Using Windows Azure Service Bus Queue with Python

Overview

In this hands-on lab you will use Python to manage Windows Azure Service Bus Queue. There is a NCBI BLAST (National Center for Biotechnology Information Basic Local Alignment Search Tool) cloud service deployed for you. You can use IPython Notebook to send a task to the Service Bus Queue and the blast cloud service worker role will do the task for you. You will also read a message from the Service Bus Queue using Python on IPython Notebook and process the task locally.

Objectives

In this hands-on lab, you will learn how to:

- Understand Windows Azure Service Bus Queue.
- Send a task to a Service Bus Queue by IPython Notebook and check the processing result.
- Receive a message from a Service Bus Queue.

Prerequisites

The following is required to complete this hands-on lab:

- A Windows Azure subscription - sign up for a free trial
- You have an IPython Notebook VM - IPython Notebook on Windows Azure Or use the Linux VM you deployed in the previous Hands on Lab.
- NCBI BLAST Windows Azure Sample Cloud Service - NCBI BLAST Windows Azure Sample http://azure4research-blast.cloudapp.net/

Exercises

This hands-on lab includes the following exercises:

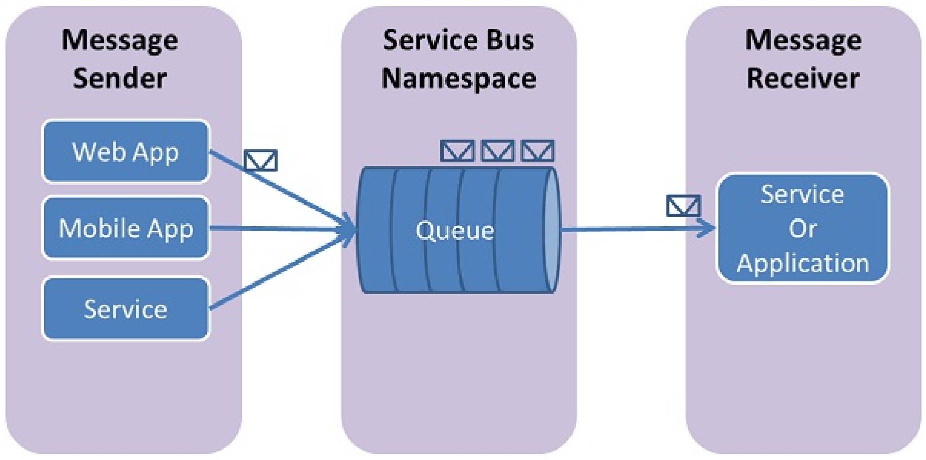
1. Exercise 1: Understand Windows Azure Service Bus Queue and NCBI BLAST.
2. Exercise 2: Send a task to a Service Bus Queue using IPython Notebook for processing.
3. Exercise 3: Receive a message from a Service Bus Queue.

Estimated time to complete this lab: **60** minutes.

Exercise 1: Understand Windows Azure Service Bus Queue and NCBI BLAST.

What is Service Bus Queues?

Service Bus Queues support a **brokered messaging communication** model. When using queues, components of a distributed application do not communicate directly with each other, they instead exchange messages via a persistent message queue, which acts as an intermediary. A message producer (sender) hands off a message to the queue and then continues its processing. Asynchronously, a message consumer (receiver) pulls the message from the queue and processes it. The producer does not have to wait for a reply from the consumer in order to continue to process and send further messages. Queues offer **First In, First Out (FIFO)** message delivery to one or more competing consumers. That is, messages are typically received and processed by the receivers in the order in which they were added to the queue, and each message is received and processed by only one message consumer.



Service Bus Queue Introduction

Service Bus queues are a general-purpose technology that can be used for a wide variety of scenarios:

- Communication between web and worker roles in a multi-tier Windows Azure application.
- Communication between on-premises apps and Windows Azure hosted apps in a hybrid solution.
- Communication between components of a distributed application running on-premises in different organizations or departments of an organization.

In order to help you understand process Service Bus Queues and distributed computing in the cloud, we also deploy the NCBI BLAST cloud service.

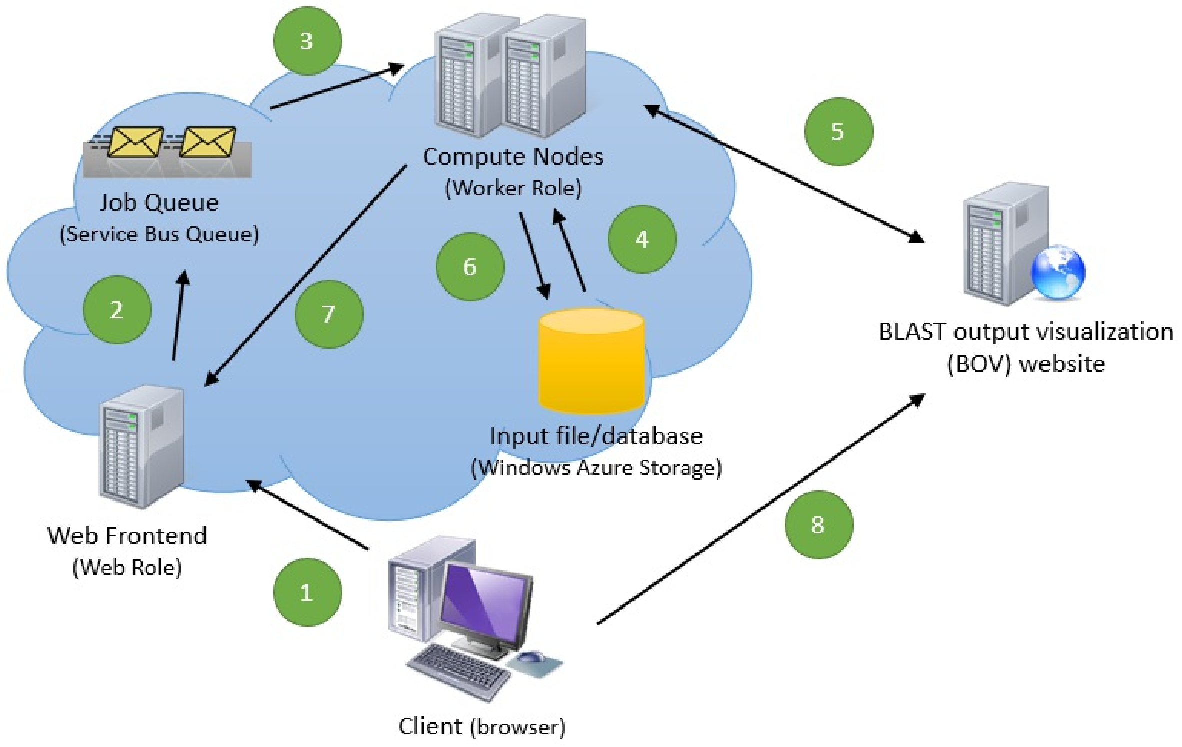
What is NCBI BLAST?

The National Center for Biotechnology Information's Basic Local Alignment Search Tool (NCBI BLAST) Sample demonstrates how to run a nucleotide match algorithm on the human genome using an HPC parametric sweep application.

The parametric sweep application uses a set of input files that contain sequences of nucleotides, comparing them to the human genome database. The application creates output files containing sequence similarities and uploads these files to a BLAST output visualizer (BOV) web site.

To run the nucleotide match, the sample uses the blastn utility, which is a part of the BLAST+ application.

