CROWD-SOURCING

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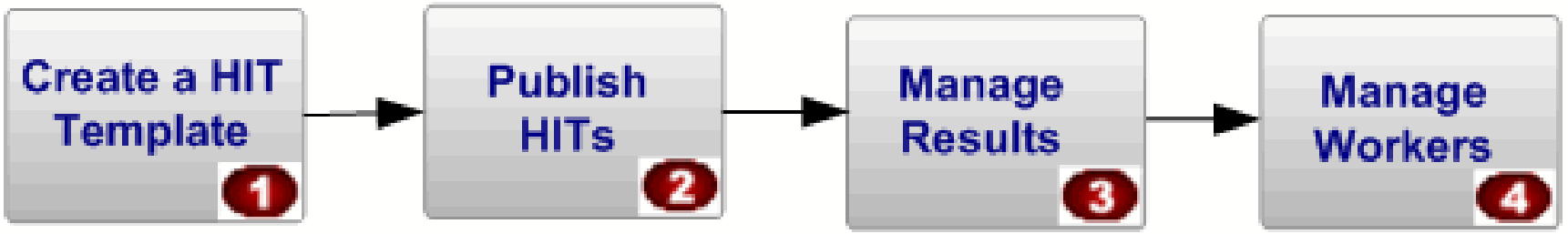
Amazon Mechanical Turk

- Advantages
  - On demand workforce
  - Scalable workforce
  - Qualified workforce
  - Pay only if satisfied

Terminology

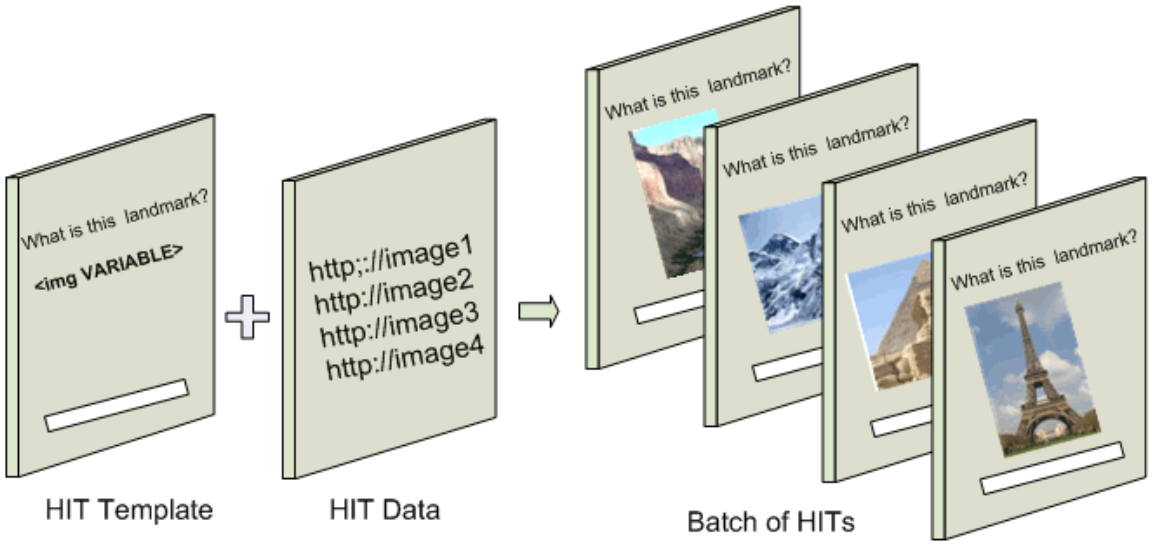
- Requestors
- HITs (Human Intelligence Tasks)
- Assignment
- Workers ('Turkers')
- Approval and Payment
- Qualification

Amazon Turk Pipeline



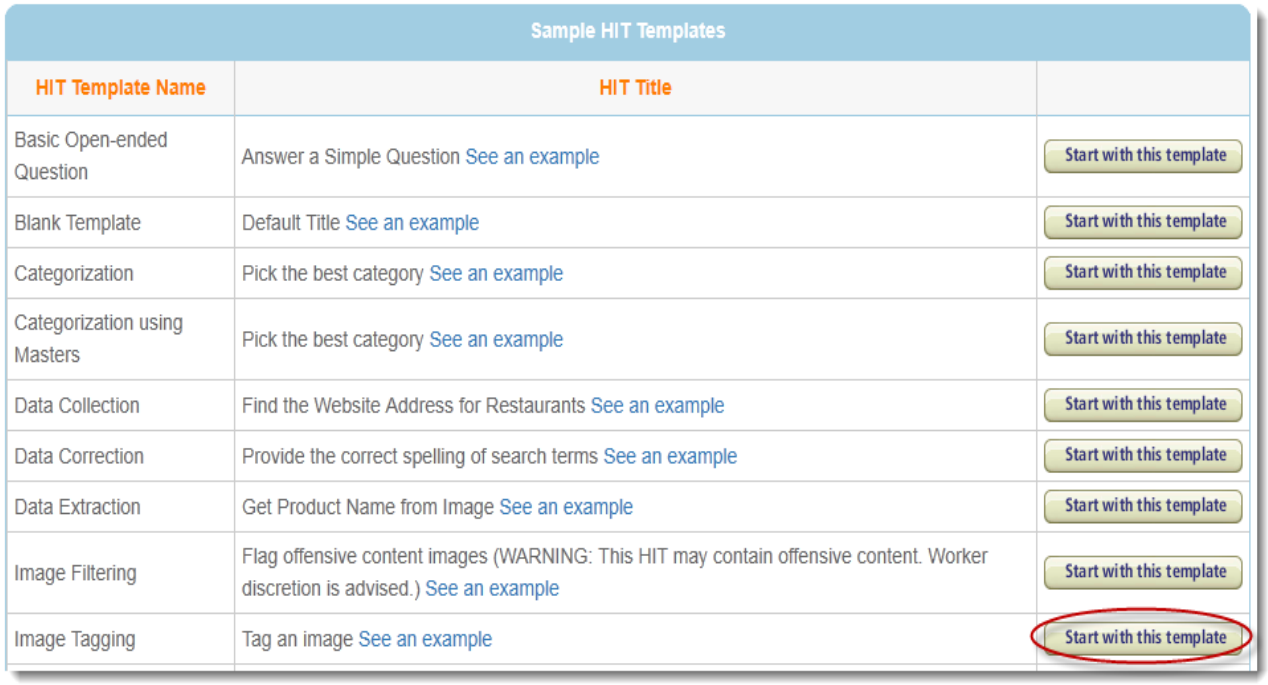
HIT Template

- HTML page that presents HITs to workers
  - Non-variable: all workers see the same page
  - Variable: every HIT has the same format, but different content



