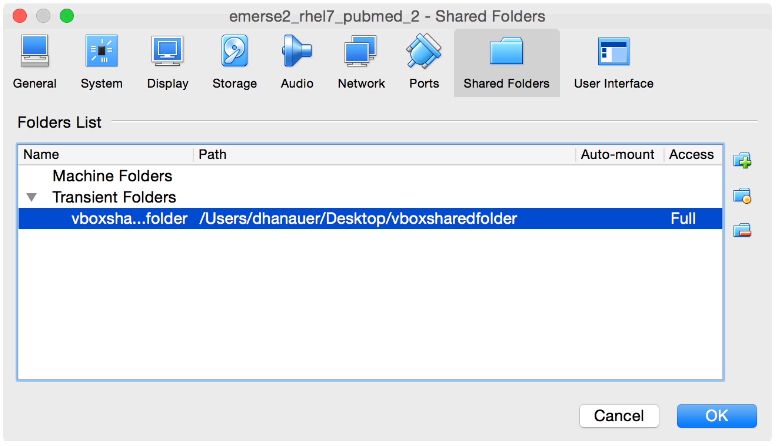


☐ Navigate to the correct folder (the one named `vboxsharedfolder`) on the Mac Desktop, click on the folder once to select it, then click on the `Open` button. It should fill in the name of the folder where it says `Folder Name`. Then click `OK` to close that section and leave the other settings unchecked (e.g., Read-only, Auto-Mount, Make Permanent).



Folder Path: ~/Desktop/vboxsharedfolder
Folder Name: vboxsharedfolder
☐ Read-only
☐ Auto-mount
☐ Make Permanent

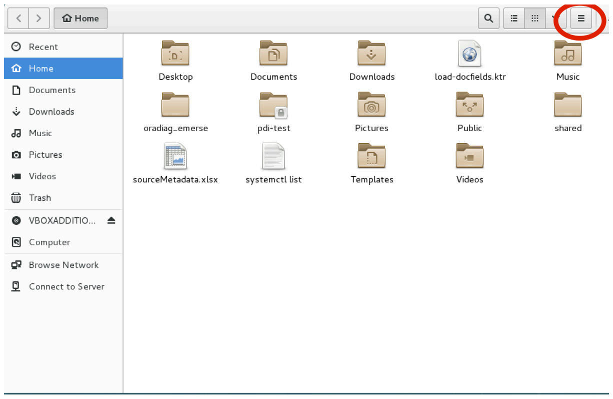
The folder will then show up in the table under the `Transient Folders` heading. Then click `OK`.

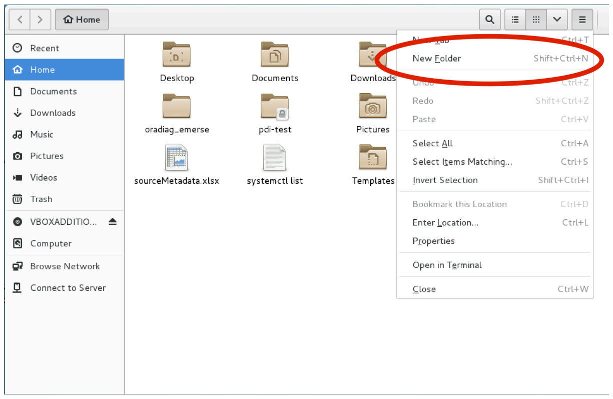

emerse2_rhel7_pubmed_2 - Shared Folders

Folders List

Name	Path	Auto-mount	Access
Machine Folders			
Transient Folders			
vboxsha...folder	/Users/dhanauer/Desktop/vboxsharedfolder		Full

