

Introduction

In this document, I'll walk through my findings from implementing a GRU and LSTM with various different types of embeddings. Please see the `main.ipynb` file for my implementation.

To recap, I implemented two types of models, Gated Recurrent Units (GRUs) and Long Short-Term Memory networks (LSTMs). I also implemented two main types of embeddings, a word2vec embedding and a BERT embedding (in four different languages).

The dataset I used contained spam and ham (not spam) text in four languages: English, Hindi, French, and German. My goal was to train the models to most accurately predict the language of the text.

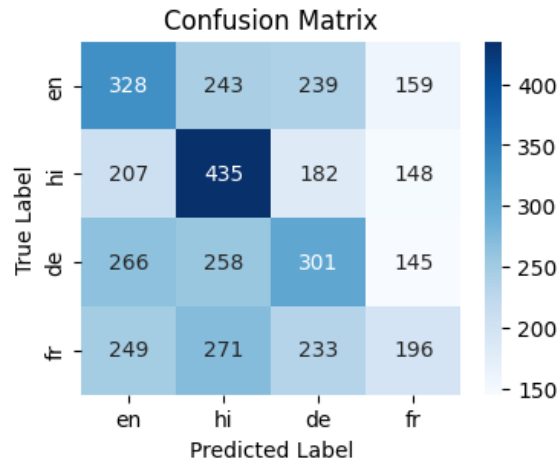
Discussion

See the bottom of the discussion for a table with all results. It was too long to put it before the discussion.

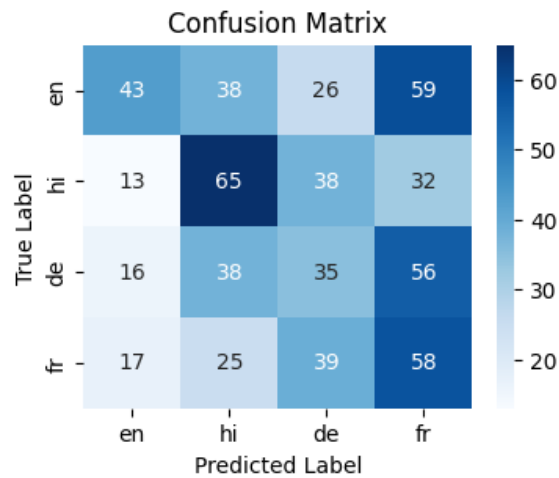
Overall, I found that both the GRU and the LSTM models did a very good job at classifying the entire dataset and the ham dataset when combined with the Word2Vec embeddings. Interestingly, the GRU model did a significantly worse job at differentiating between English and French spam text. In comparison to the LSTM, the GRU model had an accuracy of 0.79 in comparison to the LSTM's accuracy of 0.96. This surprised me because I had read online that GRUs sometimes did better with smaller datasets. LSTMs, however, probably do a better job at understanding the longer dependencies required to distinguish between the two languages.

What was most interesting was how drastically BERT embeddings trained in different languages changed the results. The English BERT embeddings did terribly across the board, with accuracies for GRU and LSTM at around 0.4. However, the English BERT embeddings did clearly distinguish between Hindi and non-Hindi languages. This isn't super surprising, but stresses the importance of having relevant training data.

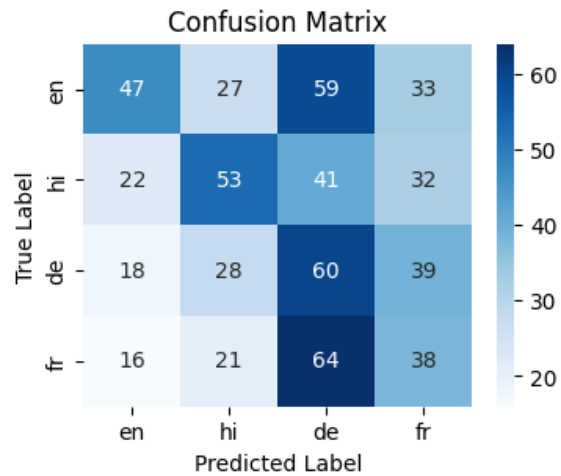
The French BERT Embeddings did even worse, with accuracies around 0.3. What was most interesting was how badly they predicted French language, specifically. Take this confusion matrix from French BERT Embeddings and GRU for ham for example.