The architecture of the sample and the steps of its execution are described:



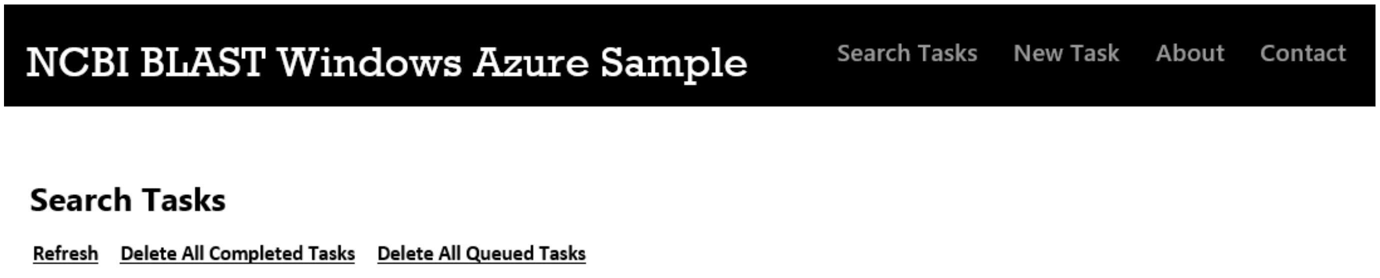
NCBI BLAST Architecture

Architecture of the BLAST sample

1. The client application (browser) submits a parametric sweep job to the Web front-end via an AJAX call to the REST API.
2. The Web front-end pushes the job to a Service Bus queue.
3. A compute node gets the sweep job from the job queue and executes on it. The compute nodes are competing consumers of the job queue. This pattern allows us to scale out compute nodes as needed and ensures a submitted job is executed at least once.
4. The parametric sweep application running on a compute node downloads an input file from a Windows Azure blob storage. The input file includes a nucleotide that is to be compared to the human genome database previously downloaded to each Windows Azure compute node (a Worker Role instance).
5. After completing a sweep index, the BLAST application uploads the resulting matches file to the BLAST output visualization (BOV) web site and receives a matching URL for the file's visualization page.
6. The output file and the URL are written to Windows Azure storage: the file is uploaded to a blob, and the URL is written in a table.
7. While the parametric sweep job is running, the compute node notifies the web front-end its progress via a SignalR channel. The web front-end then accesses the Windows Azure table storage to get updated URL list and shows it to the user.
8. The user can select any of the URLs to see the rendered image for the nucleotide match.

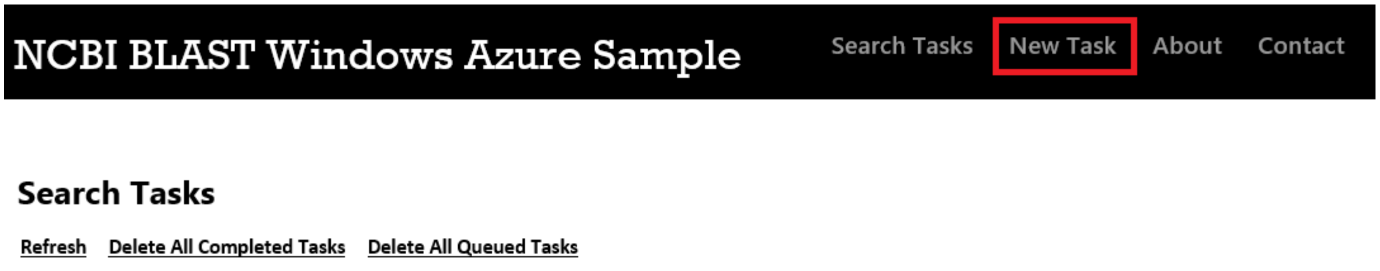
We have already deployed an NCBI BLAST web site deployed and you can just click to have a look. We've also created a sample service bus namespace **sb://sb-azure4research-blast.servicebus.windows.net/** and created a *JobQueue* under the namespace to manage our tasks.

1. Open the NCBI BLAST web site.



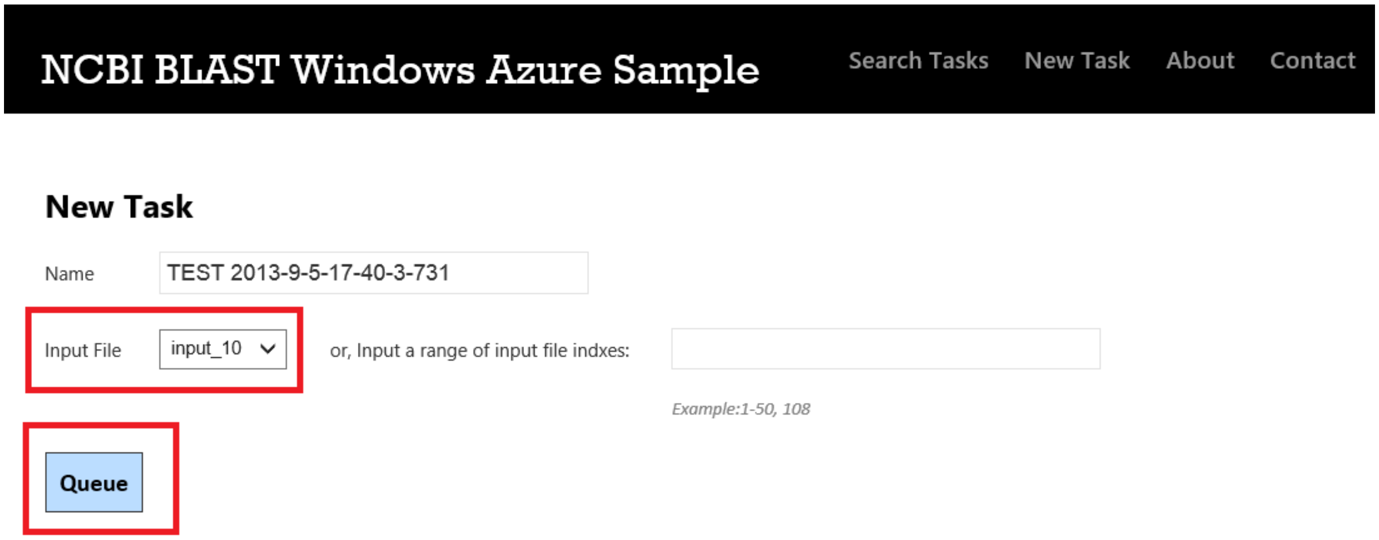
NCBI BLAST Web site

2. Click the "New Task" link to create a new task



BLAST Create New Task

3. Then you will navigate to a new page to set some parameters. Select an input file, then click *Queue*


NCBI BLAST Windows Azure Sample

New Task

Name: TEST 2013-9-5-17-40-3-731

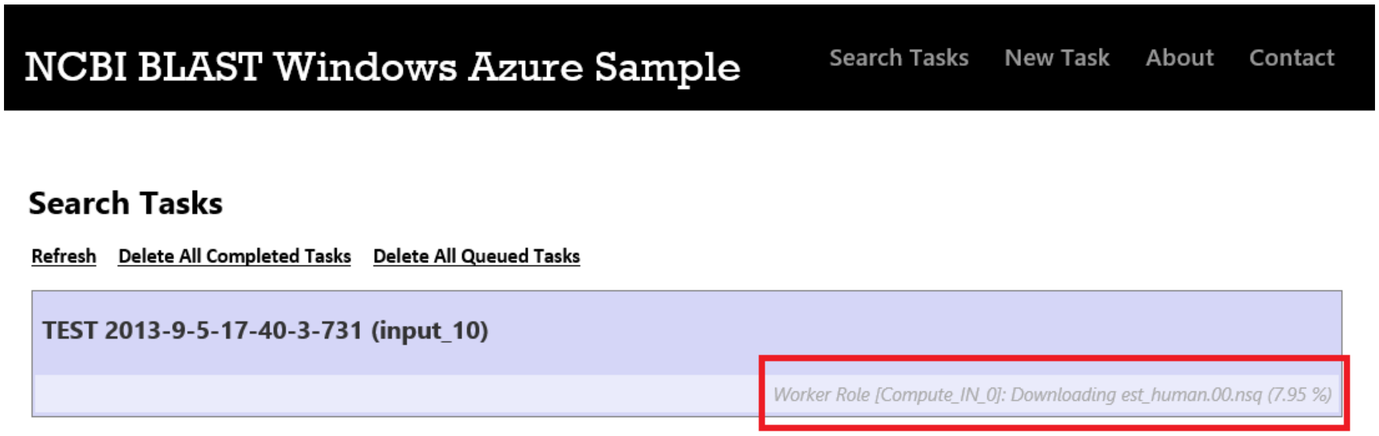
Input File: input_10

or, Input a range of input file indxes:

Example:1-50, 108

BLAST Set Task Information

4. Then you will see the task is executing.


NCBI BLAST Windows Azure Sample

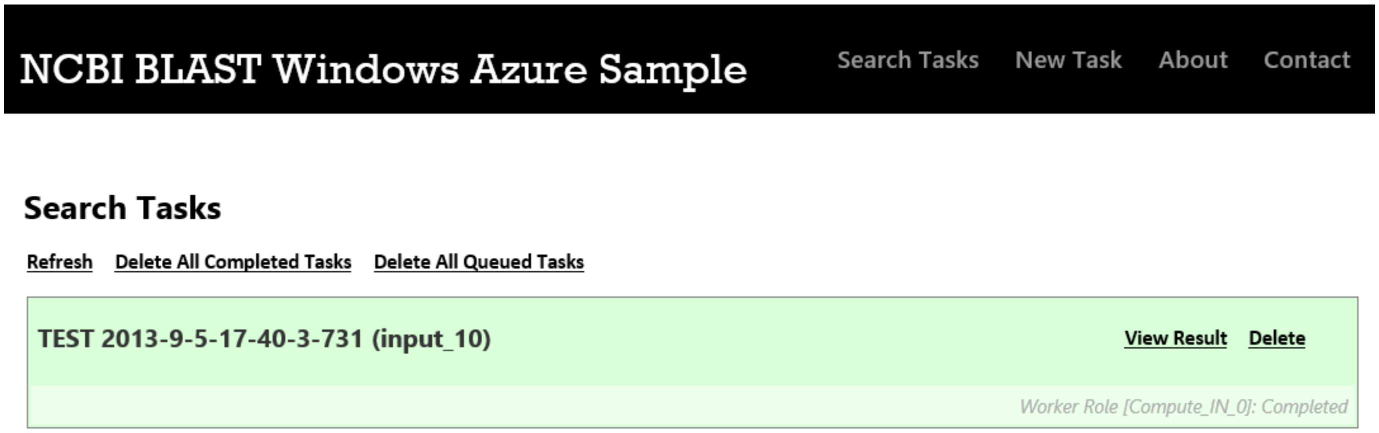
Search Tasks

TEST 2013-9-5-17-40-3-731 (input_10)

Worker Role [Compute_IN_0]: Downloading est_human.00.nsq (7.95 %)

BLAST Running Task

5. Because the system needs to download the database files, the very first task after the system has been deployed will take a long time. However, as the system caches database files, jobs after the first will be executed much faster. After several minutes, the task is finished.


NCBI BLAST Windows Azure Sample

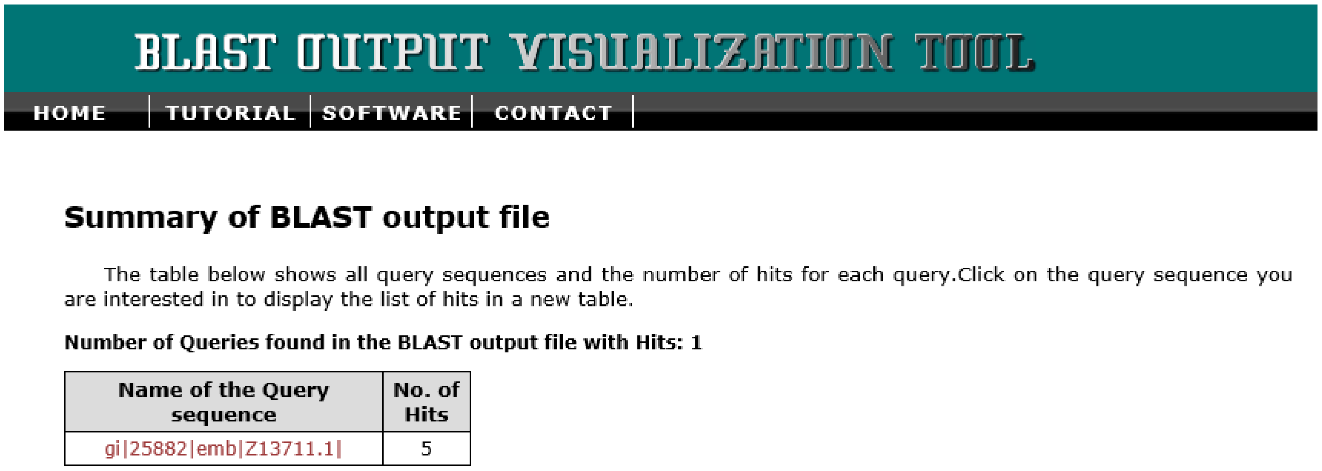
Search Tasks

TEST 2013-9-5-17-40-3-731 (input_10)

Worker Role [Compute_IN_0]: Completed

BLAST Task Complete

6. After a task completes, you can click on its View Result link to view the search result. The link takes you to bov.bioinfo.cas.unt.edu to view the result.