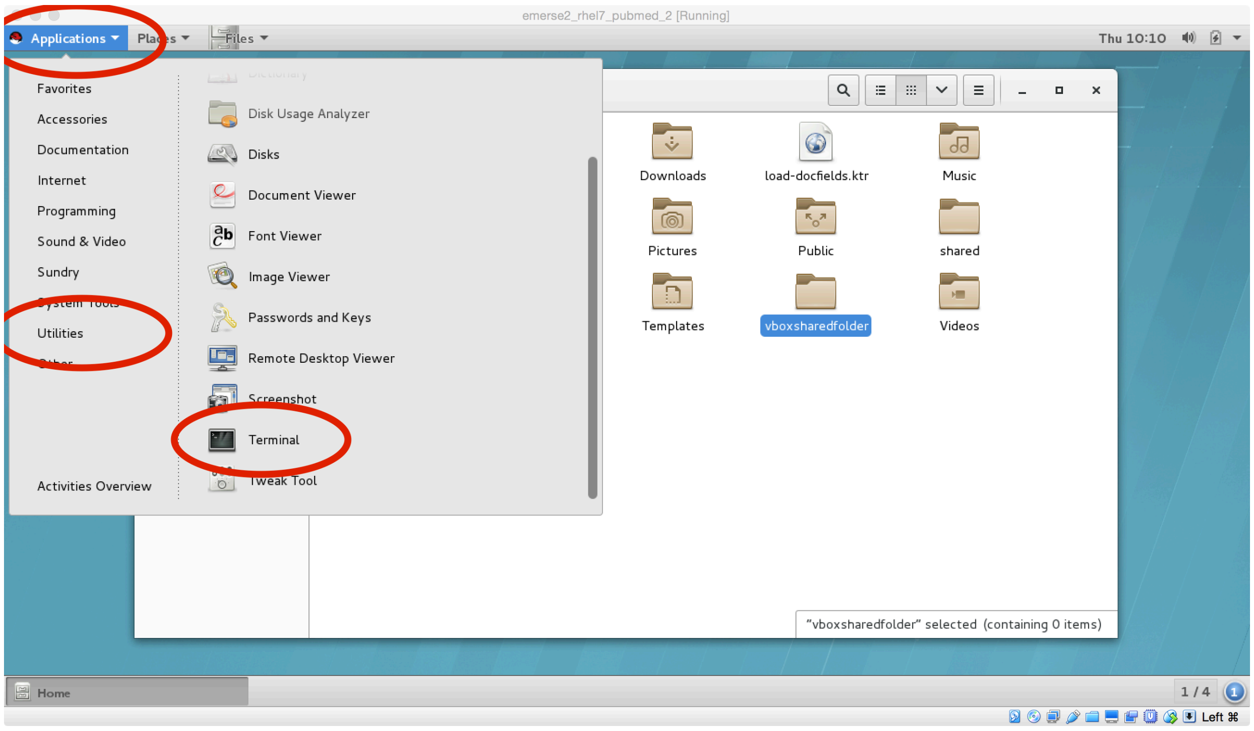
☐ Switch to the guest OS (Linux) and navigate to the `Home Directory` by double-clicking on the Home folder on the Linux Desktop or choosing `Places` → `Home` from the menu bar. In the window that opens click on the icon with the horizontal lines in the upper right corner of the window and then choose `New Folder`.





☐ Give it the same name as the one given for the folder on the Mac: `vboxsharedfolder`

☐ In the Linux OS go to the menu bar and choose `Applications` → `Utilities` → `Terminal`



☐ At the Terminal prompt type in:

```
sudo mount -t vboxsf vboxsharedfolder /home/emerse/vboxsharedfolder/
```

Then enter the password: `demouser`
Close the Terminal window.
At this point if you open the `vboxsharedfolder` on the Linux OS you should be able to see any files that are in the equivalent folder on the Mac Desktop.

Using the shared folder to copy the data files to the VM

Once the shared folder has been created, and the correct 'permissions' have been granted for access (see the prior section, "Setting up a shared directory for copying data to the VM"), you can then copy the data files to the VM. The directions for this are below.

☐ Make sure the proper files have been moved to the `vboxsharedfolder` directory on the Mac, and then open the equivalent folder on the Linux virtual machine. The files that are on the host OS should now be visible in the folder on the guest OS (the Linux VM). Keep that folder open for now.

☐ The next step is to then move those files to the right place on the Linux machine for importing. Go to the Linux menu bar and choose `Places` → `Computer`. Navigate (by double-clicking the folders to open then) to `app` → `data` → `emerse_pdi_job`

☐ Drag the files from the Linux folder `vboxsharedfolder` to the `emerse_pdi_job` folder. These would include the files called:

`documentMetadata.xlsx`
`patientMetadata.xlsx`
`sourceMetadata.xlsx`
`documentSources.xlsx`
`documents/` folder

If other files or folders with the same name are already there, replace them with the ones you are moving (or delete the older ones before copying over the new ones).

Make sure that the `solrmap.xlsx` file remains in the `emerse_pdi_job` folder. This file does not need to be edited but must be there for proper data import to occur. If it is not there, copy it there. Details about the file, and how to create a new one if necessary, are provided elsewhere in this document.

Using the scripts to load data into EMERSE

The directions in this section are based on the assumption that you have already created your metadata files for import and have the documents located in the `documents` folder as described in the previous sections of this manual. The following scripts will clear out the existing data in the system, load in the new data, and then index the documents so that they are ready to be searched. For this to work, you will need to first make sure that you have copied the updated metadata files into the `emerse_pdi_job` folder, and in that same `emerse_pdi_job` directory you have all of the documents that need to be indexed, located within a directory called `documents`. This includes:

```
documentMetadata.xlsx
patientMetadata.xlsx
sourceMetadata.xlsx
documentSources.xlsx
```
`documents/` directory

☐ Go to `Applications` → `Utilities` → `Terminal`
Navigate to the proper directory. To do this, at the command prompt type:
```
cd /app/software/PDI/jobs
```

☐ Type the following five commands in the command line. Each will take a few second/minutes to run. They should be run in this specific order:

```
./runClearAll.sh
./runStagingTablesJob.sh
./runDocFields.sh
./runPatientLoadJob.sh
./runDocsToSolr.sh
```

☐ Stop and then start Solr and Tomcat (password will be required for each command):

```
systemctl stop solr
systemctl stop tomcat
systemctl start solr
stystemctl start tomcat
```

It may be necessary to wait 1-2 minutes until everything fully starts up again before trying EMERSE.