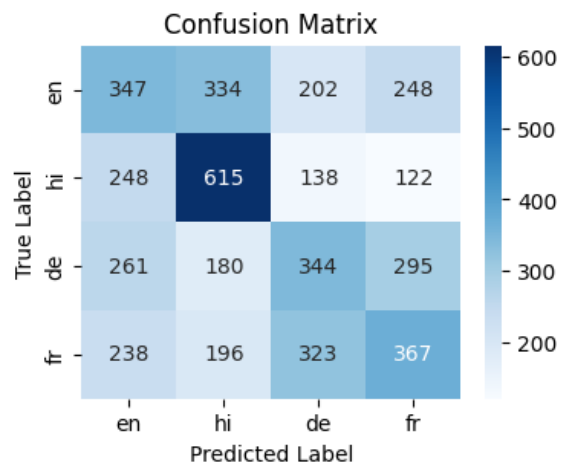
Interestingly, the confusion matrix from French BERT Embeddings and GRU for spam were significantly different.



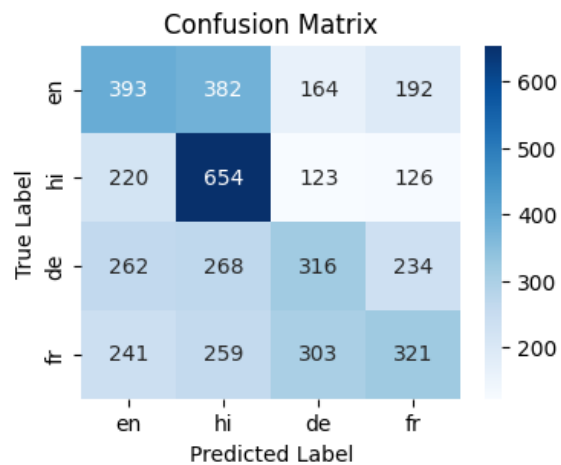
For the ham text, the French BERT Embeddings and GRU seemed almost biased against the French language, whereas, for the spam text, the French BERT Embeddings and GRU did a significantly better job. Interestingly, the LSTM model for the French BERT embedding led similar results, but was biased towards the German language.



Unsurprisingly, the Hindi BERT Embeddings did best at recognizing Hindi text, for both the GRU and LSTM models.