Summary of BLAST output file

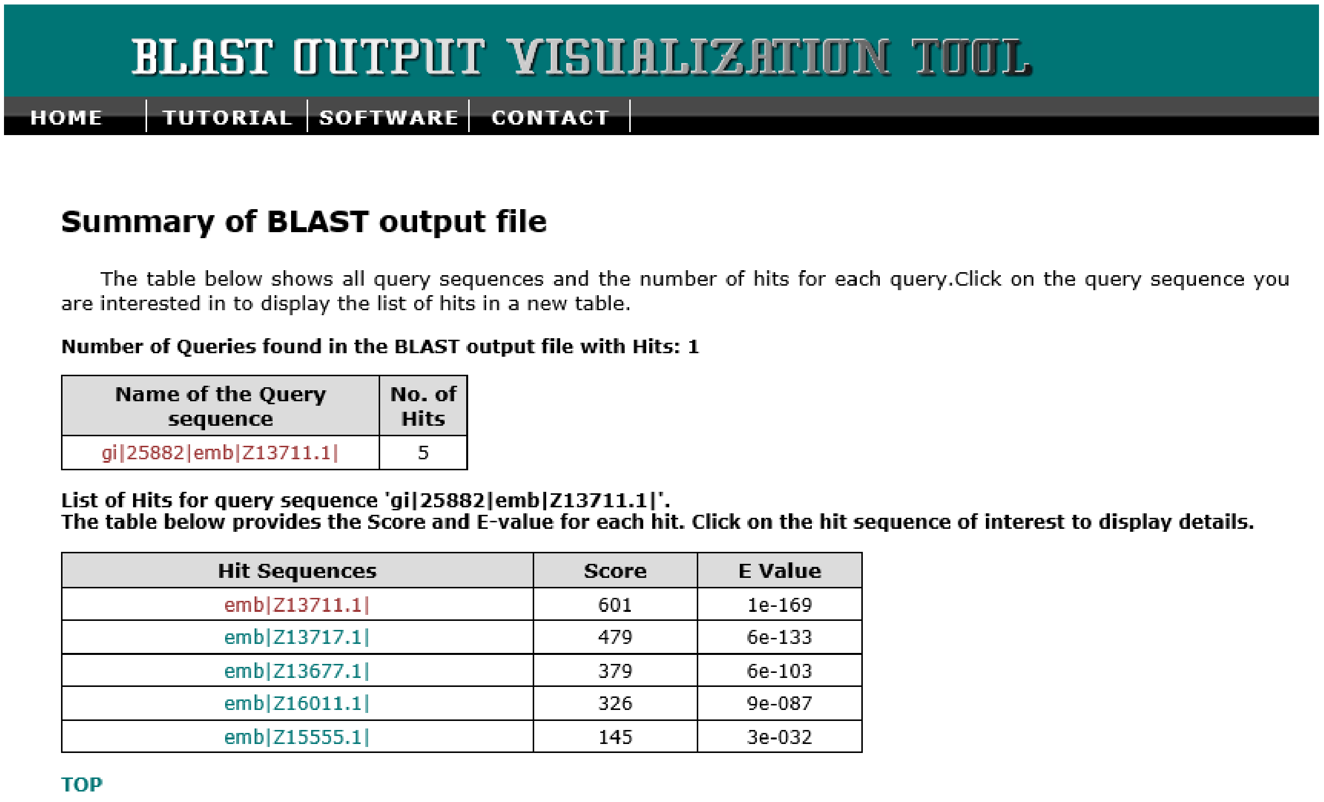
The table below shows all query sequences and the number of hits for each query.Click on the query sequence you are interested in to display the list of hits in a new table.

Number of Queries found in the BLAST output file with Hits: 1

Name of the Query sequence	No. of Hits
gi|25882|emb|Z13711.1|	5

BLAST Output File

7. Click on the link to expand hit sequences.



Summary of BLAST output file

The table below shows all query sequences and the number of hits for each query.Click on the query sequence you are interested in to display the list of hits in a new table.

Number of Queries found in the BLAST output file with Hits: 1

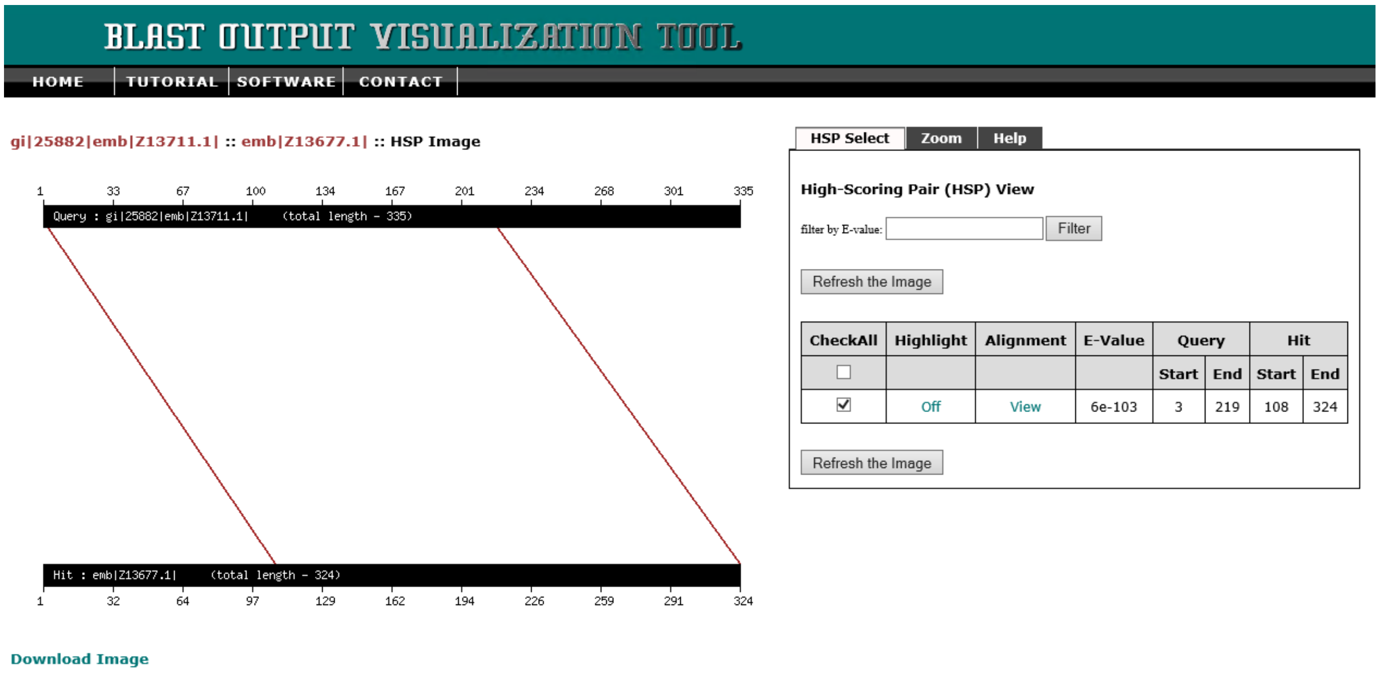
Name of the Query sequence	No. of Hits
gi|25882|emb|Z13711.1|	5

List of Hits for query sequence 'gi|25882|emb|Z13711.1|'.
The table below provides the Score and E-value for each hit. Click on the hit sequence of interest to display details.

Hit Sequences	Score	E Value
emb|Z13711.1|	601	1e-169
emb|Z13717.1|	479	6e-133
emb|Z13677.1|	379	6e-103
emb|Z16011.1|	326	9e-087
emb|Z15555.1|	145	3e-032

BLAST Output File Hit Sequences

8. Click on any of hit sequences to view its corresponding HSP image.



gi|25882|emb|Z13711.1| :: emb|Z13677.1| :: HSP Image

Query : gi|25882|emb|Z13711.1| (total length - 335)

Hit : emb|Z13677.1| (total length - 324)

High-Scoring Pair (HSP) View

filter by E-value:

CheckAll	Highlight	Alignment	E-Value	Query		Hit	
☐				Start	End	Start	End
☑	Off	View	6e-103	3	219	108	324

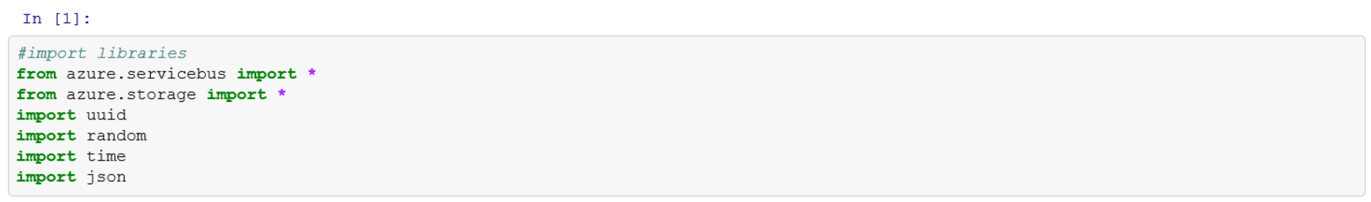
BLAST Output File Hit Sequence Image

Exercise 2: Send a task to a Service Bus Queue by IPython Notebook for processing.