After the data are loaded, the patient count in EMERSE may not show up automatically. That count is updated using the Spring Scheduler within the app itself, and should auto-update about every 30 minutes. This also may require logging out of and then logging back into EMERSE for the change to be displayed in the application.

The virtual machine currently has the date range for the documents “hard-coded”, meaning that they will not change even if the actual imported documents have a different date range. This is a configuration option and can be changed. This won’t matter unless a search was done for a specific date range, otherwise EMERSE will always search across all documents regardless of dates. Nevertheless, it is possible to change this so that the system will dynamically change the date range to accurately reflect the dates of the documents. The following directions detail how this can be done:

☐ In the menu bar of the Linux VM, choose `Places` → `Computer`

☐ Then navigate to the folder:

```
app → software → emerse → apache-tomcat-8.0.33 → webapps → emerse →
WEB-INF → classes
```

Note: the version of tomcat (8.0.33) may vary as we update the system to newer versions so that specific directory name may change from time to time.

☐ Find the file called `project.properties` and double click it to open it in a text editor

Find the two lines:

```
batch.updateIndexMinDateFromSOLRIndex=false
batch.updateIndexMaxDateFromSOLRIndex=false
```

The first line represents the command to automatically update the minimum date range of the documents, and the second line represents the command to automatically update the maximum range of the documents. Set both of them to true, as in:

```
batch.updateIndexMinDateFromSOLRIndex=true
batch.updateIndexMaxDateFromSOLRIndex=true
```

Then, save the file.

☐ Restart the Tomcat webserver by going to the Terminal application and typing:

```
systemctl stop tomcat
systemctl start tomcat
```

The password `demouser` will be required after issuing the stop and start commands.

The code that reads this properties file and updates the dates is embedded in the Java Virtual Machine (JVM) so it can’t be run automatically. However, it should update on its own about every 30-60 minutes once the properties file has been edited and saved, and Tomcat has been restarted.

Incrementally adding new data

New data (patients and documents) can be added after an initial loading of data. To do this, clear out the prior two spreadsheets (`documentMetadata.xlsx` and `patientMetadata.xlsx`) that were used to load the previous data. Also clear out the `documents` folder that contained the previous documents that needed to be loaded. Then add in just the new data to be loaded (new patients, new documents, and new document metadata) into the two spreadsheets, and add the documents to the `documents` folder. Then, simply go back to the directions in the section: “Using the scripts to load data into EMERSE” but run just these two scripts:

```
./runPatientLoadJob.sh
./runDocsToSolr.sh
```

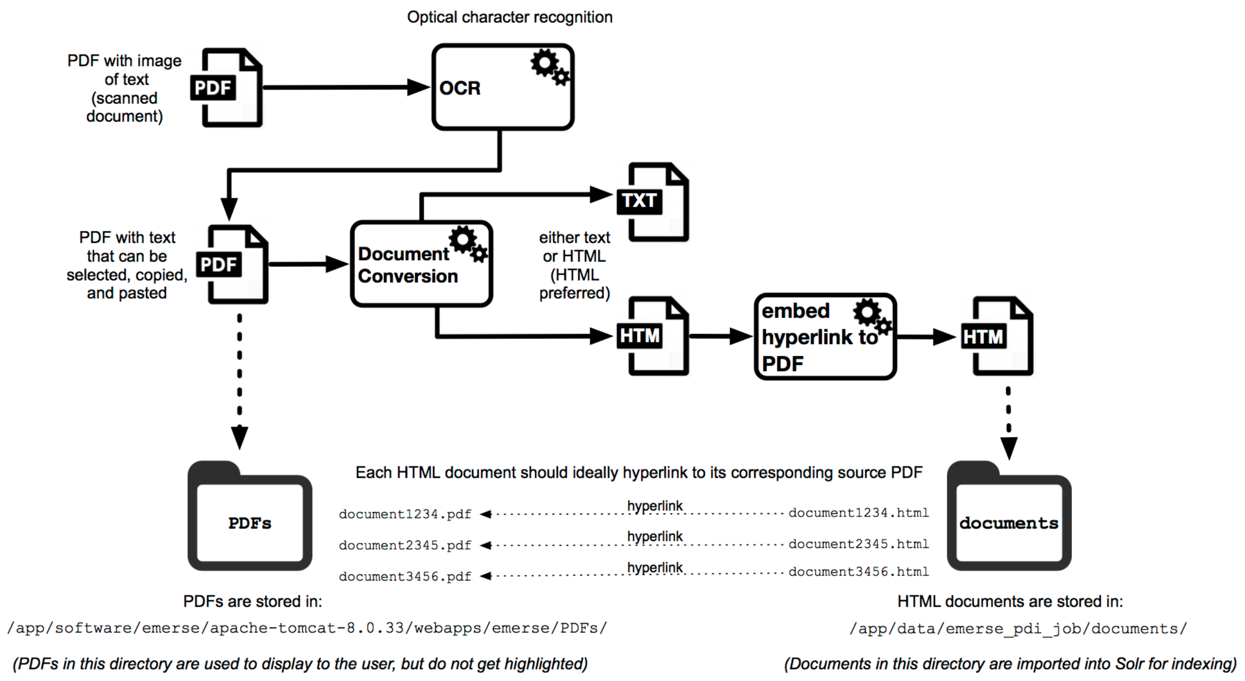
And finally, stop and start the servers:

```
systemctl stop solr
systemctl stop tomcat
systemctl start solr
stystemctl start tomcat
```