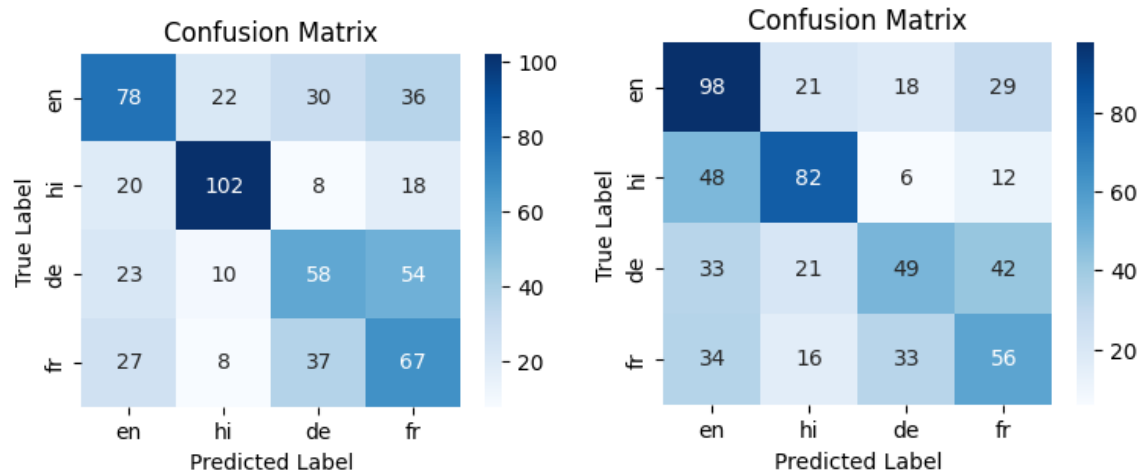


GRU



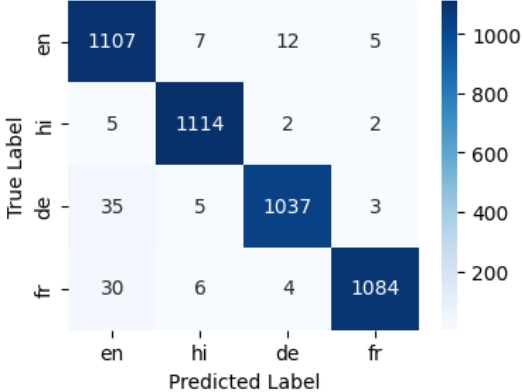
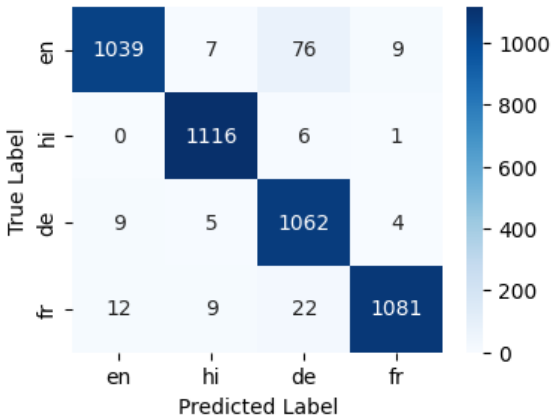
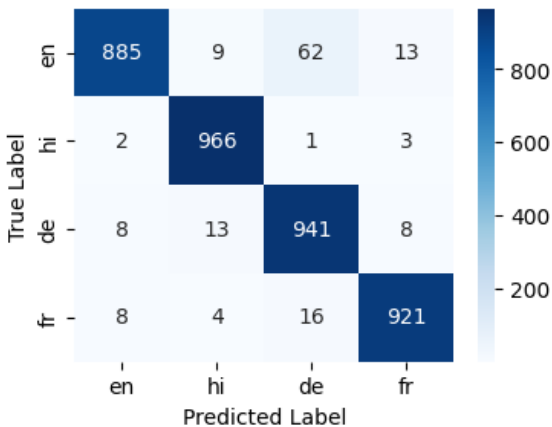
LSTM

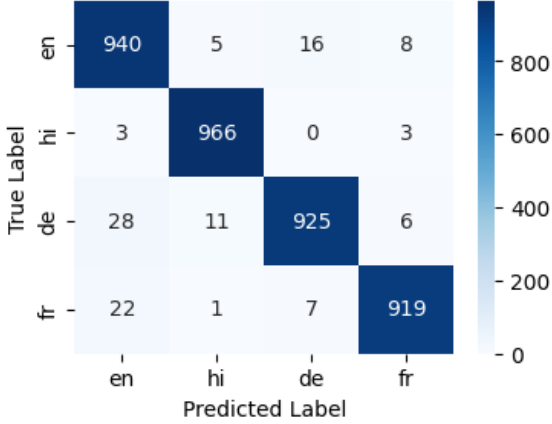
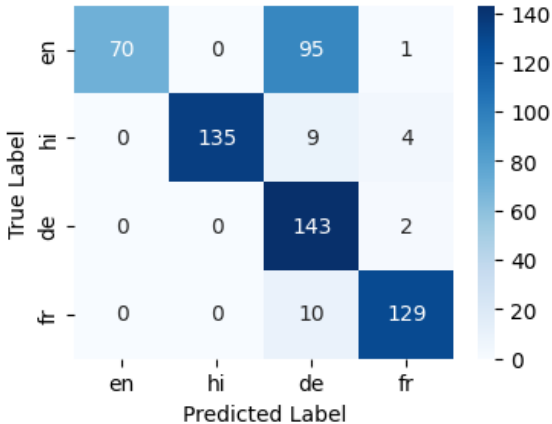
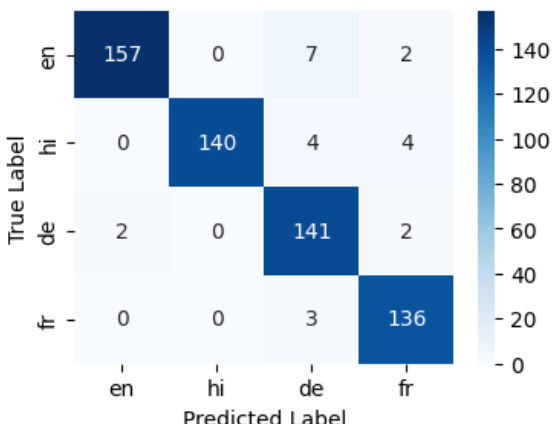
It was interesting that both models did relatively well recognizing the spam text. This may simply be due to the smaller testing size.

