Results from the First NINJA Project

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What is NINJA

• Numerical INJection Analysis

• The goals of NINJA are:

  • Study the response of gravitational-wave search pipelines to waveforms from numerical relativity simulations

  • Foster close collaboration between the numerical relativity and data analysis communities
NINJA Waveform Data
126 injections were made into ~ 30 hours of data.
9 data analysis groups analyzed the data using a variety of algorithms. Burst searches, inspiral searches and parameter estimation were performed.

Data analysis groups decide what analysis to perform and how to present the results.

Guidelines for NINJA analysis contributions:

- The use of different kinds of data analysis algorithms was encouraged
- Format of results was left to the contributing groups
- Encouraged comparisons between methods, where possible
LSC-Virgo CBC Matched-filter search

- Standard “low mass” search (Cardiff, UWM)
- Extended stationary-phase templates (Cardiff, Syracuse)
- Effective One Body inspiral-merger-ringdown templates (Cardiff, Maryland)
- Phenomenological inspiral-merger-ringdown templates (AEI)
Banks used by Inspiral Searches and NINJA signals
## Summary of inspiral results

<table>
<thead>
<tr>
<th>Search</th>
<th>“Low mass” CBC</th>
<th>2 pN TaylorF2 ISCO</th>
<th>3.5 pN TaylorF2 ERD</th>
<th>EOBNR waveforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template Bank Range (solar masses)</td>
<td>2 &lt; M &lt; 35</td>
<td>20 &lt; M &lt; 90</td>
<td>20 &lt; M &lt; 90</td>
<td>30 &lt; M &lt; 200</td>
</tr>
<tr>
<td>Coincident Candidates</td>
<td>48</td>
<td>59</td>
<td>81</td>
<td>85</td>
</tr>
</tbody>
</table>
# Summary of inspiral results II

<table>
<thead>
<tr>
<th>Search</th>
<th>3.5 pN TaylorF2 “WRD”</th>
<th>3.5 pN TaylorF2 “WRD”</th>
<th>EOB Lightring ERD</th>
<th>Phenom. waveforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template Bank Range (solar masses)</td>
<td>$20 &lt; M &lt; 90$</td>
<td>$20 &lt; M &lt; 90$</td>
<td>$20 &lt; M &lt; 90$</td>
<td>$40 &lt; M &lt; 160$</td>
</tr>
<tr>
<td>Coincident Candidates</td>
<td>81</td>
<td>81</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>
The NINJA project has been a great success

Data analysts and numerical relativists are communicating and working together

This is only a first step, however...

The limited scope of the first NINJA project makes it dangerous to draw too many conclusions about the performance of searches
Next Steps

• We have begin discussing a follow-on NINJA analysis to broaden the scope of the project:

• Expanding the waveform parameter space

• Stitching of PN waveforms onto NR data

• Data containing non-Gaussian noise transients

• Lots more work needs to be done!