HIT Template

- Define properties
- Design layout
- Preview



Sample HIT Templates

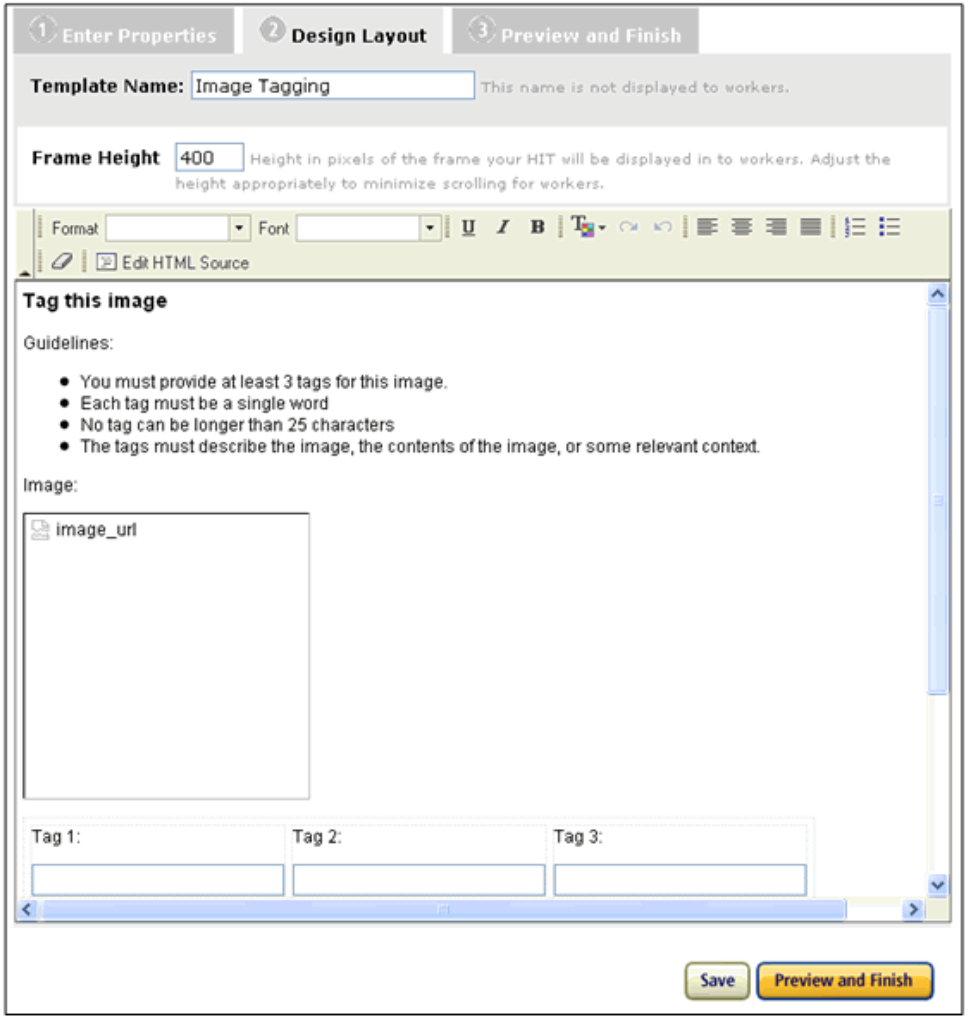
HIT Template Name	HIT Title	
Basic Open-ended Question	Answer a Simple Question See an example	Start with this template
Blank Template	Default Title See an example	Start with this template
Categorization	Pick the best category See an example	Start with this template
Categorization using Masters	Pick the best category See an example	Start with this template
Data Collection	Find the Website Address for Restaurants See an example	Start with this template
Data Correction	Provide the correct spelling of search terms See an example	Start with this template
Data Extraction	Get Product Name from Image See an example	Start with this template
Image Filtering	Flag offensive content images (WARNING: This HIT may contain offensive content. Worker discretion is advised.) See an example	Start with this template
Image Tagging	Tag an image See an example	Start with this template

HIT Template

- Properties
  - Template Name
  - Title
  - Description
  - Keywords
  - Time Allowed
  - Expiration Date
  - Qualifications
  - Reward
  - Number of assignments
  - Custom options

HIT Template

- Design
  - HTML



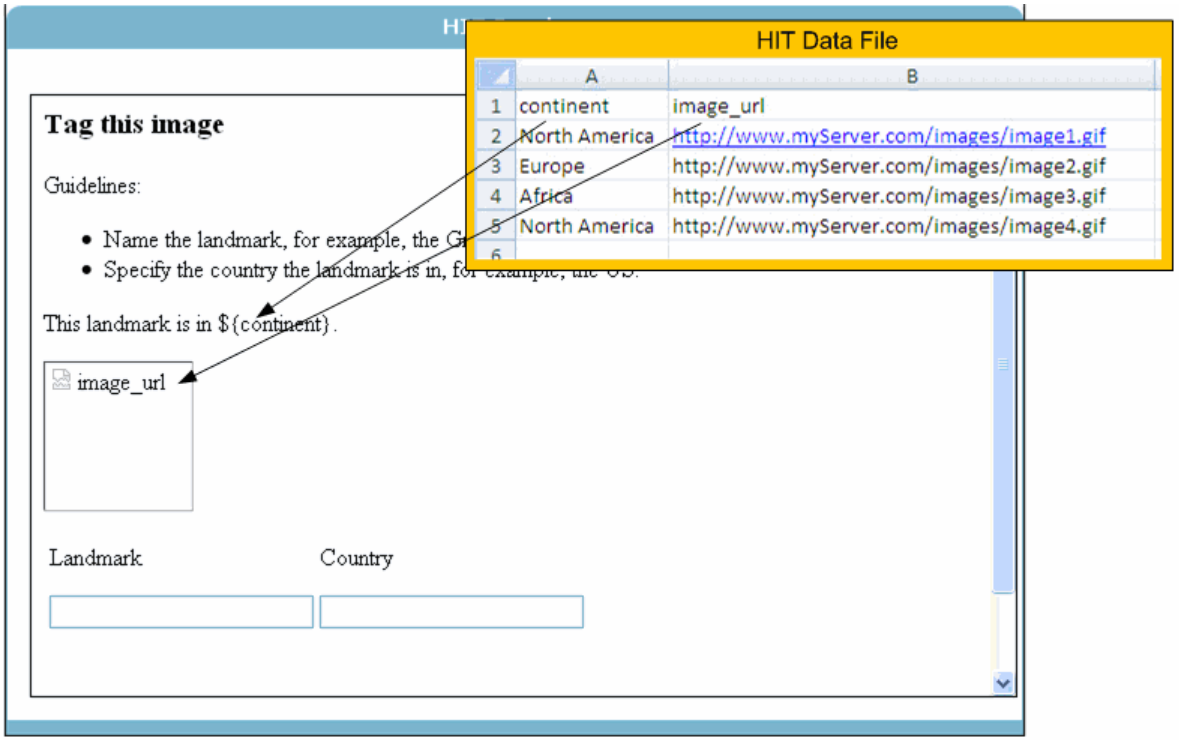
HIT Template

- Design
  - Template Variables
    - Variables are replaced by data from a HIT data file

```
<img width="200" height="200" alt="imagevariableName"
style="margin-right: 10px;" src="${image_url}" />
```

HIT Template

- Design
  - Data File
    - .CSV file (Comma Separated Value)



Row 1: Variable Names
Rows 2-5: Variable for each HIT

HIT Template

- Result
  - Also .CSV

	A	B	C	D
1	CompanyName	City	State	Country
2	Amazon	Seattle	WA	USA
3	Zappos	Las Vegas	NV	USA
4	Starbucks	Seattle	WA	USA
5	Coke	Atlanta	GA	USA
6	Facebook	Menlo Park	CA	USA

Table rows separated by line breaks.
Columns separated by commas.