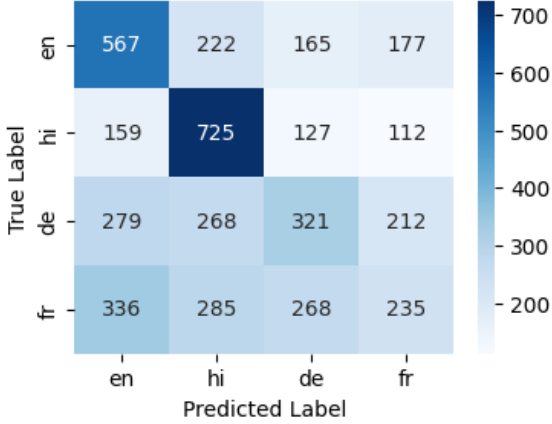
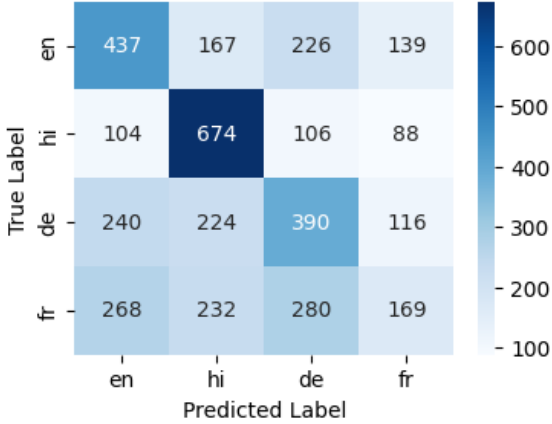
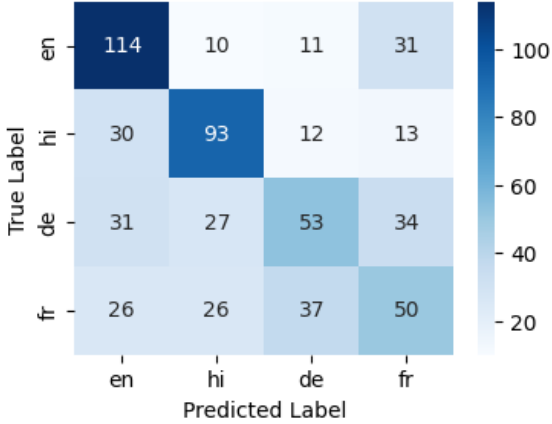