Incorporating PDFs into the VM

For demonstration purposes it may be useful to include documents that are in PDF format since clinical documents are sometimes stored in that format. The directions below do not cover all aspects of handling PDFs, since it can be a complex task, but some basic instructions are provided. Also note that, as described elsewhere in this manual, this VM is provided primarily for demonstration purposes so if you plan to include any documents that contain real protected health information it is best to check with your local compliance and IT groups for guidance.

The following figure provides a high-level overview of the process for incorporating PDFs into the EMERSE VM, with more details described below.


Optical character recognition
PDF with image of text (scanned document)
PDF
OCR
TXT
PDF with text that can be selected, copied, and pasted
PDF
Document Conversion
either text or HTML (HTML preferred)
HTM
embed hyperlink to PDF
HTM
Each HTML document should ideally hyperlink to its corresponding source PDF
PDFs
document1234.pdf
document2345.pdf
document3456.pdf
hyperlink
hyperlink
hyperlink
document1234.html
document2345.html
document3456.html
documents
PDFs are stored in:
/app/software/emerse/apache-tomcat-8.0.33/webapps/emerse/PDFs/
(PDFs in this directory are used to display to the user, but do not get highlighted)
HTML documents are stored in:
/app/data/emerse_pdi_job/documents/
(Documents in this directory are imported into Solr for indexing)

Note that the location of the PDF directory in the example diagram above is not necessarily where that directory must be located. This is just for demonstration purposes. EMERSE has no built-in expectation of where PDFs should be located, but including them within the Tomcat webapps directory is a simple way to make them accessible to the web application.

The first step for incorporating a PDF into EMERSE is to determine if the PDF contains actual ‘text or just an image (a scan/photograph) of text. PDFs created from software such as Microsoft Word should already have the text incorporated inside the PDF, but if a document was scanned then it will likely contain only an image of the text. One way to tell the difference is to try to select, highlight, and copy the text inside the PDF and paste it into a word processor. If you can select, copy and paste it, then the text is already incorporated. If the text can’t be selected, copied, and pasted, then it is likely only an image. If the text is an image then you may need to use optical character recognition (OCR) software to turn the pictures of the text into actual computer text that can be copied or, in the case of EMERSE, extracted and indexed. There are various options for OCR, including one built into Adobe Acrobat, and there is also the open source Tesseract software that was developed by Google. OCR is not built into EMERSE.

If the text is already incorporated into the PDF then the next step is to extract the text and convert it to a document that Solr can handle natively, which would be either HTML or TXT. Details for how this can be done on a Mac are described in the section “Preparing documents for import: File Conversion.” One possible approach is to convert PDF to RTF and then RTF to HTML (to preserve any formatting), or to even simply convert PDF to TXT and just use the plain text file for importing into Solr. Note that Apache also provides a tool for extracting text from PDF (called “Tika”) that can work with Solr, but it is not an automated process--in other words, you can’t just push a PDF document to Solr like you could a plain text or HTML document.

For the following example of how these PDFs can be incorporated into EMERSE, assume that the PDF text has been extracted and converted to a similarly named HTML document. Each PDF document should ideally have a name with no spaces (so it can easily be displayed within a web browser).

Store all of the PDF documents in a directory called `PDFs` (it can be any name, but for this example that is the name used). Then, in the corresponding HTML document with the extracted text, add a link to the original PDF from the HTML document. For example ssume that the original PDF is called `document_12345.pdf` and the corresponding HTML document with the extracted PDF text is called `document_12345.html`. The PDF document will be stored in a directory called `PDFs` (location of the directory is defined belw), and the corresponding HTML document will be in the `documents` directory, which is the one used for importing the documents into Solr.

Inside the HTML document, within the body of the text, add a link to the PDF, for example:

```
<html>
...
<body>
       <a href="PDFs/document_12345.pdf" target="_blank">Link to original PDF</a>
...
</body>
```

Note that adding this link/URL could be done automatically with some simple coding such as identifying the `<body>` tag and appending the URL immediately after that.