First row is a header with labels for each column.

```
1  CompanyName,City,State,Country
2  Amazon,Seattle,WA,USA
3  Zappos,Las Vegas,NV,USA
4  Starbucks,Seattle,WA,USA
5  Coke,Atlanta,GA,USA
6  Facebook,Menlo Park,CA,USA
```

HIT Template

- Accessing assignment details in JavaScript

```
var assignmentId = turkGetParam('assignmentId', '');
  if (assignmentId != '' && assignmentId != 'ASSIGNMENT_ID_NOT_AVAILABLE') {
    var workerId = turkGetParam('workerId', '');
```

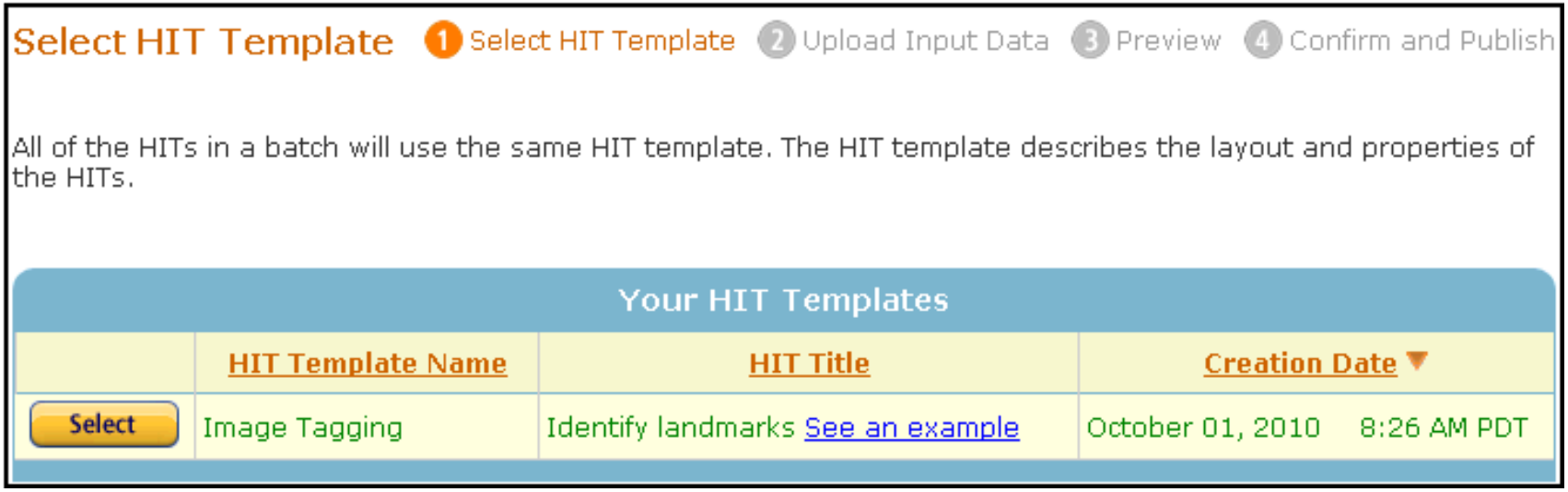
```
function turkGetParam( name, defaultValue ) {
    var regexS = "[\?&]"+name+"=([^&#]*)";
    var regex = new RegExp( regexS );
    var tmpURL = window.location.href;
    var results = regex.exec( tmpURL );
    if( results == null ) {
        return defaultValue;
    } else { return results[1]; }
}
```