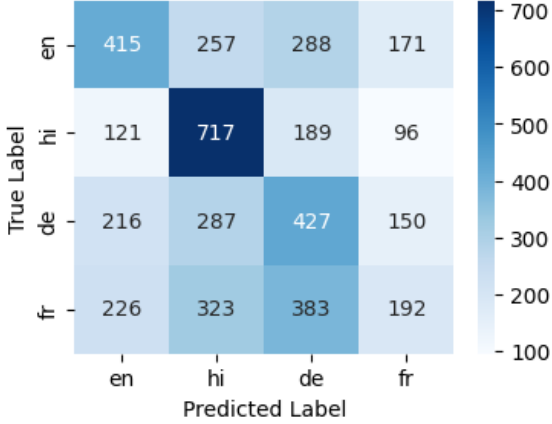
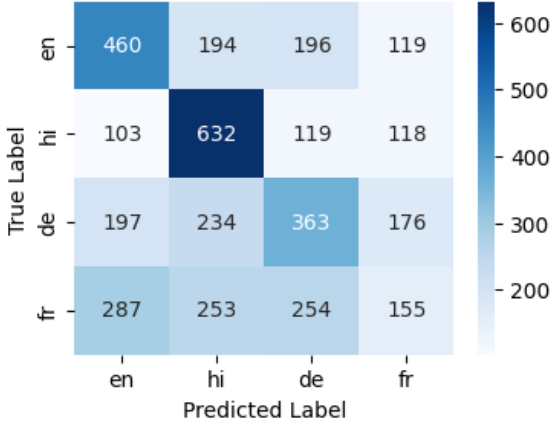
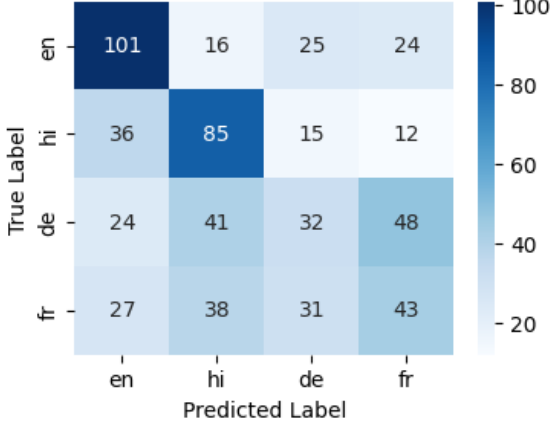
Finally, it was interesting to find that the German BERT Embeddings with both the GRU and LSTM did the best across the board for the language-specific BERT Embeddings. The embeddings had between 0.43 and 0.49 accuracy. While this was significantly worse than the Word2Vec embeddings, they were by far higher than the other BERT Embeddings. My hypothesis for why this is the case is that, while French and English are relatively similar syntactically and semantic words are similar, German's grammar structure is dramatically different. While it is still very different from Hindi, it sits at more of a middle ground and thus could classify the spam and ham text relatively better.

