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## Brijesh Vora

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# ODE 15{i,s} : Matlab Compatible DAE solvers

## A: An Introduction

My name is Brijesh Vora. I am from Gujarat, India. I have completed my 2nd year of my computer science degree in **IIT TIRUPATI**.

Q. Which languages do you speak?

A. English, Hindi, Gujarati

Q. What's your overall background?

A. My major is in computer science and I am interested in maths and programming.

Q. Why do you want to participate in the Google Summer of Code? What do you hope to gain by doing so?

A. I want to contribute to open source organizations and get some experience with working them. So, GSoC seemed perfect to me. Also, If I once start contributing to open source them I will become regular contributor.

Q. Why are you choosing Octave?

A. I love mathematics and programming so Octave seemed perfect for me to simultaneously work on maths and programming and that to in big organisation like this. It's a dream come true.

Q. what time do you code?

A. I generally code from 8 am to 6-7 pm (IST) with 1-2 hr break in between and from monday to saturdays.

<https://wiki.octave.org/User:Vorabrijesh#C:> Contact <https://github.com/vorabrijesh>

## C: Contact

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IRC Nickname- vorabrijesh but I generally reply faster to mail and I am really new to IRC but I will get hang of it.

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## Project Description

This project is about extending the work done by Francesco Faccio in GSoC-2016 and done by Carlo de Falco, Marco Caliarì, Jacopo Corno, Sebastian Schöps earlier.

I have gone through the work done by Francesco Faccio in 2016 in which he implemented ode15i and ode15s and also wrote the tests and evaluated performance gain. It was really great to achieve this feat. And I want to extend his coursework.

For eg. I saw he implemented ode15i fully but ode15s was left untested and performance gain was not measured properly. I want to cover that in my project by making tests and evaluating them. As benchmark problems he had chosen two examples which deal with dense and sparse methods for ode15i.

1. Robertson chemical kinetics problem
2. 2D heat equation

So, I would like to propose two or more similar benchmark problem for ode15s and evaluate them and also some more tests for ode15i as well would be good to include in the first 2-3 weeks.

Task -> make ode15{i,s} with data types other than double

Francesco Faccio compiled Octave and linked to Sundials and after setting some correct flags he wrote a minimal wrapper of ode15i of the form:

```
[t, y] = ode15i (odefun, tspan, y0, yp0, options)
```

Now Sundials uses reatype and N\_Vector. An N\_Vector is a vector of reatype, while a reatype can be both a float, a double or a long double, depending on how Sundials has been built (default type is double). He assumed to use the default double reatype and wrote functions N\_Vector ColToNVec (ColumnVector data, long int n) and ColumnVector NVecToCol (N\_Vector v, long int n), which convert an Octave ColumnVector to an N\_Vector and viceversa.

Currently, these two methods are not supported in ode15s,

- complex valued systems are not supported (actually anything except double)
- JPattern option is not supported

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And seeing the interest and importance of this,

<http://octave.1599824.n4.nabble.com/state-of-ode15s-implementation-td4681014.html> I will spend enough time to implement this. Also the JPattern, Vectorized is not supported in ode15i. So, I like to implement that also. And the other files like odeset.m decic.m will be changed appropriately.

After the midterm evaluation a better function will be made for selecting consistent initial conditions compatible with Matlab's decic.m. The algorithm is already given on project site. I would try to implement this and I think that with some more mentorship or by doing some more research I will be able to achieve this. <http://faculty.smu.edu/shampine/cic.pdf>

Basically we want to make Matlab compatible ode15i and ode15s and I want to give maximum time effort for implementing ode15s and ode15i because of its importance.

In the last one and half month , refactoring of code and optimizing the code by removing unnecessary loops and memory access (or memory leak) and efficiency check will be done to check whether the new data type is correctly implemented or not.

In the last 2-3 weeks general code profiling and optimization will be done and (optional) possibly improving documentation and tests in odepkg and removing overlaps with the documentation in core Octave and also implement and improve ode23 and ode45 and ode113. I will work for the optional part even after GSoC is over.

## GOALS

The final goal is to have a well tested and documented implementation of ode15s and ode15i.

## TIMELINE

### Community Bonding Period: May 6 - 27, 2019

-Familiarize with Autotools/make files and the structure of Octave. And the understand the code written by Francesco Faccio.

-Study the documentation of SUNDIALS and Oct-files and research about the benchmark problems to be tested for ode15s and discuss it with mentors. Also preparing for some tests in which ode's are failing and finding limitations of them.

### Week 1-2 (May 27 - Jun 10):

Implement the benchmark problems discussed during community bonding period and perform tests on ode{i,s}

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**Week 3-4** (Jun 10-Jun 24):

Implementing complex valued systems and Jpattern.

**MidTerm Evaluation****Week 4-5**(Jun 25-July 10):

Perform test on above implemented methods and extend/optimize it.

**Week 6-7**(July 10-July 25):

A better function will be made for selecting consistent initial conditions compatible with Matlab's decic.m.

**Week 8-9**( July 26- Aug 9):

Perform test on above function and write oct-files.

**Week 10-11** (Aug 10 - Aug 25):

Improving documentation and tests in odepkg and removing overlaps with the documentation in core Octave but most probably solving bugs.

**Week 12:**

Review of the work

**OPTIONAL:** implement ode45, ode23, ode113, ode23s, ode23t, ode23tb. At Least some basic functionality would be implemented.

<https://www.cheric.org/education/lecture/process/CHBE506/ode.pdf> .They have used explicit Runge-Kutta for ode45 and in ode113 Adams-Bashforth-Moulton PECE solver will be implemented.

**FINAL SUBMISSION**

P.S:

I have filled the necessary details in wiki page:

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I haven't submitted any patches or fixed bugs to octave but I opened PR in sympy and godot . If the submission date for GSoC proposal is gone i.e after apr 9th, and if you receive any patches from me please do consider it for my application.

Thank You,

Brijesh Vora