Next we are going to use IPython Notebook to send a new task to BLAST Cloud Service and request it to process. You can find the sample code inside **Source\python*service*bus.py**

1. First we need to import required libraries:

```
#import libraries
from azure.servicebus import *
from azure.storage import *
import uuid
import random
import time
import json
```

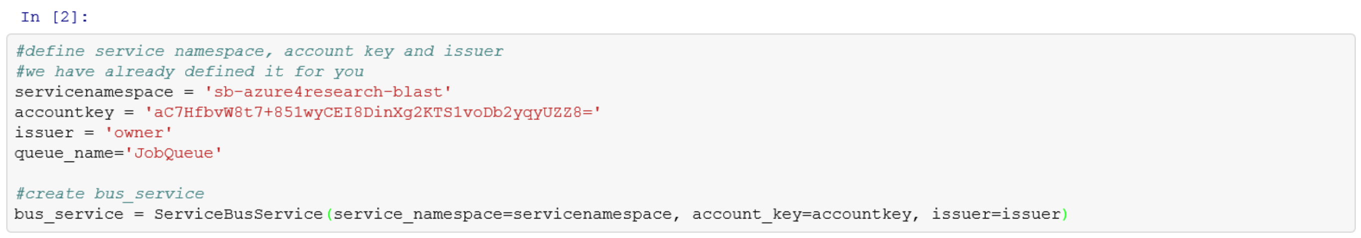


```
In [1]:
#import libraries
from azure.servicebus import *
from azure.storage import *
import uuid
import random
import time
import json
```

IPython Notebook Import Libraries

2. Run the following code to define private variables we can use to interact with the Service Bus.

```

#define service namespace, account key and issuer
#we have already defined it for you
servicenamespace = 'sb-azure4research-blast'
accountkey = 'aC7HfbvW8t7+851wyCEI8DinXg2KTS1voDb2yqyUZZ8='
issuer = 'owner'
queue_name='JobQueue'
#create bus_service
bus_service = ServiceBusService(service_namespace=servicenamespace, account_key=accountkey, issuer=issuer)
```

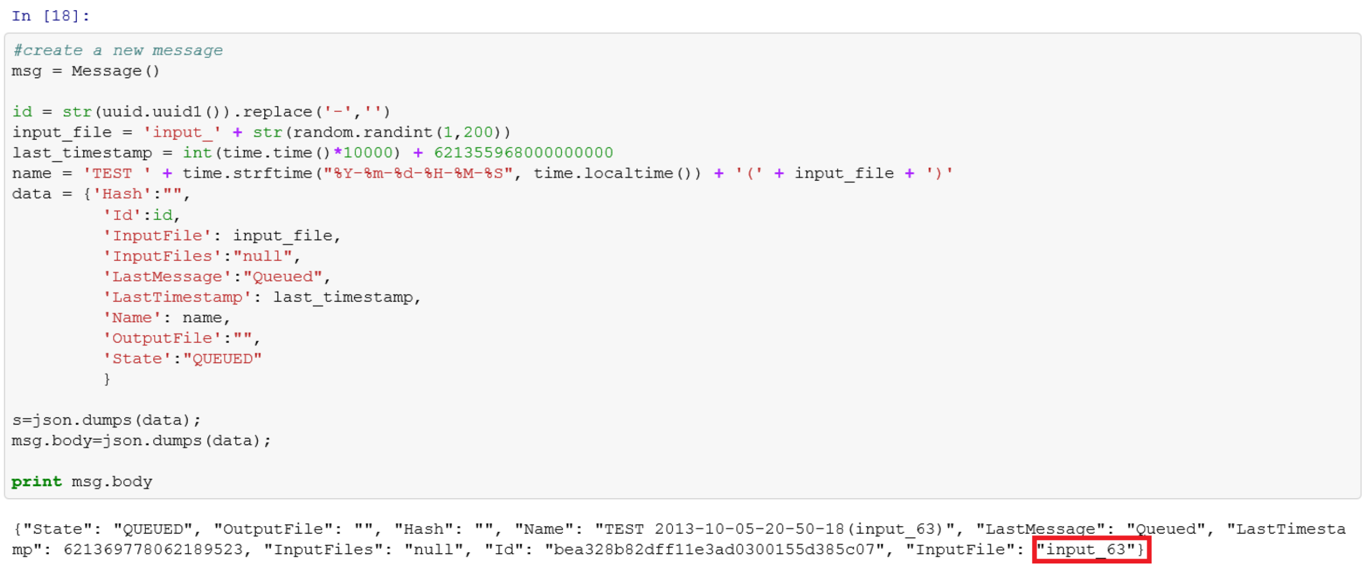


```
In [2]:
#define service namespace, account key and issuer
#we have already defined it for you
servicenamespace = 'sb-azure4research-blast'
accountkey = 'aC7HfbvW8t7+851wyCEI8DinXg2KTS1voDb2yqyUZZ8='
issuer = 'owner'
queue_name='JobQueue'

#create bus_service
bus_service = ServiceBusService(service_namespace=servicenamespace, account_key=accountkey, issuer=issuer)
```

IPython Notebook Create Service Bus Service

3. Now we create a dict in Python and save all properties into the dictionary. Then we will use json library's dumps method to convert the dictionary into a json string. Then we set the message body to be the json string. The code randomly pick a file from 1 to 200 as the input file. In the example, we use *input_63* as the input file.

```
#create a new message
msg = Message()
id = str(uuid.uuid1()).replace('-','')
input_file = 'input_' + str(random.randint(1,200))
last_timestamp = int(time.time()*10000) + 621355968000000000
name = 'TEST ' + time.strftime("%Y-%m-%d-%H-%M-%S", time.localtime()) + '(' + input_file + ')'
data = {'Hash':"",
  'Id':id,
  'InputFile': input_file,
  'InputFiles':"null",
  'LastMessage':"Queued",
  'LastTimestamp': last_timestamp,
  'Name': name,
  'OutputFile':"",
  'State':"QUEUED"
}
s=json.dumps(data);
msg.body=json.dumps(data);
print msg.body
```



```
In [18]:
#create a new message
msg = Message()

id = str(uuid.uuid1()).replace('-','')
input_file = 'input_' + str(random.randint(1,200))
last_timestamp = int(time.time()*10000) + 621355968000000000
name = 'TEST ' + time.strftime("%Y-%m-%d-%H-%M-%S", time.localtime()) + '(' + input_file + ')'
data = {'Hash':"",
         'Id':id,
         'InputFile': input_file,
         'InputFiles':"null",
         'LastMessage':"Queued",
         'LastTimestamp': last_timestamp,
         'Name': name,
         'OutputFile':"",
         'State':"QUEUED"
         }

s=json.dumps(data);
msg.body=json.dumps(data);

print msg.body
```