At this point, the documents and metadata can be loaded into EMERSE using the directions provided elsewhere in this manual. The only other thing that needs to be done is to move the directory of PDFs (called `PDFs`) over the to virtual machine. That directory should be copied to:

```
/app/software/emerse/apache-tomcat-8.0.33/webapps/emerse/
```

Note that the version number of Tomcat may differ as the system is updated, but the general location should not change. Currently, EMERSE can highlight the extracted text in the HTML document that EMERSE indexed, but EMERSE cannot highlight the corresponding text within the PDF itself. However, linking to the original PDF file containing the text should still be useful for users, and a user could still use the “Find” command (control-F on Windows, command-F on Mac) within the web browser or the PDF viewer to look for the text within the PDF. This can still be a timesaver.

SECURITY CONSIDERATIONS

The virtual machine that EMERSE runs on or may or may not be able to access the Internet depending on how it, and the host Virtual Box application, is configured. If real patient data were to be loaded into the VM, it will be important to understand this configuration to make sure the security settings are in compliance with your institution's policies. It may be important to contact your local IT department to obtain guidance about how the VM is configured to ensure that the data are kept secure.

If the networking on the VM is set to NAT mode, then it is basically "sandboxed" and invisible to the outside world, with any exceptions defined in the NAT port forwarding table. However, if the VM is in bridged mode then the VM would be completely visible to the outside world since it essentially would have its own IP address on the network. If the VM (and host computer) is running behind an institutional firewall, additional protections may be in place because of where it is running, but that protection would not be available if the host machine were running outside of that firewall. Again, consult with your local IT group on advice about the best way to configure the VM to ensure security.

Of course, one way to reduce exposure to the outside world is to disconnect your host machine (the computer running the VM) from the Internet entirely (unplug it from Ethernet, turn off wireless, etc). When accessing EMERSE from the VM, a connection to the Internet is not necessary since everything runs locally.

Also, note that the VM ships with a standard username and password for all aspects of the system (Linux, EMERSE login, Oracle database, etc). These should be changed if real patient data were loaded into the system. Additionally, the Solr API in this demonstration system has no password set at all, which means it can be accessed without any authentication. This is useful for testing and demonstrations, but in a production system that API should be protected.

Some of the default passwords required by the application are located in the `project.properties` file which is itself located in:

```
/app/software/emerse/apache-tomcat-8.0.33/webapps/emerse/WEB-INF/classes/
```

MAKING EMERSE AVAILABLE ON THE HOST MACHINE

There may be cases in which you want to let EMERSE run on the virtual machine (the *guest* operating system) but would prefer to access EMERSE via the browser on your primary machine (the *host* operating system). This is possible to do, but requires some configuration. Further, this may make the system more accessible to the outside world, so it is important to consider any security implications about changing how the system might be accessed from outside the VM itself.

For those wishing to proceed, here are the directions, assume Virtual Box is already installed:

☐ Launch Virtual Box

☐ Install the VM VirtualBox Extension Pack. This can be found here:

https://www.virtualbox.org/wiki/Downloads

Download the file, which has a `.vbox` extension, and then double-click on it to install it.

☐ In the VirtualBox app itself (not a virtual machine), go to `VirtualBox` → `Preferences`