Results

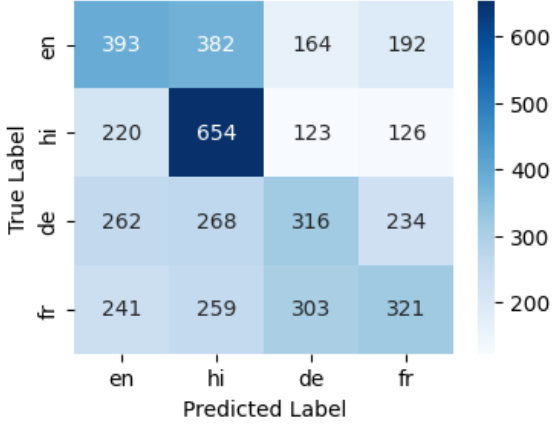
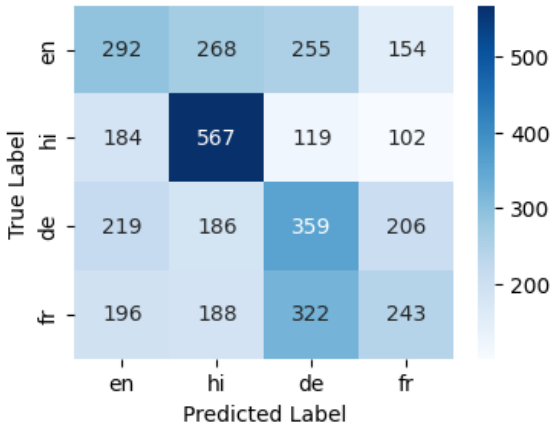
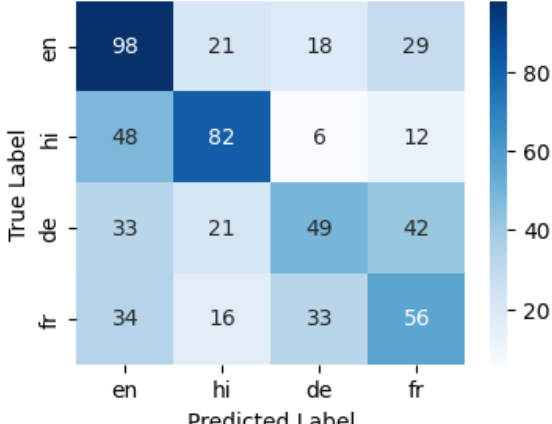
Dataset	Embeddings	Model	Confusion Matrix	Accuracy																									
Entire Dataset	Word2Vec	GRU	<p>Confusion Matrix</p>  <table border="1"> <thead> <tr> <th>True Label \ Predicted Label</th><th>en</th><th>hi</th><th>de</th><th>fr</th></tr> </thead> <tbody> <tr> <th>en</th><td>1107</td><td>7</td><td>12</td><td>5</td></tr> <tr> <th>hi</th><td>5</td><td>1114</td><td>2</td><td>2</td></tr> <tr> <th>de</th><td>35</td><td>5</td><td>1037</td><td>3</td></tr> <tr> <th>fr</th><td>30</td><td>6</td><td>4</td><td>1084</td></tr> </tbody> </table>	True Label \ Predicted Label	en	hi	de	fr	en	1107	7	12	5	hi	5	1114	2	2	de	35	5	1037	3	fr	30	6	4	1084	Accuracy: 0.97397935 Precision: 0.99268514 Recall: 0.97896004
True Label \ Predicted Label	en	hi	de	fr																									
en	1107	7	12	5																									
hi	5	1114	2	2																									
de	35	5	1037	3																									
fr	30	6	4	1084																									
Entire Dataset	Word2Vec	LSTM	<p>Confusion Matrix</p>  <table border="1"> <thead> <tr> <th>True Label \ Predicted Label</th><th>en</th><th>hi</th><th>de</th><th>fr</th></tr> </thead> <tbody> <tr> <th>en</th><td>1039</td><td>7</td><td>76</td><td>9</td></tr> <tr> <th>hi</th><td>0</td><td>1116</td><td>6</td><td>1</td></tr> <tr> <th>de</th><td>9</td><td>5</td><td>1062</td><td>4</td></tr> <tr> <th>fr</th><td>12</td><td>9</td><td>22</td><td>1081</td></tr> </tbody> </table>	True Label \ Predicted Label	en	hi	de	fr	en	1039	7	76	9	hi	0	1116	6	1	de	9	5	1062	4	fr	12	9	22	1081	Accuracy: 0.9641095 Precision: 0.97292525 Recall: 0.993688
True Label \ Predicted Label	en	hi	de	fr																									
en	1039	7	76	9																									