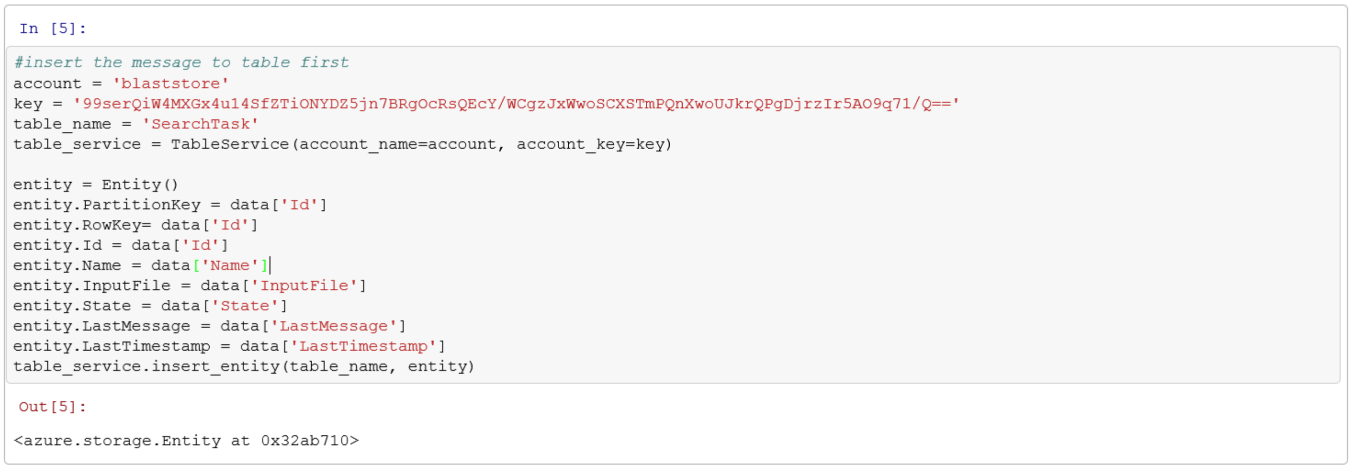
```
{"State": "QUEUED", "OutputFile": "", "Hash": "", "Name": "TEST 2013-10-05-20-50-18(input_63)", "LastMessage": "Queued", "LastTimesta
mp": 621369778062189523, "InputFiles": "null", "Id": "bea328b82dff11e3ad0300155d385c07", "InputFile": "input_63"}
```

IPython Notebook Create Message

4. Before we submit the message to a Service Bus queue, we have to insert a new entity into a table first for the BLAST web site to track the status correctly.

```
#insert the message to table first
account = 'blaststore'
key = '99serQiW4MXGx4u14SfZTiONYDZ5jn7BRgOcRsQEcY/WCgzJxWwoSCXSTmPQnXwoUJkrQPgDjrzIr5AO9q71/Q=='
table_name = 'SearchTask'
table_service = TableService(account_name=account, account_key=key)
```

```
entity = Entity()
entity.PartitionKey = data['Id']
entity.RowKey= data['Id']
entity.Id = data['Id']
entity.Name = data['Name']
entity.InputFile = data['InputFile']
entity.State = data['State']
entity.LastMessage = data['LastMessage']
entity.LastTimestamp = data['LastTimestamp']
table_service.insert_entity(table_name, entity)
```



```
In [5]:
#insert the message to table first
account = 'blaststore'
key = '99serQiW4MXGx4u14SfZTiONYDZ5jn7BRgOcRsQEcY/WCgzJxWwoSCXSTmPQnXwoUJkrQPgDjrzIr5AO9q71/Q=='
table_name = 'SearchTask'
table_service = TableService(account_name=account, account_key=key)

entity = Entity()
entity.PartitionKey = data['Id']
entity.RowKey= data['Id']
entity.Id = data['Id']
entity.Name = data['Name']
entity.InputFile = data['InputFile']
entity.State = data['State']
entity.LastMessage = data['LastMessage']
entity.LastTimestamp = data['LastTimestamp']
table_service.insert_entity(table_name, entity)

Out[5]:
<azure.storage.Entity at 0x32ab710>
```

IPython Notebook Insert Table

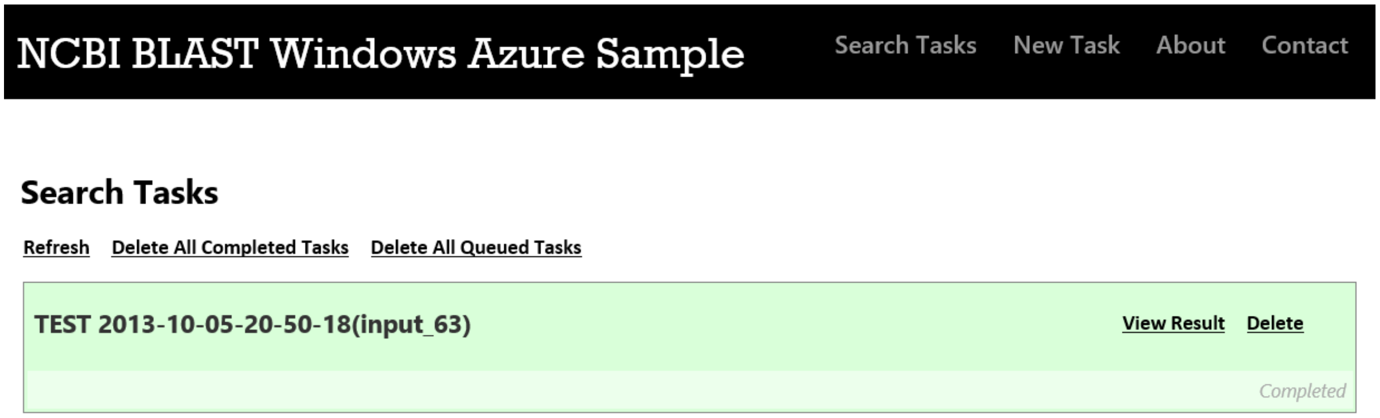
5. Finally we execute the following command to submit a message.

```
    #submit the message to service bus queue
  bus_service.send_queue_message(queue_name, msg)
```

```
In [6]:
#submit the message to service bus queue
bus_service.send_queue_message(queue_name, msg)
```

IPython Notebook Submit to Queue

6. Then let's navigate to the BLAST web site again, click **Refresh** button and check the new task. We can see a task with input file 63 is completed.



NCBI BLAST Windows Azure Sample

Search Tasks

TEST 2013-10-05-20-50-18(input_63)

Completed

New Task Complete

You can do the same thing to check the hit sequences and HSP image as you did in Exercise1.

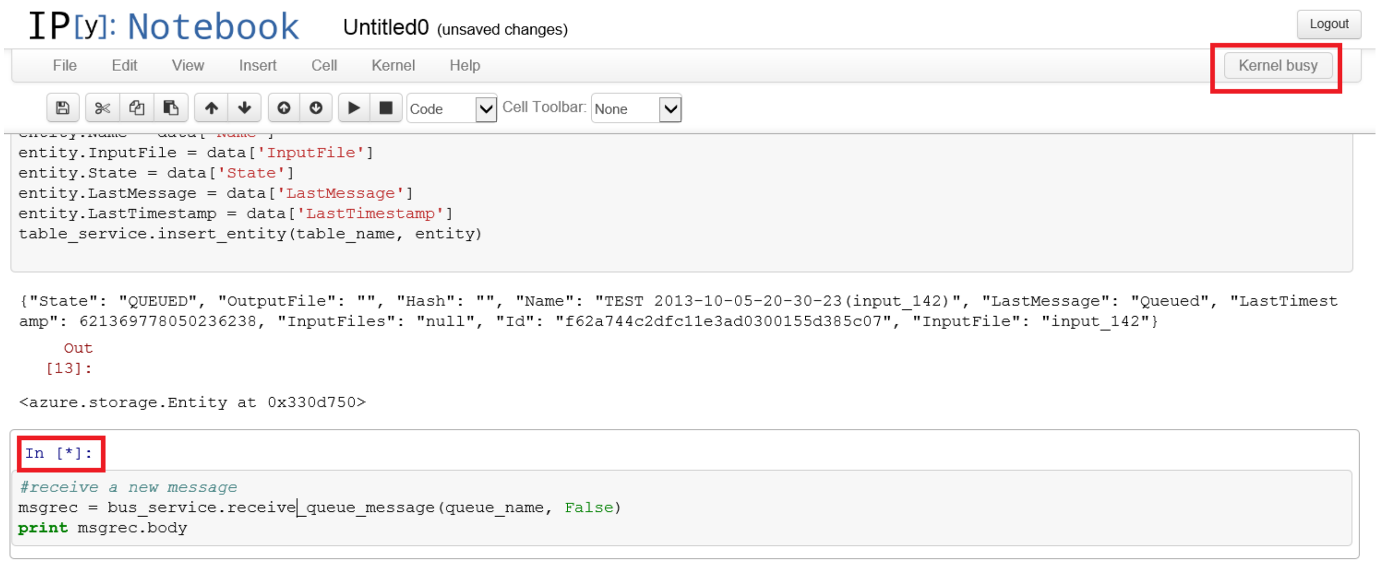
Service Bus queues support a maximum message size of 256 KB (the header, which includes the standard and custom application properties, can have a maximum size of 64 KB). There is no limit on the number of messages held in a queue but there is a cap on the total size of the messages held by a queue. This queue size is defined at creation time, with an upper limit of 5 GB.