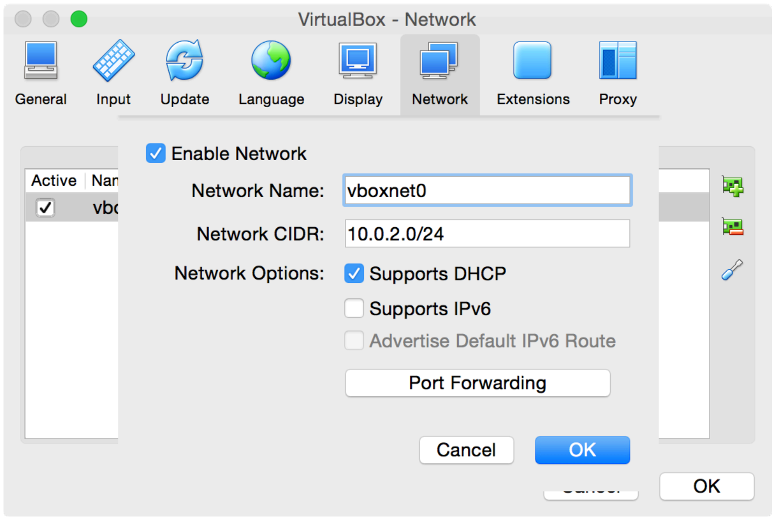
☐ Go to the `Network` Tab

Right click in the table, or click on the Plus icon to `Add new NAT network`

Can give it any name, but here we use `vboxnet0`

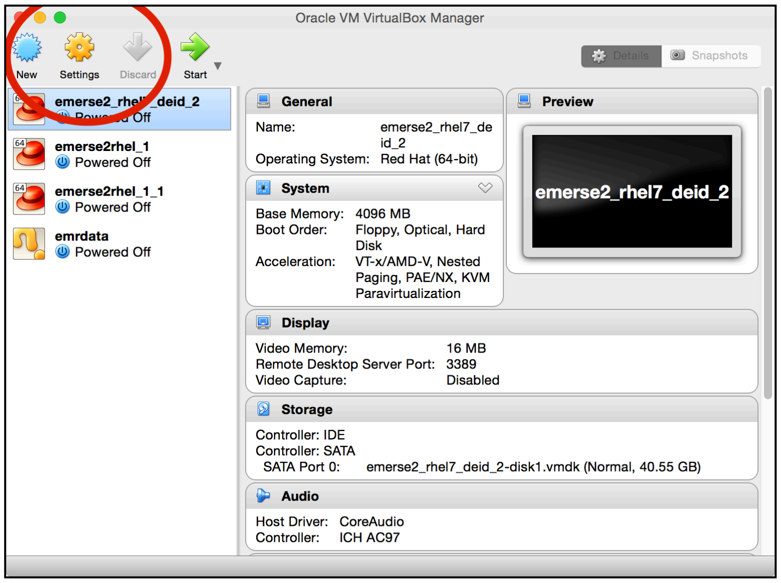
Can leave the other settings the same for now (will ignore Port Forwarding for now)

Click `OK`



☑ Enable Network
Network Name: vboxnet0
Network CIDR: 10.0.2.0/24
Network Options: ☑ Supports DHCP
☐ Supports IPv6
☐ Advertise Default IPv6 Route

☐ In the main VirtualBox application, click once on the correct virtual machine in the list to select it, and the click on `Settings`.



emerse2_rhel7_deid_2 Powered Off
emerse2rhel_1 Powered Off
emerse2rhel_1_1 Powered Off
emrdata Powered Off

General
Name: emerse2_rhel7_deid_2
Operating System: Red Hat (64-bit)

System
Base Memory: 4096 MB
Boot Order: Floppy, Optical, Hard Disk
Acceleration: VT-x/AMD-V, Nested Paging, PAE/NX, KVM Paravirtualization

Preview
emerse2_rhel7_deid_2

Display
Video Memory: 16 MB
Remote Desktop Server Port: 3389
Video Capture: Disabled

Storage
Controller: IDE
Controller: SATA
SATA Port 0: emerse2_rhel7_deid_2-disk1.vmdk (Normal, 40.55 GB)

Audio
Host Driver: CoreAudio
Controller: ICH AC97

☐ In the `Settings` section,

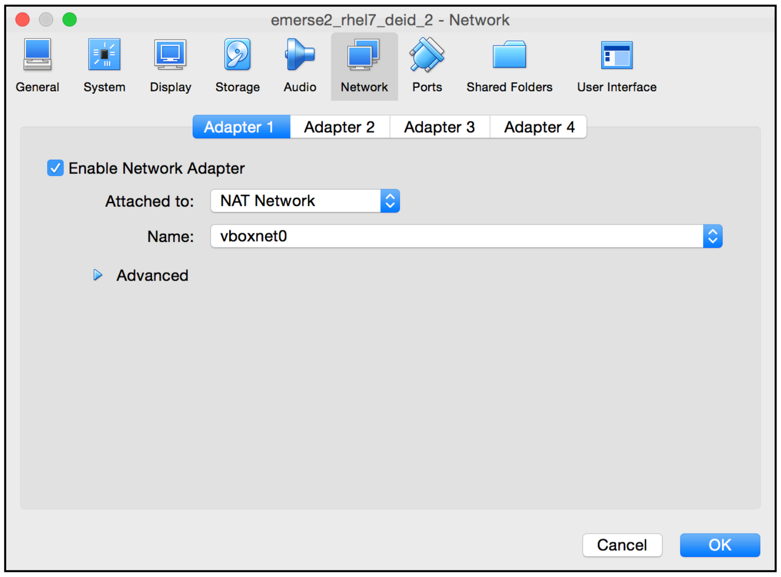
Make sure “`Enable Network Adapter`” is checked

Set it to, “`Attached to: NAT Network`”

Under `Name`, select the name given to the Network Name above, in this case `vboxnet0`

Can leave `Advanced` unchanged.

Click `OK`



☑ Enable Network Adapter
Attached to: NAT Network
Name: vboxnet0
Advanced

☐ Start the VM by selecting it in the VirtualBox app, and the clicking the green `Start` arrow.