Function automatically included by Amazon

Also commonly see a gup function used for the same purpose

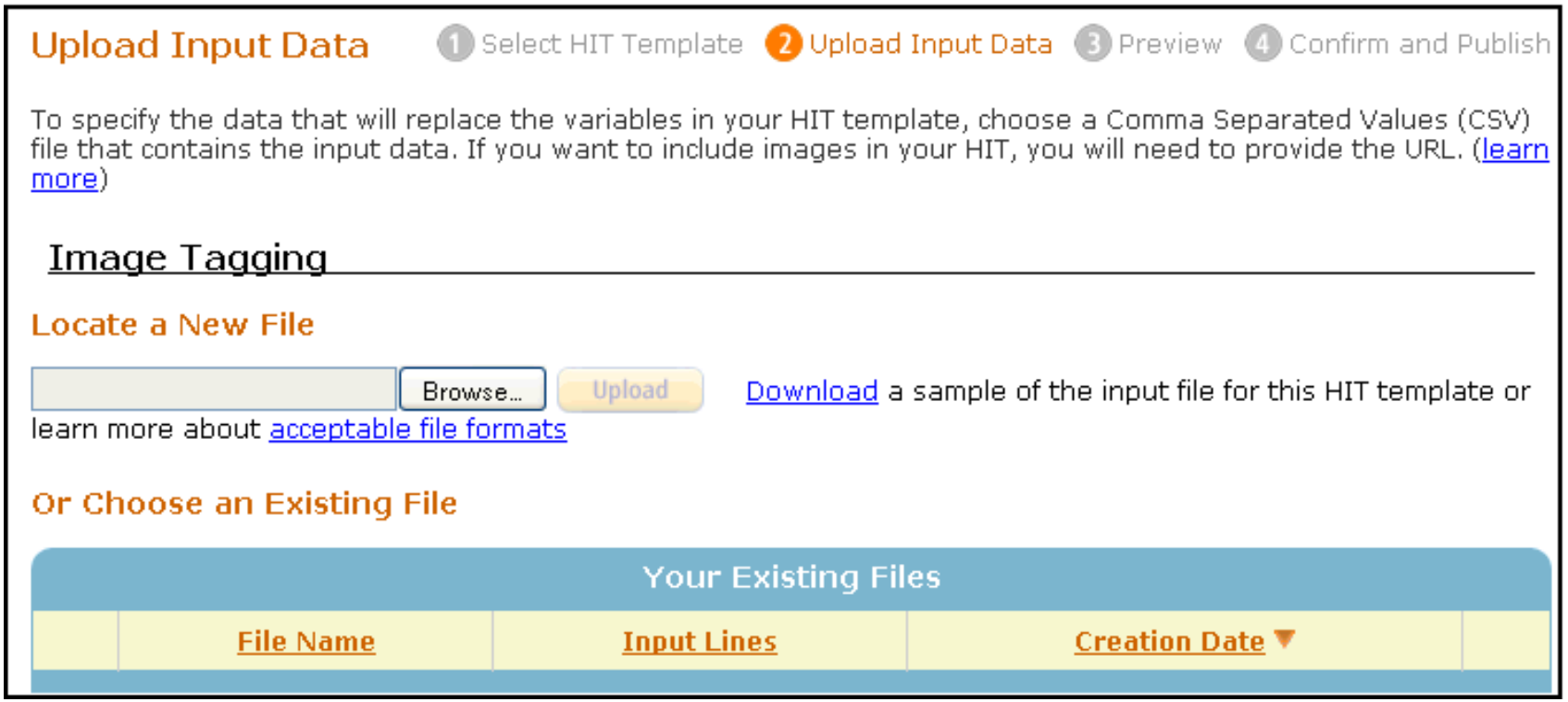
Publishing HITs

- Select created template



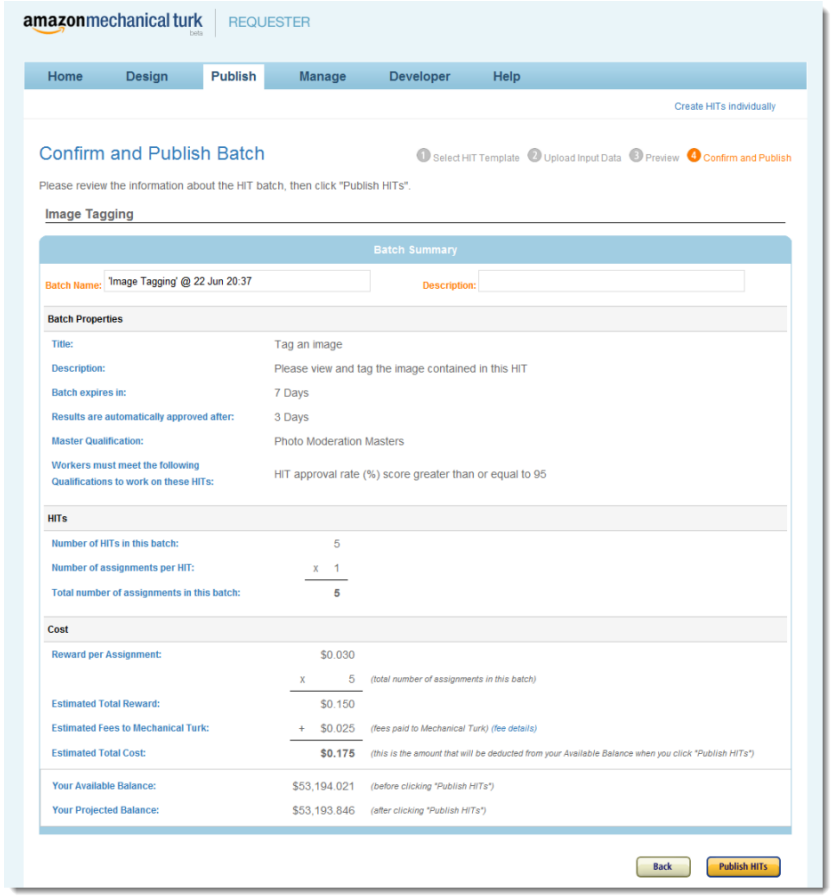
Publishing HITs

- Upload Data File



Publishing HITs

- Preview and Publish



Qualification

- Qualification
  - Make sure that a worker meets some criteria for the HIT
    - 95% Approval rating, etc.
  - Requester User Interface (RUI) doesn't support Qualification Tests for a worker to gain a qualification
    - Must use Mechanical Turk APIs or command line tools

Masters

- Workers who have consistently completed HITs of a certain type with a high degree of accuracy for a variety of requestors
  - Exclusive access to certain work
  - access to private forum
- Performance based distinction
- Masters, Categorization Masters, Photo Moderation Masters – superior performance for thousands of HITs

Command Line Interface

- Abstract from the “muck” of using web services
- Create solutions without writing code
- Allows you to focus more on solving the business problem and less on managing technical details
- mturk.properties file for keys and URLs
- Input: *.input, *.properties, and *.question files
- Output: *.success, and *.results

*.input

- Tab delimited file
- Contains variable names and locations

Image1	Image2	Image3
Image1.jpg	Image2.jpg	Image3.jpg

```
Image1    Image2    Image3
Image1.jpg          Image2.jpg          Image3.jpg
```

*.properties

- Title
- Description
- Keywords
- Reward
- Assignments
- Annotation
- Assignment duration
- Hit lifetime
- Auto approval delay
- Qualification

*.question

- XML format
- Define the HIT layout
- Consists of:
  - <Overview>: Instructions and information
  - <Question>
- Can be a QuestionForm, ExternalQuestion, or a HTMLQuestion

<Question>

- *QuestionIdentifier
- DisplayName
- IsRequired
- *QuestionContent
- *AnswerSpecification
  - FreeTextAnswer, SelectionAnswer, FileUploadAnswer

<Question>

```
<Question>
    <QuestionIdentifier>my_question_id</QuestionIdentifier>
    <DisplayName>My Question</DisplayName>
    <IsRequired>true</IsRequired>
    <QuestionContent> [...] </QuestionContent>
    <AnswerSpecification> [...] </AnswerSpecification>
</Question>
```

<QuestionContent> (and <Overview>) can contain:

- <Application>: JavaApplet or Flash element
- <EmbeddedBinary>: image, audio, video
- <FormattedContent> (later)

*.success and *.results

- *.success: tab delimited text file containing HIT IDs and HIT Type IDs
  - Auto-generated when HIT is loaded
  - Used to generate *.results
- Submitted results in the last columns
  - generate *.results with getResults command
  - tab-delimited file, last columns contain worker responses

Command Line Operations

- ApproveWork
- getBalance
- getResults
- loadHITs
- reviewResults
- grantBonus
- updateHITs
- etc

Loading a HIT

- loadHITs -input *.input -question *.question -properties *.properties -sandbox

- -sandbox flag to create HIT in sandbox to preview
- -preview flag also available
  - requires XML to be written in a certain way

FormattedContent

- Use FormattedContent inside a QuestionForm to use XHTML tags directly
  - No JavaScript
  - No XML comments
  - No element IDs
  - No class and style attributes
  - No and elements
  - URLs limited to http:// https:// ftp:// news:// nntp:// mailto:// gopher:// telnet://
  - Etc.

FormattedContent

- Specified in XML CDATA block inside a FormattedContent element

```
<QuestionContent>
    <FormattedContent><![CDATA[
    <font size="4" color="darkblue" >Select the image below that best represents:
        Houses of Parliament, London, England</font>
    ]]></FormattedContent>
</QuestionContent>
```

Qualification Requirements

- qualification.1: qualification type ID
- qualification.comparator.1: type of comparison (greaterthan, etc.)
- qualification.value.1: integer value to be compared to
- qualification.locale.1: locale value
- qualification.private.1: public or private HIT

- Increment the *.1 to specify additional qualifications

*.properties

- *.properties example

```
qualification.1:00000000000000000L0
qualification.comparator.1:greaterthan
qualification.value.1:25
qualification.private.1:false
```

Qualification TypeId for percent assignments approved

- Worker must have 25% approval rate and HIT can be previewed by those that don't meet the qualification

External HIT

- Use an ExternalQuestion

```
<ExternalQuestion
xmlns="http://mechanicalturk.amazonaws.com/AWSMechanicalTurkDataSchemas/2006-07-14/ExternalQuestion.xsd">
<ExternalURL>http://s3.amazonaws.com/mturk/samples/sitecategory/externalpage.htm?url=${helper.urlencode($urls)}</ExternalURL>
<FrameHeight>400</FrameHeight>
</ExternalQuestion>
```

- ${helper.urlencode($urls)} to encode urls from *.input to show in externalpage.htm