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True Label \ Predicted Label	en	hi	de	fr																									
en	885	9	62	13																									
hi	2	966	1	3																									
de	8	13	941	8																									
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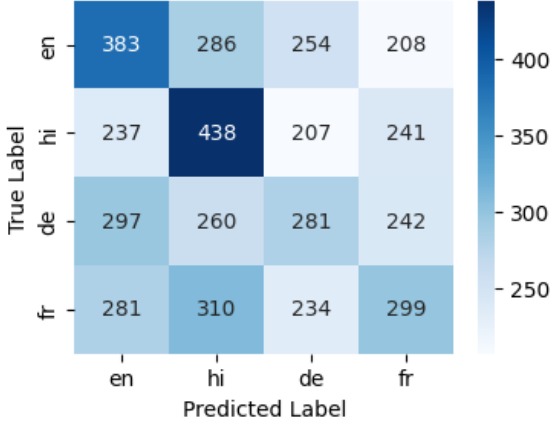
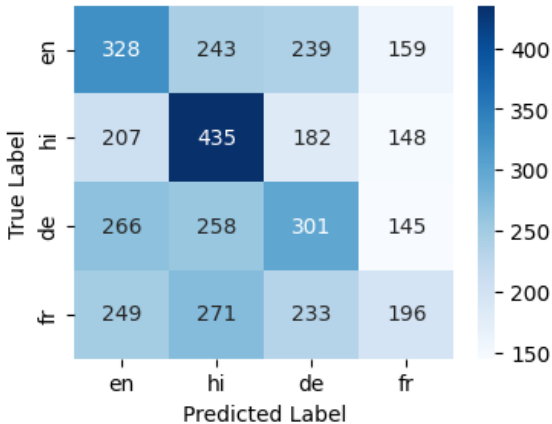
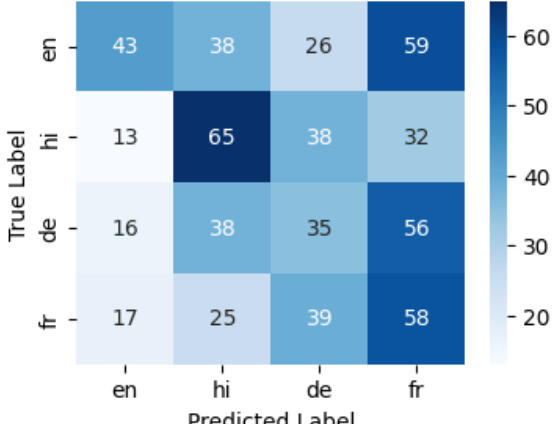
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hi	3	966	0	3																				
de	28	11	925	6																				
fr	22	1	7	919																				
Spam	Word2Vec	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>70</td><td>0</td><td>95</td><td>1</td></tr><tr><td>hi</td><td>0</td><td>135</td><td>9</td><td>4</td></tr><tr><td>de</td><td>0</td><td>0</td><td>143</td><td>2</td></tr><tr><td>fr</td><td>0</td><td>0</td><td>10</td><td>129</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	70	0	95	1	hi	0	135	9	4	de	0	0	143	2	fr	0	0	10	129	Accuracy: 0.79765886 Precision: 0.8181818 Recall: 1.0
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hi	0	135	9	4																				
de	0	0	143	2																				
fr	0	0	10	129																				
Spam	Word2Vec	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>157</td><td>0</td><td>7</td><td>2</td></tr><tr><td>hi</td><td>0</td><td>140</td><td>4</td><td>4</td></tr><tr><td>de</td><td>2</td><td>0</td><td>141</td><td>2</td></tr><tr><td>fr</td><td>0</td><td>0</td><td>3</td><td>136</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	157	0	7	2	hi	0	140	4	4	de	2	0	141	2	fr	0	0	3	136	Accuracy: 0.9598662 Precision: 0.97949886 Recall: 0.9953704
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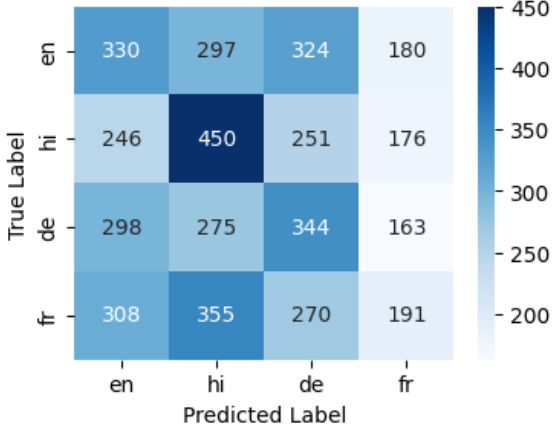
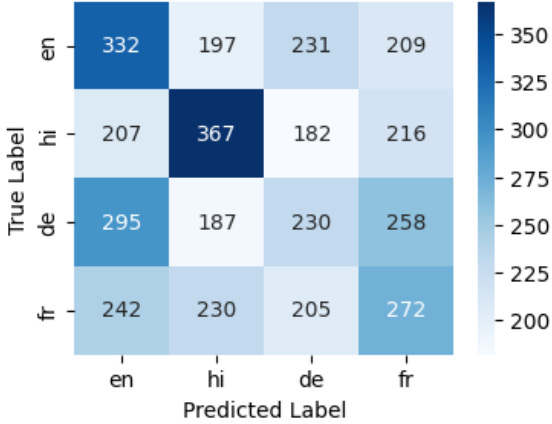
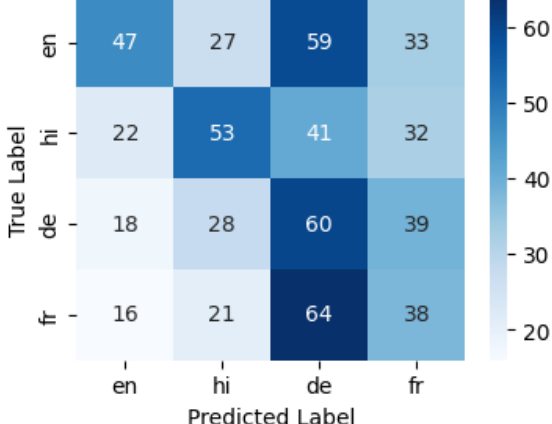