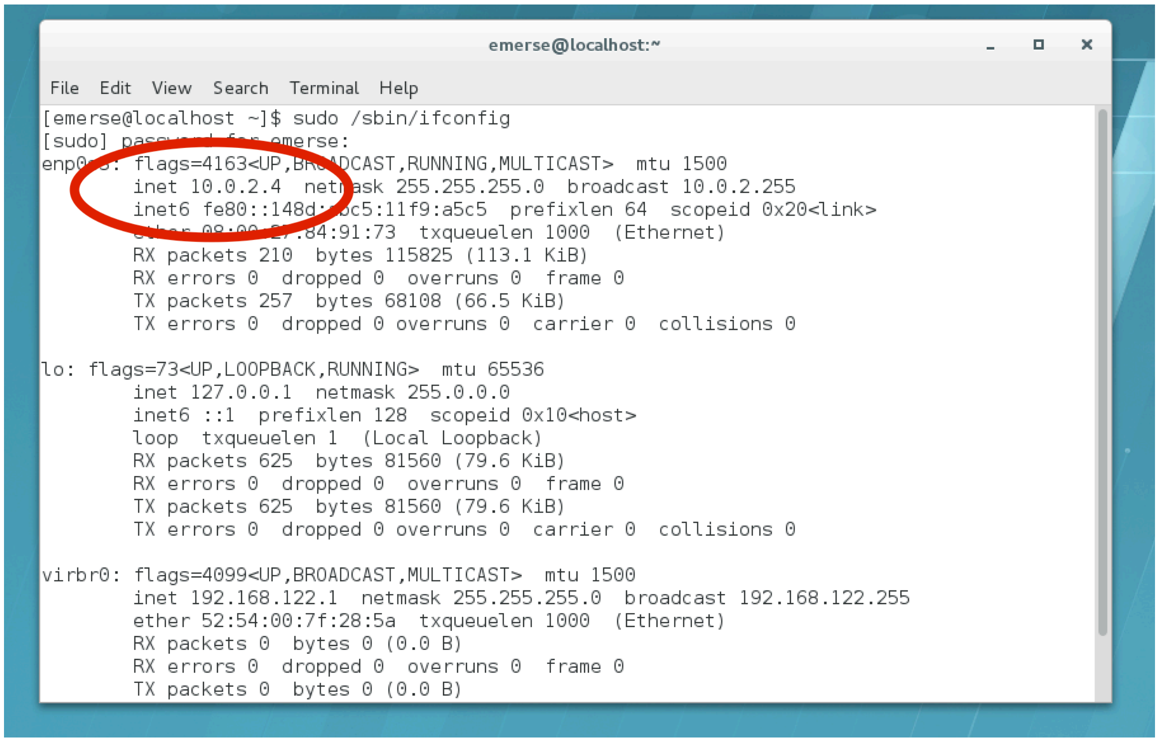
☐ Login to the VM (username: `emerse`, password: `demouser`)

☐ Go to `Utilities` → `Terminal`

Type: `sudo /sbin/ifconfig`

☐ Write down the IP address shown near the `enps03`:

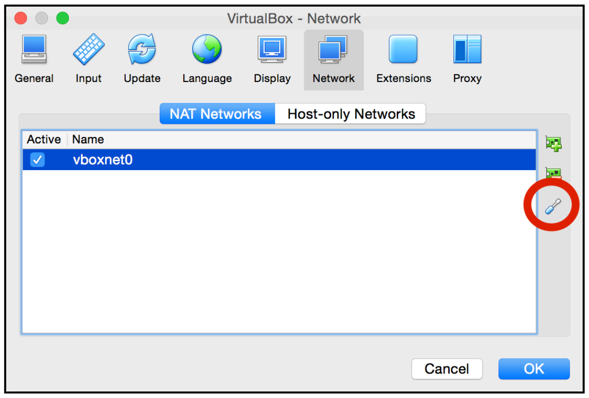
In the example screen shot below it says `inet 10.0.2.4`



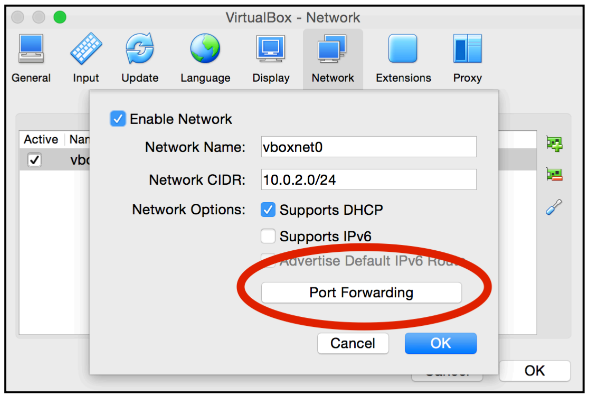
```
[emerse@localhost ~]$ sudo /sbin/ifconfig
[sudo] password for emerse:
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.4  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::148d:[illegible]bc5:11f9:a5c5  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:84:91:73  txqueuelen 1000  (Ethernet)
        RX packets 210  bytes 115825 (113.1 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 257  bytes 68108 (66.5 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1  (Local Loopback)
        RX packets 625  bytes 81560 (79.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 625  bytes 81560 (79.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

virbr0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 192.168.122.1  netmask 255.255.255.0  broadcast 192.168.122.255
        ether 52:54:00:7f:28:5a  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
```

☐ Go back to the VirtualBox VM application (not the VM itself) and choose `Preferences…` and got to the `Network` tab, and in that table go to the `NAT Networks` section