External HIT

- In the external .htm:

```
<form id="mturk_form" method="POST"
action="http://www.mturk.com/mturk/externalSubmit">
(…question…)
```

And then submit the assignment to Mturk

```
if (gup('assignmentId') == "ASSIGNMENT_ID_NOT_AVAILABLE") {
    …
} else {
        var form = document.getElementById('mturk_form');
        if (document.referrer && ( document.referrer.indexOf('workersandbox') != -1) ) {
            form.action = "http://workersandbox.mturk.com/mturk/externalSubmit";
        }
    }
```

Other Useful Options

- *.question
  - Create five questions, where the first 3 are required

```
#set( $minimumNumberOfTags = 3 )
#foreach( $tagNum in [1..5] )
<Question>
<QuestionIdentifier>tag${tagNum}</QuestionIdentifier>
#if( $tagNum <= $minimumNumberOfTags)
<IsRequired>true</IsRequired>
#else
<IsRequired>false</IsRequired>
#end
```

Qualification Test

- Given a request for a qualification from a worker, you can:
  - Manually approve qualification request
  - Provide answer key and Mturk will evaluate request
  - Auto-grant qualification
- Qualifications can also be assigned to a worker without a request

Qualification Test

- *.question, *.properties, *.answer
- Define the test questions in *.question and answers in *.answer

```
createQualificationType -properties qualification.properties
                        -question qualification.question
                        -answer qualification.answer
                        -sandbox
```

Qualification Test (Question)

```
<QuestionForm
xmlns="http://mechanicalturk.amazonaws.com/AWSMechanicalTurkDataSchemas/2005
-10-01/QuestionForm.xsd">
   <Overview>
      <Title>Trivia Test Qualification</Title>
   </Overview>
   <Question>
      <QuestionIdentifier>question1</QuestionIdentifier>
      <QuestionContent>
         <Text>What is the capital of Washington state?</Text>
      </QuestionContent>
      <AnswerSpecification>
         …
```

Qualification Test (Answer Key)

```
<?xml version="1.0" encoding="UTF-8"?>
<AnswerKey
xmlns="http://mechanicalturk.amazonaws.com/AWSMechanicalTurkDataSchemas/2005-10-01/AnswerKey.xsd">
 <Question>
  <QuestionIdentifier>question1</QuestionIdentifier>
  <AnswerOption>
   <SelectionIdentifier>1b</SelectionIdentifier>
   <AnswerScore>10</AnswerScore>
  </AnswerOption>
 </Question>
</AnswerKey>
```

Auto-assign qualification and score with answer key

Qualification Test Properties

- name
- description
- keywords
- retrydelayinseconds
- testdurationinseconds
- autogranted

Matlab Turk Tool

```
aws_access_key = ;
aws_secret_key = ;
sandbox = true;
```

Initialize with keys and sandbox option

```
turk = InitializeTurk(aws_access_key, aws_secret_key, sandbox);

result = RequestTurk(turk, 'GetAccountBalance',
{'ResponseGroup.0','Minimal','ResponseGroup.1','Request'});
result.GetAccountBalanceResponse.GetAccountBalanceResult.AvailableBalance.Amount
.Text
```

Command line operation

Parameters Operations

Matlab Turk Tool

```
<GetAccountBalanceResult>
   <Request>
      <IsValid>True</IsValid>
   </Request>
   <AvailableBalance>
      <Amount>10000.000</Amount>
      <CurrencyCode>USD</CurrencyCode>
      <FormattedPrice>$10,000.00</FormattedPrice>
   </AvailableBalance>
</GetAccountBalanceResult>
```

result.GetAccountBalanceResponse.GetAccountBalanceResult.AvailableBalance.Amount.Text

Paid By Bonus

- Approve individually or by batch
- Reject individually or by batch
- Give bonuses to good workers
- Can download batch into a .CSV, mark accept/reject, then upload updated .CSV to the Mechanical Turk

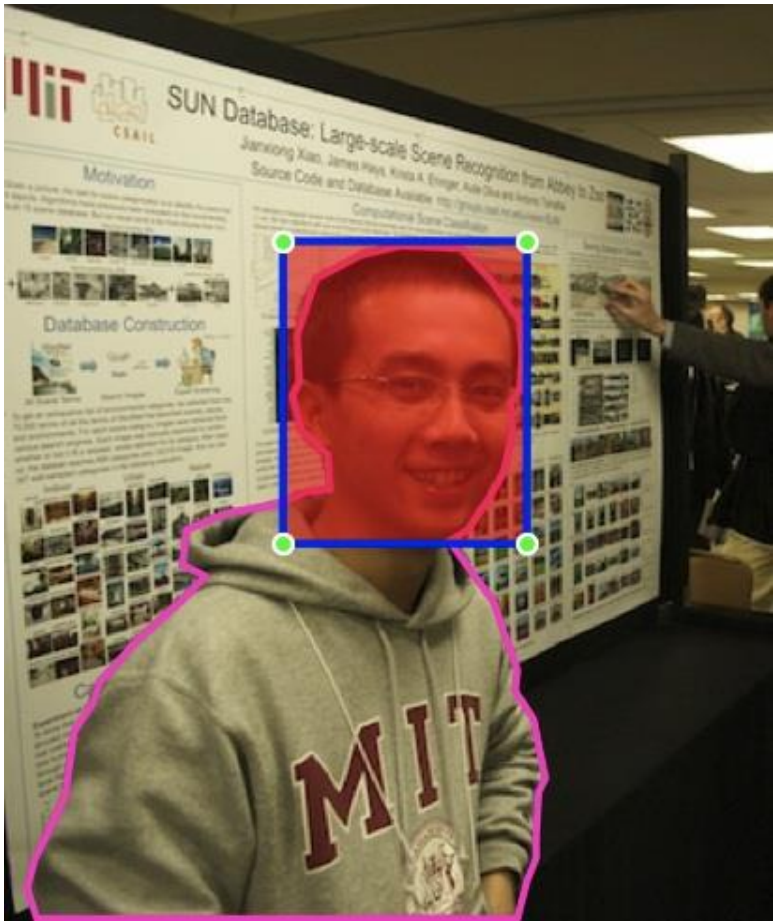
TurkCleaner

- Have the user select a subset of images that satisfy certain rules.

