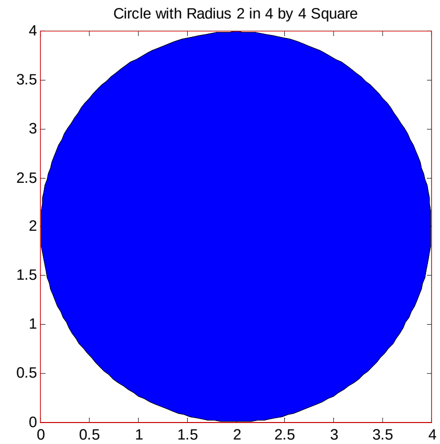
Lecture 37: Using Monte Carlo Simulations to Find Area of a Circle



The Idea Behind the Problem

- Place a circle with radius *r* in a square that has one corner at the origin.
- Now conduct *n* trials where:
    - ***x=2*r*rand(1);***
    - ***y=2*r*rand(1);***
    - Why don't we use ***ceil*** in these commands
- if $(x-r)^2 + ((y-r)^2 \leq r^2$ then the point is inside the circle.
- count the number of points *m* that fall inside the circle.
- divide it by the number of trials *n*.
- thus area of circle will be approximately *m/n* times the area of the square $(2r)^2$.
- The larger the number of trials, the better the approximations.
- How does this compare to the actual area πr^2?

Some Code

```
clf;close all;
success=0;
axis([0,2*r,0,2*r]);
hold on;
for i=1:n;
   x=2*r*rand(1); %find a random x between 0 and 2r
   y=2*r*rand(1); %find a random y between 0 and 2r
   if (x-r)^2+(y-r)^2<=r^2 % success if point is inside or on the circle.
      success=success+1;
      plot(x,y,'r.','MarkerSize',3); %plot red dots on/inside the circle.
   else
      plot(x,y,'.','MarkerSize',3); %plot blue dots outside the circle.
   end
   if floor(i/1000)==i/1000, disp(i), end;
end
axis square;
area=(success/n)*(2*r)^2; %estimate the area.
a=pi*r^2; %actual area.
title(['Monte Carlo Simulation to find Area of Circle with r=',num2str(r)])
xlabel([num2str(n), ' Trials Conducted.  Estimated Area=',num2str(area),' Actual
Area=',num2str(a)]);
```

Homework 37

Adapt the code above to determine the volume of a sphere with radius *r*. You will need the ***plot3*** command and a *z* variable to this. Use 10,000 trials to estimate the volume of a sphere with radius 1.33. Compare this to the actual volume. Plot the sphere (note: do not plot the points outside the sphere). A sample output appears below.