☐ Go to the Edit section for the NAT Network `vboxnet0` by right-clicking to `Edit NAT Network`, or by clicking on the small screwdriver icon:



☐ Click on the Port Forwarding Button:



Enable Network ✓
Network Name: vboxnet0
Network CIDR: 10.0.2.0/24
Network Options: Supports DHCP ✓
Supports IPv6
Advertise Default IPv6 Route

☐ Make sure, the `IPv4` pane is selected, then,

For `Name`, can enter anything, such as `EMERSE Tomcat`

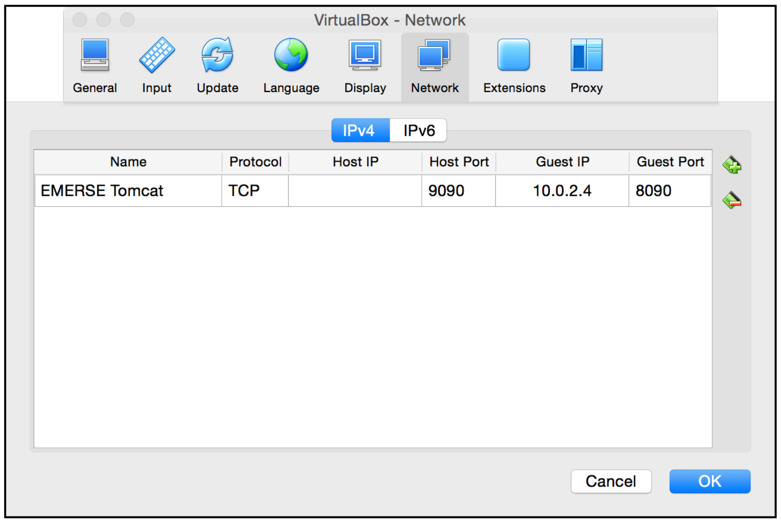
Set `Protocol` to `TCP`

For `Host IP`, leave it blank

For `Host Port` enter `9090`

For `Guest IP` enter in the prior IP address that was written down (in this example it is `10.0.2.4`, but that may not always be the case, and it may even change from time to time but hopefully not).

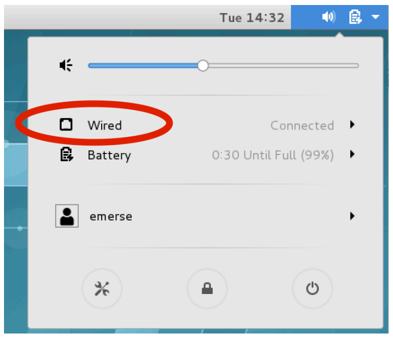
For `Guest Port` enter `8090`

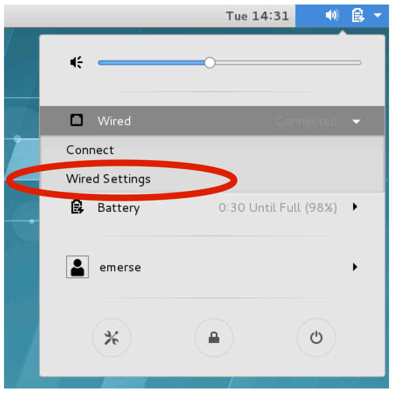


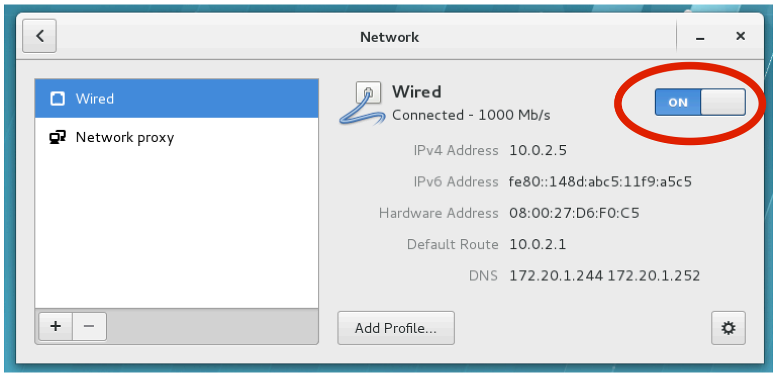
Name	Protocol	Host IP	Host Port	Guest IP	Guest Port
EMERSE Tomcat	TCP		9090	10.0.2.4	8090

☐ If the actual EMERSE VM is running, it may be necessary to turn the network settings off and then on again to have them change:

In the upper right of the VM screen click on the icons, then `Wired` → `Wired Settings`, then turn the connection `OFF`, then `ON` again.







IPv4 Address 10.0.2.5
IPv6 Address fe80::148d:abc5:11f9:a5c5
Hardware Address 08:00:27:D6:F0:C5
Default Route 10.0.2.1
DNS 172.20.1.244 172.20.1.252

At this point should it should now be possible to go to the browser on the host machine (not the VM) and enter the URL:

```
localhost:9090/emerse/
```