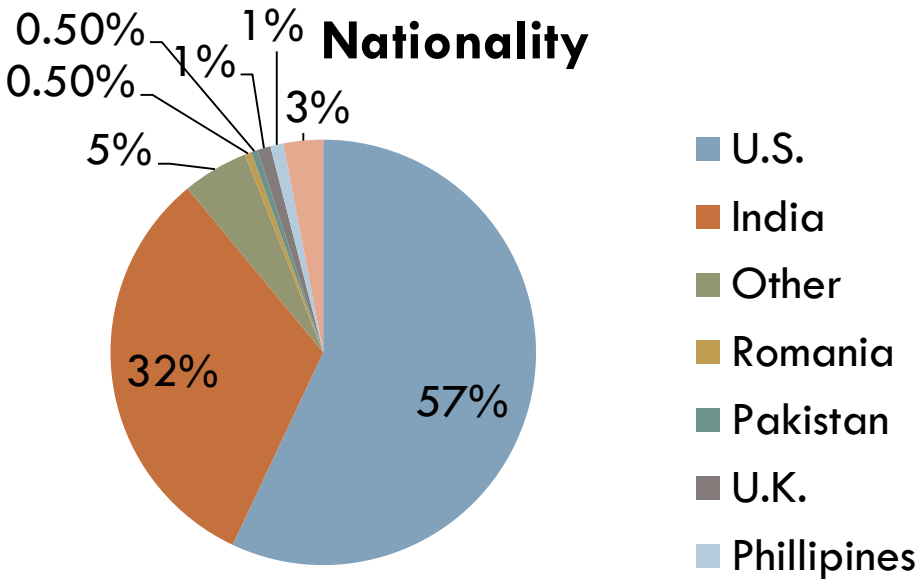
Copy .html into template, parse .CSV into Matlab readable format

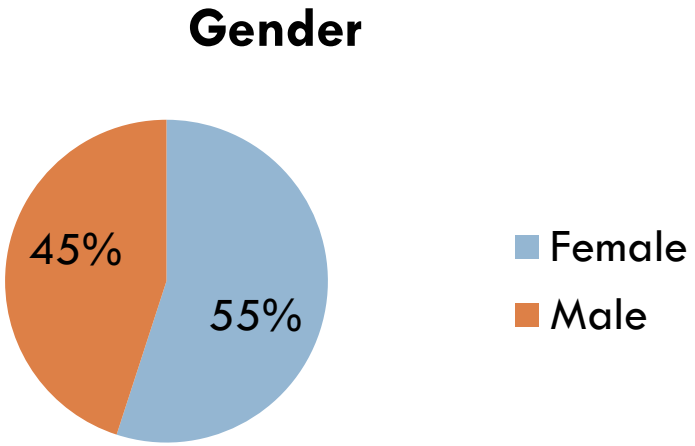
DrawMe

- Line drawing on an image.
- Copy .html into Mturk template
- .CSV file can be parsed into Matlab cell arrays for processing

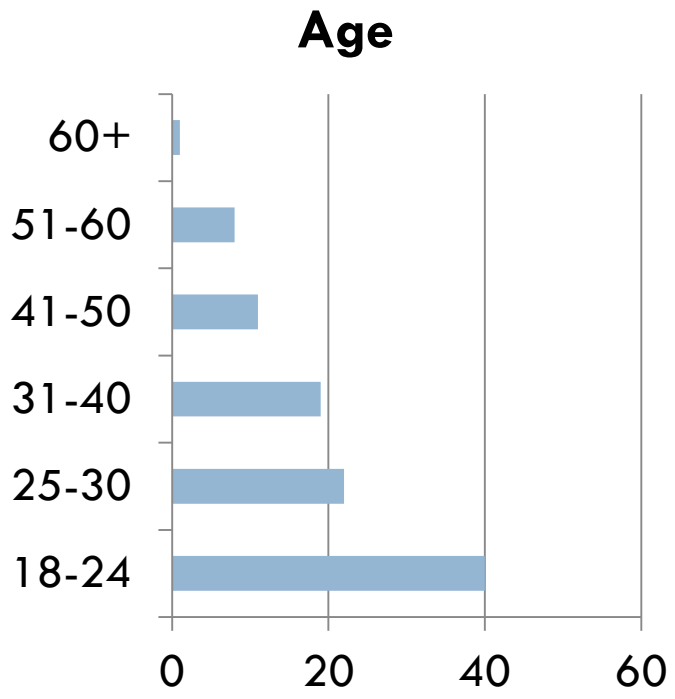


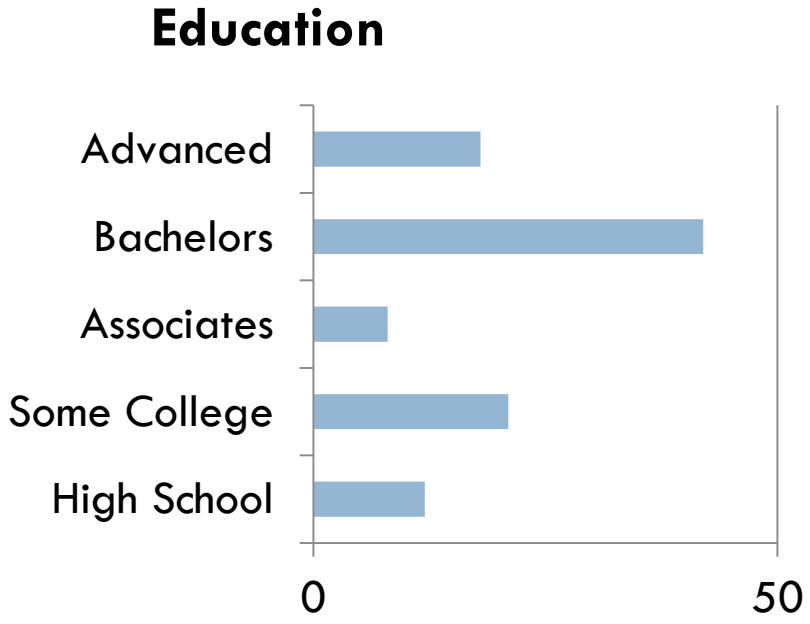
Demographics





Demographics





Best Practice

- Motivation
  - Incentives: entertainment, altruism, financial reward
- Task Design
  - Easy to understand visuals, design interface such that accurate task completion requires as much effort as adversarial task completion, financial gain for amount of work tradeoff for worker
  - Creation task vs. Decision task
- High Quality Results
  - Heuristics such as gold standard and majority vote
- Cost Effectiveness

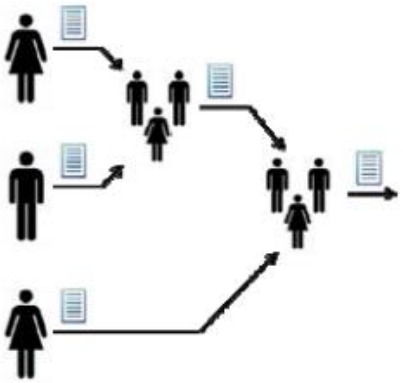
Creation Task vs Decision Task

- Creation:
  - Write a description of an image
- Decision:
  - Given two descriptions for the same image, decide which description is best

Iterative and Parallel

- Iterative: sequence of tasks, where each task's result feeds into the next task (better average response)

- Parallel: workers are not shown previous work (better best response)



Task Design

(A) Easy for Humans

Chair? Airplane? …

(B) Hard for Humans

Finch? Bunting?…

(C) Easy for Humans

Yellow Belly? Blue Belly? …

Gold Standard

- Present workers with control questions where the answer is known to judge the ability of the worker.
- Requires keeping track of workers over time or presenting multiple questions per task.