Exercise 3: Receive a message from a Service Bus Queue.

You can use Python to receive a message as well! Messages are received from a queue using the **receive*queue*message method** on the **ServiceBusService** object.

1. Execute following command to receive a message in IPython Notebook. If there is no message in the queue, IPython Notebook will block until either a message arrives or the thread times out. You can see **Kernel busy** on the top right.

```
#receive a new message
msgrec = bus_service.receive_queue_message(queue_name, False)
print msgrec.body
```

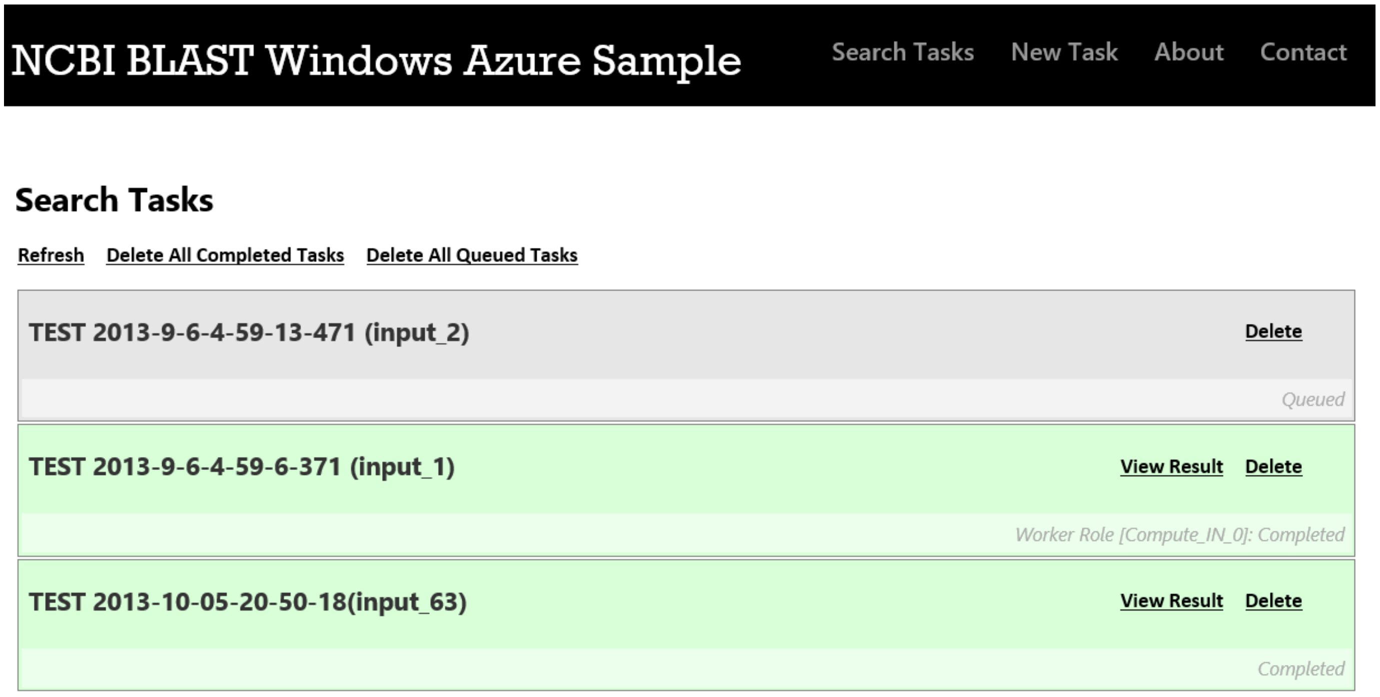


```
entity.InputFile = data['InputFile']
entity.State = data['State']
entity.LastMessage = data['LastMessage']
entity.LastTimestamp = data['LastTimestamp']
table_service.insert_entity(table_name, entity)

{"State": "QUEUED", "OutputFile": "", "Hash": "", "Name": "TEST 2013-10-05-20-30-23(input_142)", "LastMessage": "Queued", "LastTimest
amp": 621369778050236238, "InputFiles": "null", "Id": "f62a744c2dfc11e3ad0300155d385c07", "InputFile": "input_142"}
    Out
   [13]:

<azure.storage.Entity at 0x330d750>

In [*]:
#receive a new message
msgrec = bus_service.receive_queue_message(queue_name, False)
print msgrec.body
```

IPython Notebook Receive Message

2. On the BLAST web site, click **New Task** twice to create 2 new tasks. Since we set the worker role to process only 1 task at one time, your ipython notebook can receive another message.

> If there are multiple people using the BLAST service, just do the previous step as many times as needed until you receive a message.



Search Tasks

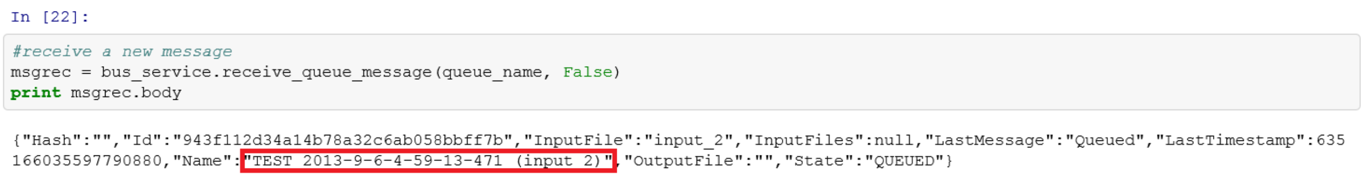
TEST 2013-9-6-4-59-13-471 (input_2) — Queued

