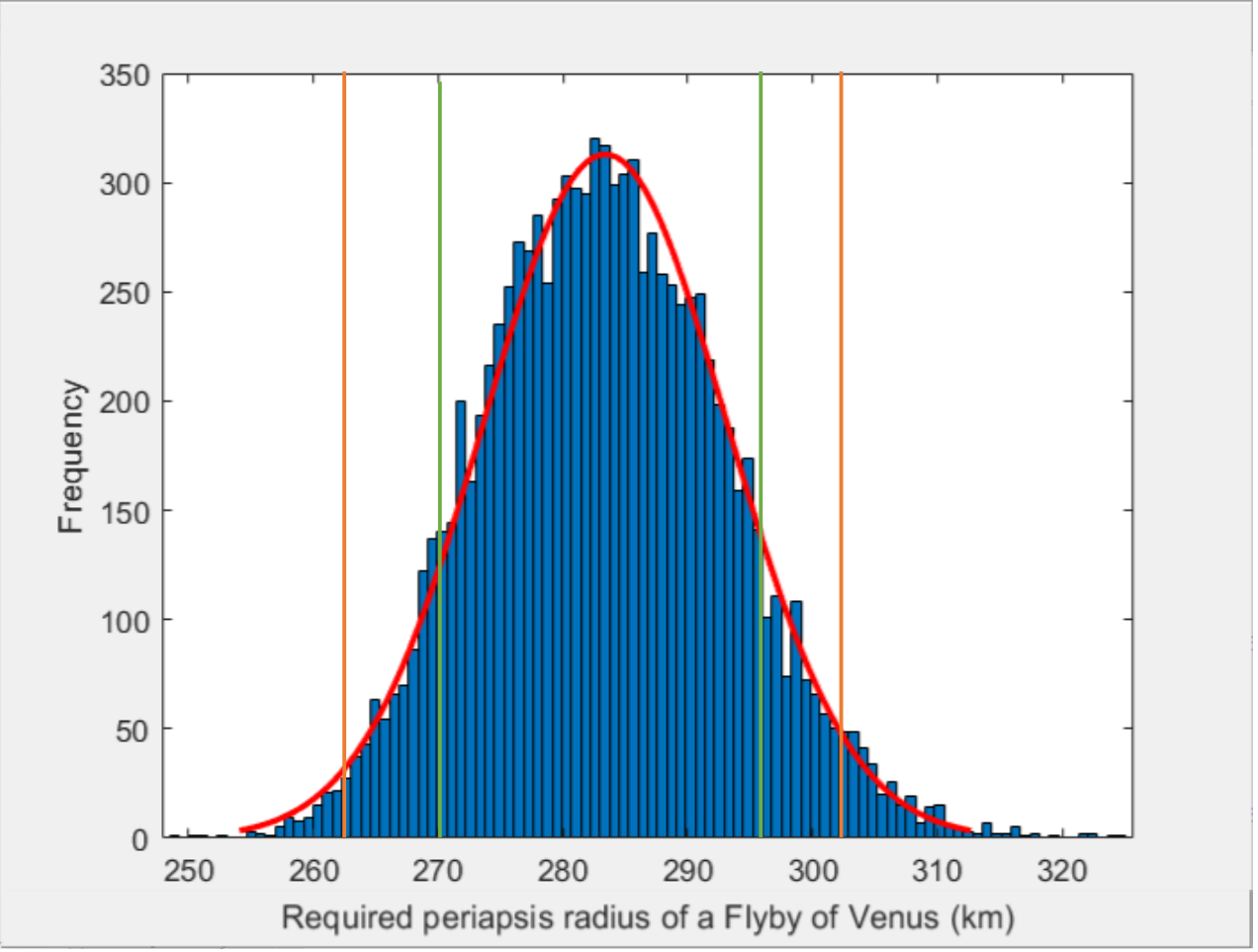
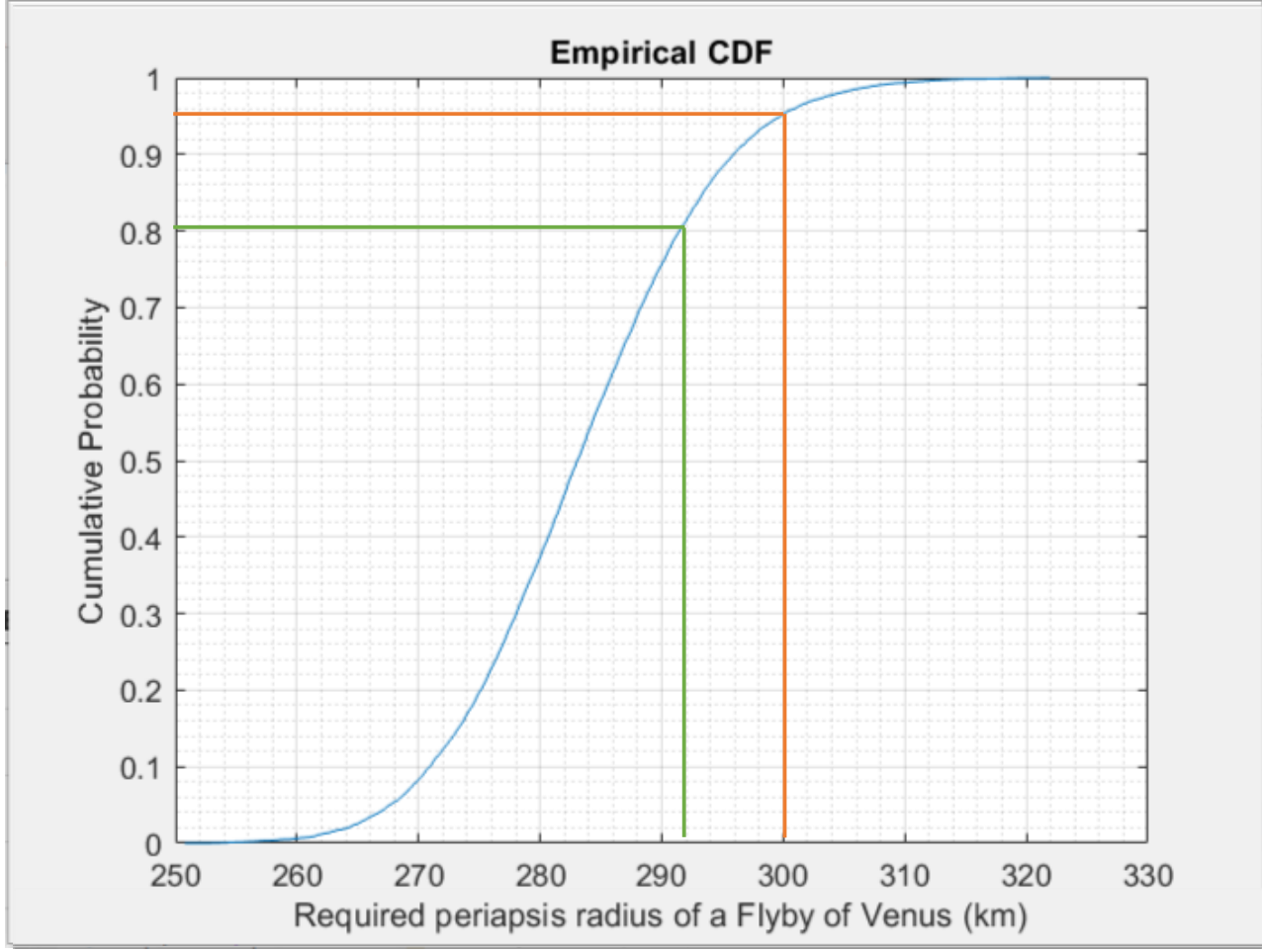
$$\Delta = r_p \sqrt{1 + \frac{2\mu_2}{r_p v_\infty^2}},$$

