Last name _____

First name _____

LARSON—MATH 353–CLASSROOM WORKSHEET 15
$n^2 + 1$ Primes Investigation.

1. Sign in to your CoCalc account.

   (a) Start the Chrome browser.

   (b) Go to `https://cocalc.com`

   (c) Log in to your account.

   (d) You should see an existing Project for our class. Click on that.

   (e) Make sure you are in your Home directory (if you put files in the Handouts directory they could be overwritten.)

   (f) Click "New", then "Jupyter Notebook", then call it **353-c15**.

   (g) Make sure you have SAGE as the *kernel*.

   (h) Look in your `Home` directory. You should see a `conjecturing.py` file and an `expressions` file **AND** today's Jupyter notebook.

Review

2. We wanted some data. We made a list L with all the primes up to 1000. How did we do that? I added this work to our `number_theory.py` file. We don't want to use all these when we produce conjectures (so that we have simpler conjectures and less overfitting), but we can use them to check if a given conjecture is true.

3. We need `conjecturing.py` loaded for our investigation. I added the command to the `number_theory.py` file. Every time that file is loaded, the `Conjecturing` program will get loaded too.

4. **Open Conjectures**.

```
count_prime_divisors(x) <= digits10(x)
count_prime_divisors(x) <= 1/2*count_divisors(x)
count_prime_divisors(x) <= count_divisors(x) - 1

count_prime_divisors(x) >= digits10(x) - 1
count_prime_divisors(x) >= (1/digits10(x))
```

   Are any of these resolved?

Experiments

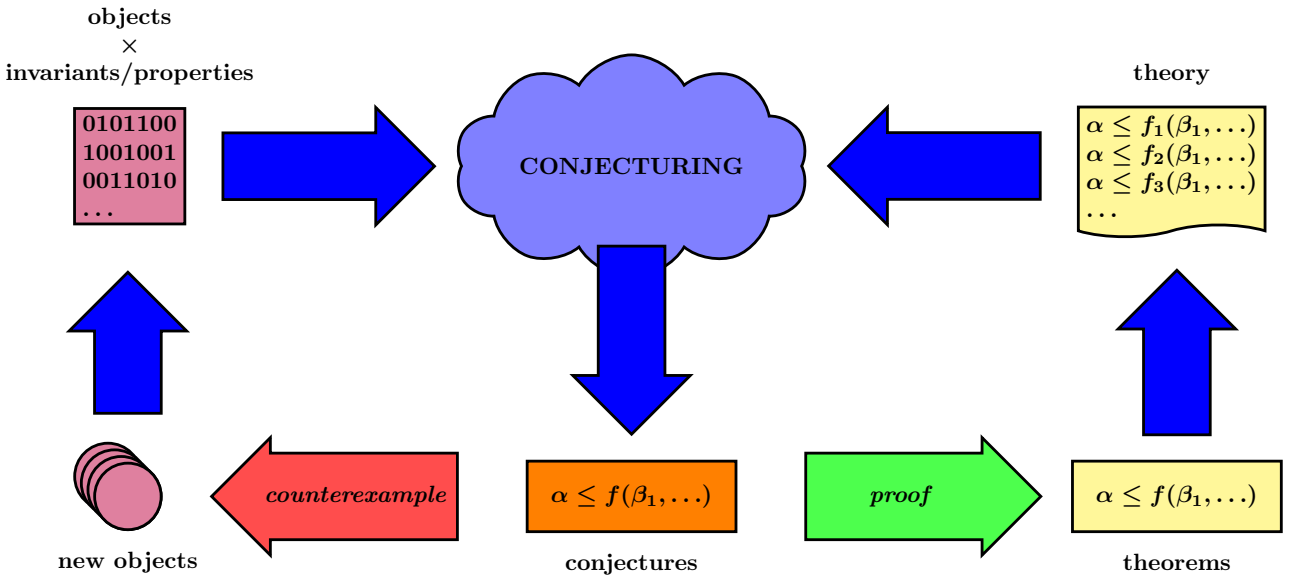
The **question** is: are the infinitely many primes of the form $n^2 + 1$?

5. To use the `Conjecturing` program, we'll need some *invariants*. The ones we've coded in class are in the *number_theory.sage* file in your Handouts folder. We don't want to keep re-coding those. We can use this file as a permanent record of everything we've coded for this research. Copy or move this file to your Home directory.

6. We started with a few prime and non-prime integers of the form $n^2 + 1$. We found 901 and 325 were counterexamples to conjectures, and added those. Here is where we are:

```
#lets try to make conjectures using a *few* of the numbers from N
#lets get a couple primes and non-primes
objects = [5,17,65,901,325]

#need invariants for integers
invariants = [digits10, digits2, count_divisors, count_prime_divisors,
    number]

#maybe count_prime_divisors is worth investigating
#Note: this invariant is 1 for primes and bigger than 1 for non-primes

invariant_of_interest = invariants.index(count_prime_divisors)

conjs = conjecture(objects, invariants, invariant_of_interest,upperBound
     = False, debug=True)
for conj in conjs:
    print(conj)
```

7. How should we proceed?



Getting your classwork recorded

When you are done, before you leave class...

1. Click the "Print" menu choice (under "File") and make a pdf of this worksheet (html is OK too).
2. Send me an email (`clarson@vcu.edu`) with an informative header like "Math 353 - c15 worksheet attached" (so that it will be properly recorded).
3. Remember to attach today's classroom worksheet!