TEST 2013-9-6-4-59-6-371 (input_1) — Worker Role [Compute_IN_0]: Completed

TEST 2013-10-05-20-50-18(input_63) — Completed

IPython Notebook Create Many New Tasks

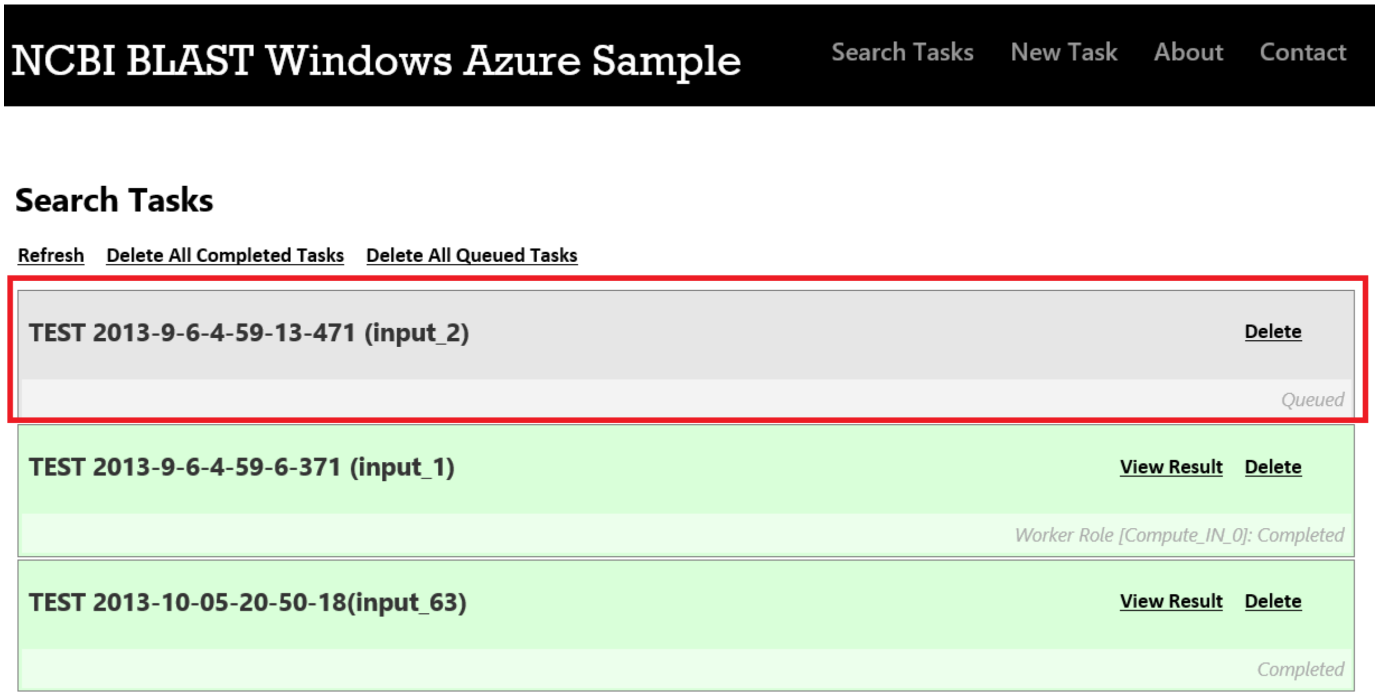
3. If your IPython notebook receives a new message, then the message's body will be printed.



```
In [22]:
#receive a new message
msgrec = bus_service.receive_queue_message(queue_name, False)
print msgrec.body

{"Hash":"","Id":"943f112d34a14b78a32c6ab058bbff7b","InputFile":"input_2","InputFiles":null,"LastMessage":"Queued","LastTimestamp":635
166035597790880,"Name":"TEST 2013-9-6-4-59-13-471 (input_2)","OutputFile":"","State":"QUEUED"}
```

IPython Notebook Received New Message

4. Checking the web site again, we can see the task is stuck in **`Queued`** status because the message was read by IPython Notebook and BLAST will never see it.



NCBI BLAST Windows Azure Sample

Search Tasks

TEST 2013-9-6-4-59-13-471 (input_2) Delete
Queued

TEST 2013-9-6-4-59-6-371 (input_1) View Result Delete
Worker Role [Compute_IN_0]: Completed

TEST 2013-10-05-20-50-18(input_63) View Result Delete
Completed

IPython Notebook Task Will NOT be Processed

Messages are deleted from the queue as they are read; however, you can read (peek) and lock the message without deleting it from the queue by setting the optional parameter peek_lock to True.

The default behavior of reading and deleting the message as part of the receive operation is the simplest model, and works best for scenarios in which an application can tolerate not processing a message in the event of a failure. To understand this, consider a scenario in which the consumer issues the receive request and then crashes before processing it. Because Service Bus will have marked the message as being consumed, then when the application restarts and begins consuming messages again, it will have missed the message that was consumed prior to the crash.

If the peek_lock parameter is set to True, the receive becomes a two stage operation, which makes it possible to support applications that cannot tolerate missing messages. When Service Bus receives a request, it finds the next message to be consumed, locks it to prevent other consumers receiving it, and then returns it to the application. After the application finishes processing the message (or stores it reliably for future processing), it completes the second stage of the receive process by calling the delete method on the Message object. The delete method will mark the message as being consumed and remove it from the queue.

5. Execute the following code.

```
#receive a new message when peek lock = True
msgrec = bus_service.receive_queue_message(queue_name, True)
print msgrec.body
```

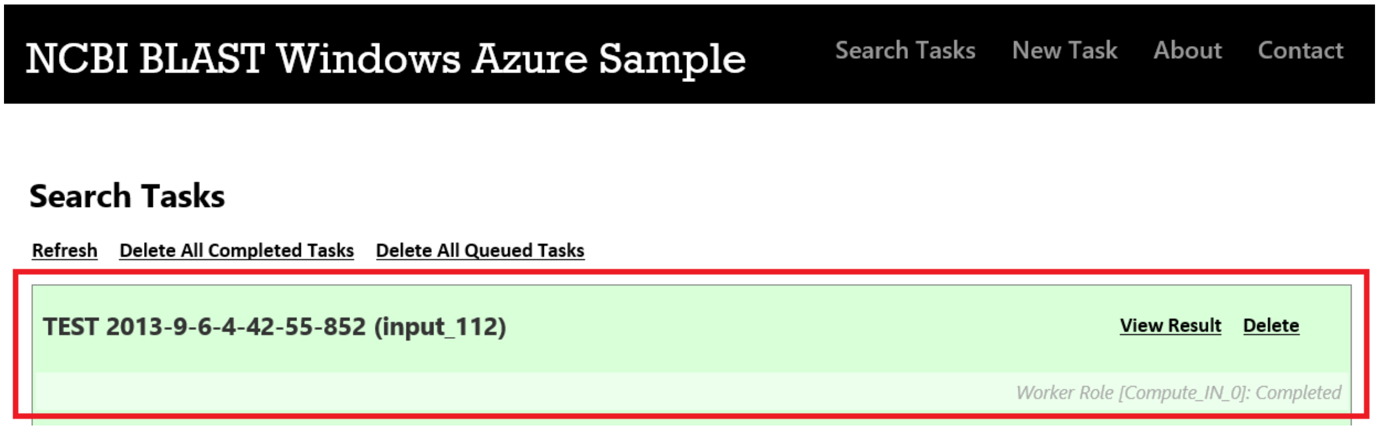
In [17]:

```
#receive a new message when peek lock = True
msgrec = bus_service.receive_queue_message(queue_name, True)
print msgrec.body
```

```
{"Hash":"","Id":"8d108ebe4b2a4b57b6222751965486f4","InputFile":"input_112","InputFiles":null,"LastMessage":"Queued","LastTimestamp":6
35166025782931780,"Name":"TEST 2013-9-6-4-42-55-852 (input_112)","OutputFile":"","State":"QUEUED"}
```

IPython Notebook Receive Message With Peek Lock

6. By default the peek lock time is 30 seconds. After that, check the BLAST web site again, you will see the task is picked up by the default worker role and it is in *Completed* status:



Search Tasks

TEST 2013-9-6-4-42-55-852 (input_112)

Worker Role [Compute_IN_0]: Completed

IPython Notebook Message Processed Again

If you use peek lock, you must remember to call **delete()** after you successfully processed the task.

Summary

By completing this hands-on lab you learned the following:

- Understand Windows Azure Service Bus Queue.
- Send a task to a Service Bus Queue by IPython Notebook and check the processing result.
- Receive a message from a Service Bus Queue.

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