- Input Variables: Periapsis Radius (r_p), Gravitational Parameter(μ_2), Hyperbolic Excess Velocity(v_∞)
- Output Variable: Distance from Planet of a Flyby Maneuver (Δ).
- All input variables were modeled with a normal distribution except the Gravitational Parameter which was modeled by a uniform distribution

Relevance

- In our trajectory to Jupiter we are planning to slingshot our spacecraft from a Venus Flyby that will drastically accelerate our final velocity towards Jupiter. Cassini did a Venus flyby at 284 km that which gave the spacecraft 7 km/s boost towards its destination of Saturn. That change of speed can make our mission more efficient in its long trip towards Europa, therefore we should make the success of this flyby a priority.





95% Confidence: [264.0463, 302.7411]
80% Confidence: [270.7587, 296.0288]

Our desired range of outputs would be between 264.0463 km and 302.7411 km because my Monte Carlo Analysis guarantees a 95% confidence of our spacecraft having this distance in our Venus Flyby. I consider this an acceptable level of confidence because I wouldn't like to risk more than 5% probability on having our spacecraft be far enough from the planet to not get slingshot or having our spacecraft be close enough to just crash into Venus.

Code (MATLAB)

```
v=normrnd(.910,.030,10000,1);
gp=randi([3.2486e5,3.257e5],10000,1);
r=normrnd(.102,.002,100000,1);
delta=zeros(10000,1);

for i=1:10000
delta(i)=r(i)*sqrt(1+2*gp(i)/(r(i)*v(i)^2));
end
figure
histfit(delta)
xlabel('Required periapsis radius of a Flyby of Venus
(km)')
ylabel('Frequency')
figure
cdfplot(delta);
xlabel('Required periapsis radius of a Flyby of Venus
(km)')
ylabel('Cumulative Probability')
grid minor


pd = fitdist(delta,'Normal')
sd=9.871133766295580; %from fitdist
mean=2.833937222857811e+02 %from fitdist
ninetyfive_upper=mean+1.96*sd %1.96 is the z value for 85%
ninetynine_lower=mean-1.96*sd %1.96 is the z value for 85%
eightyfive_upper=mean+1.28*sd %1.28 is the z value for 85%
eightyfive_lower=mean-1.28*sd %1.28 is the z value for 85%
```

Sources

- https://space.stackexchange.com/questions/10506/calculating-the-periapsis-radius-of-a-flyby-manoeuvre-without-knowledge-of-the-e
- http://www.ae.utexas.edu/courses/ase366k/constants.pdf
- https://www.researchgate.net/figure/ariation-of-hyperbolic-excess-velocity-on-arrival_fig10_245433230
- https://solarsystem.nasa.gov/news/12181/cassini-completes-first-venus-flyby/