Majority Vote

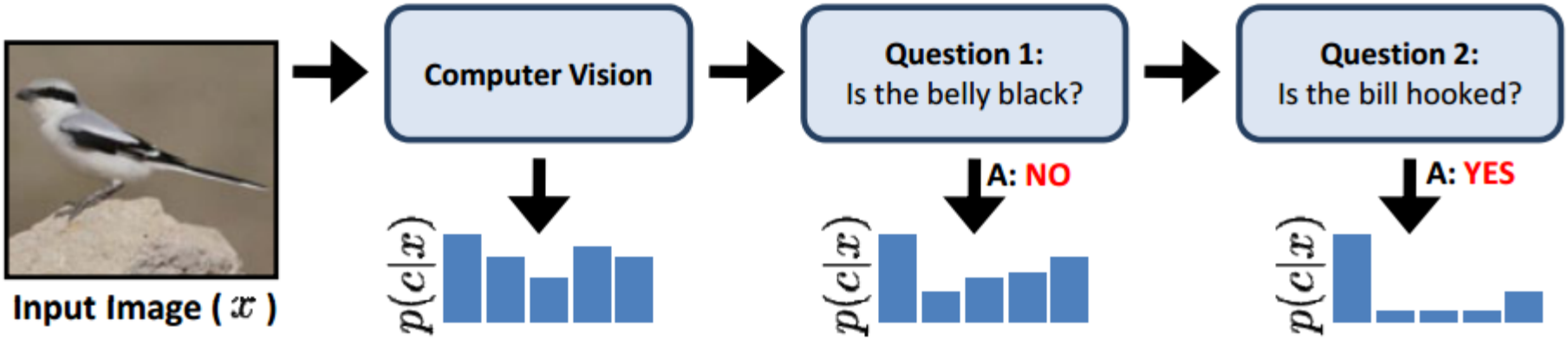
- Check the responses from multiple turkers against each other.
- Averaging multiple labels, etc.

Cost Effectiveness

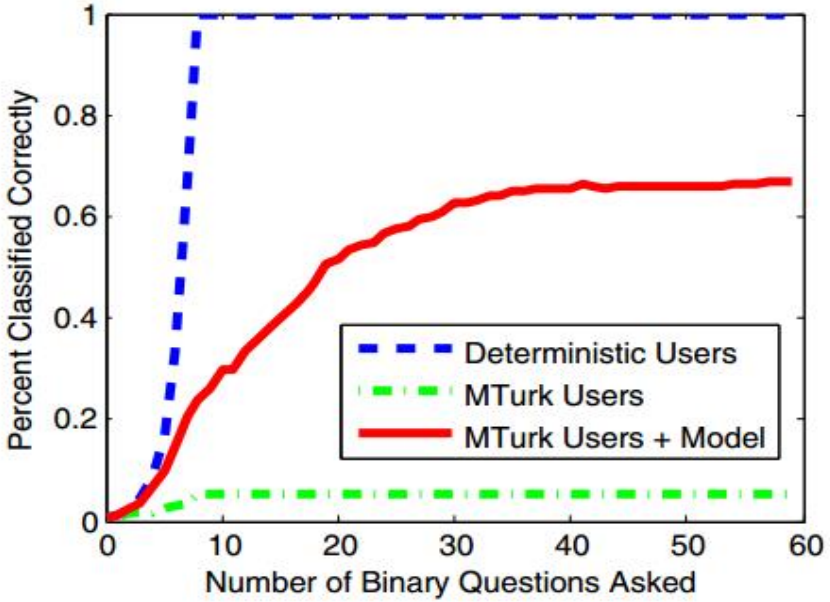
- [Welinder, et. al.] Estimation of annotator reliabilities
  - Use the reliability of the annotator to determine how many additional labels are needed to correctly label the image.

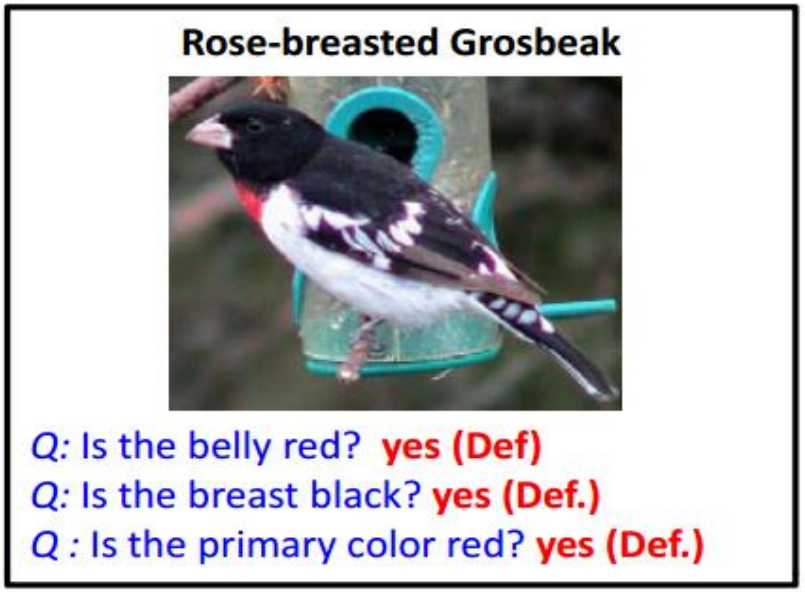
Augmenting Computer Vision

- Using humans to improve performance



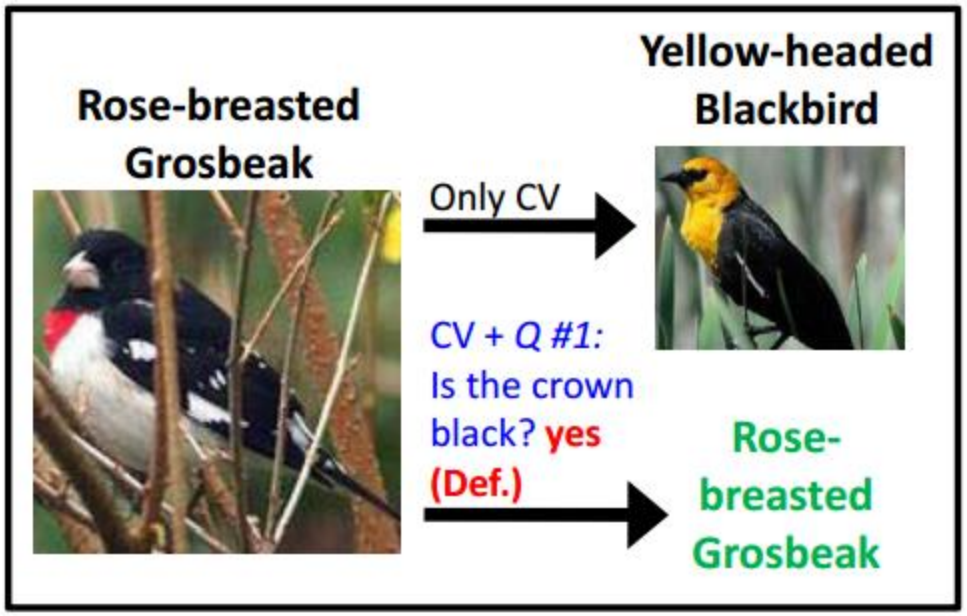
Augmenting Computer Vision





- Deterministic Users: assumed perfect users
- Turkers: subjective answers degrade performance (brown vs buff)

Augmenting Computer Vision



- Human answer corrects computer vision's initial prediction

TurKit

- Toolkit for prototyping and exploring algorithmic human computation

TurKit Script

- extension of JavaScript
- wrapper for MTurk API

```
ideas = []
for (var i = 0; i < 5; i++) {
    idea = mturk.prompt(
        "What's fun to see in New York City?
         Ideas so far: " + ideas.join(", "))
    ideas.push(idea)
}

ideas.sort(function (a, b) {
    v = mturk.vote("Which is better?", [a, b])
    return v == a ? -1 : 1
})
```

Generates ideas for things to see from 5 different workers and getting workers to sort the list

Crash-and-rerun programming

- Script is executed until it crashes
- Every line that is successfully run is stored in a database
- If script needs to be rerun, cost of rerunning human computation task is avoided by looking up the previous result (use keyword **once**)
- waitForHIT function that crashes unless results are ready

TurKit: Quicksort

```
quicksort(A)
    if A.length > 0
        pivot ← A.remove(once A.randomIndex())
        left ← new array
        right ← new array
        for x in A
            if compare(x, pivot) A
                left.add(x)
            else
                right.add(x)
        quicksort(left)
        quicksort(right)
        A.set(left + pivot + right)
A
compare(a, b) A
    hitId ← once createHIT(...a...b...)
    result ← once getHITResult(hitId)
    return (result says a < b) A
```

Use **once** if function is:

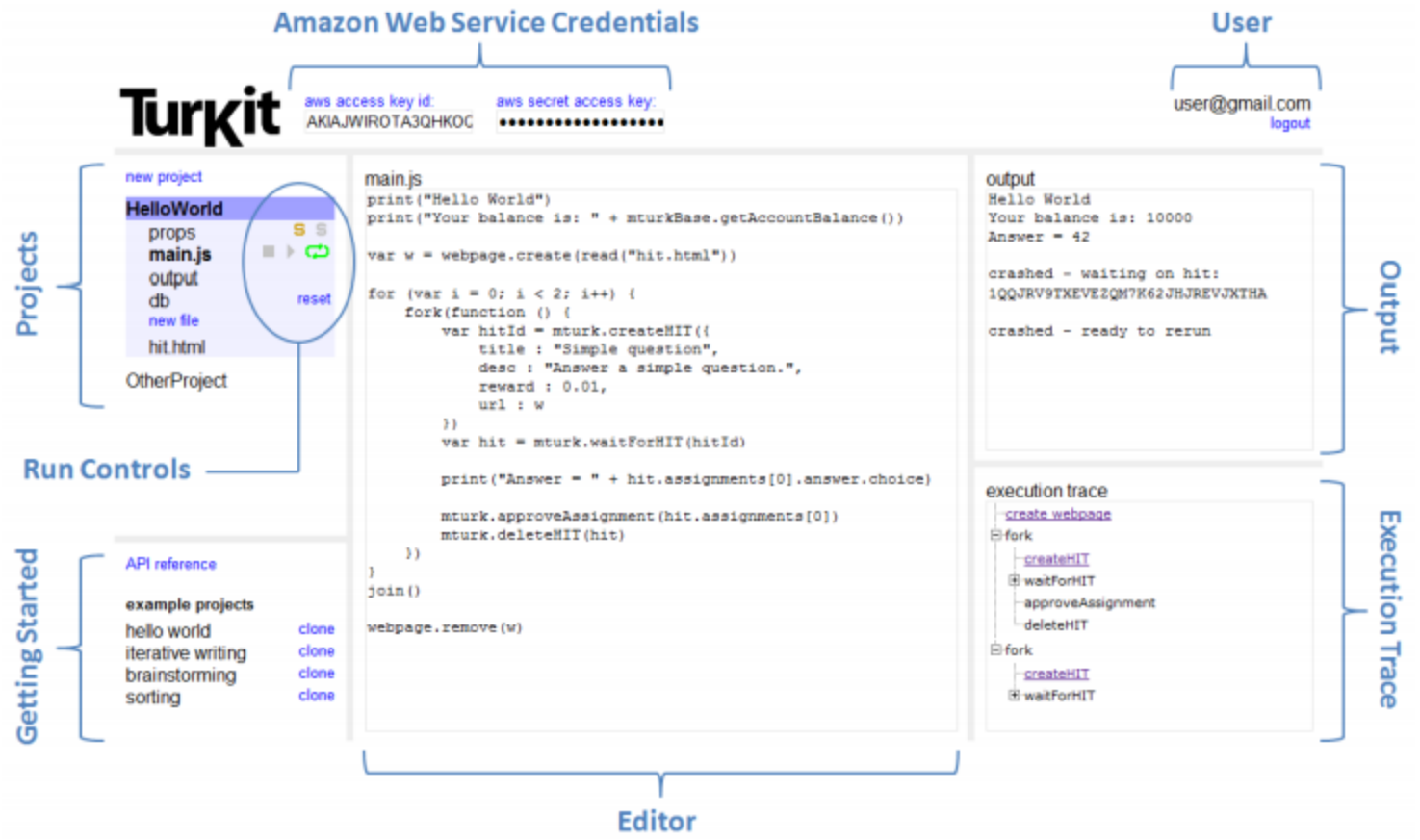
- deterministic
  - once Math.random() would result in the same value every run
- high cost
- has side-effects
  - ex: approving results from a HIT multiple times causes errors

TurKit: Parallelism

```
fork(function () {
    a = createHITAndWait()        // HIT A
    b = createHITAndWait(...a...) // HIT B
})
fork(function () {
    c = createHITAndWait()        // HIT C
})
```

- If HIT A doesn't finish, crash that fork and the next fork creates HIT C
- Subsequent runs will check each HIT to see if it's done
- join() to ensure previous forks were successful
  - if previous forks unsuccessful, join crashes current path

TurKit IDE


Amazon Web Service Credentials
User
Turkit
aws access key id:
AKIAJWIROTA3QHKOC
aws secret access key:
user@gmail.com
logout
Projects
new project
HelloWorld
props
main.js
output
db
reset
new file
hit.html
OtherProject
Run Controls
main.js
print("Hello World")
print("Your balance is: " + mturkBase.getAccountBalance())
var w = webpage.create(read("hit.html"))
for (var i = 0; i < 2; i++) {
fork(function () {
var hitId = mturk.createHIT({
title : "Simple question",
desc : "Answer a simple question.",
reward : 0.01,
url : w
})
var hit = mturk.waitForHIT(hitId)
print("Answer = " + hit.assignments[0].answer.choice)
mturk.approveAssignment(hit.assignments[0])
mturk.deleteHIT(hit)
})
}
join()
webpage.remove(w)
output
Hello World
Your balance is: 10000
Answer = 42
crashed - waiting on hit:
1QQJRV9TXEVEZQM7K62JHJREVJXTHA
crashed - ready to rerun
Output
execution trace
create webpage
fork
createHIT
waitForHIT
approveAssignment
deleteHIT
fork
createHIT
waitForHIT
Execution Trace
Getting Started
API reference
example projects
hello world clone
iterative writing clone
brainstorming clone
sorting clone
Editor

Turker Forum and Browser Plugin

- Turkopticon: (Union 2.0) shows reviews of requestors on Amazon MTurk
- TurkerNation
- Helpful Blogs for Requestors:
  - [Tips for Requestors]
  - [The Mechanical Turk Blog]