Original	English BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>567</td><td>222</td><td>165</td><td>177</td></tr><tr><td>hi</td><td>159</td><td>725</td><td>127</td><td>112</td></tr><tr><td>de</td><td>279</td><td>268</td><td>321</td><td>212</td></tr><tr><td>fr</td><td>336</td><td>285</td><td>268</td><td>235</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	567	222	165	177	hi	159	725	127	112	de	279	268	321	212	fr	336	285	268	235	Accuracy: 0.41453567 Precision: 0.8190568 Recall: 0.767358
en	567	222	165	177																				
hi	159	725	127	112																				
de	279	268	321	212																				
fr	336	285	268	235																				
Ham	English BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>437</td><td>167</td><td>226</td><td>139</td></tr><tr><td>hi</td><td>104</td><td>674</td><td>106</td><td>88</td></tr><tr><td>de</td><td>240</td><td>224</td><td>390</td><td>116</td></tr><tr><td>fr</td><td>268</td><td>232</td><td>280</td><td>169</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	437	167	226	139	hi	104	674	106	88	de	240	224	390	116	fr	268	232	280	169	Accuracy: 0.4326425 Precision: 0.8107435 Recall: 0.78830856
en	437	167	226	139																				
hi	104	674	106	88																				
de	240	224	390	116																				
fr	268	232	280	169																				
Spam	English BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>114</td><td>10</td><td>11</td><td>31</td></tr><tr><td>hi</td><td>30</td><td>93</td><td>12</td><td>13</td></tr><tr><td>de</td><td>31</td><td>27</td><td>53</td><td>34</td></tr><tr><td>fr</td><td>26</td><td>26</td><td>37</td><td>50</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	114	10	11	31	hi	30	93	12	13	de	31	27	53	34	fr	26	26	37	50	Accuracy: 0.51839465 Precision: 0.86901766 Recall: 0.7986111
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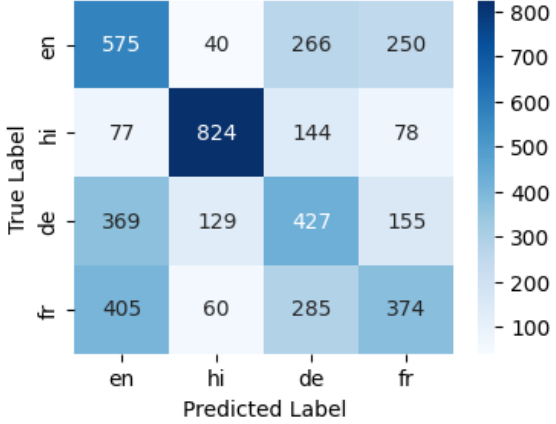
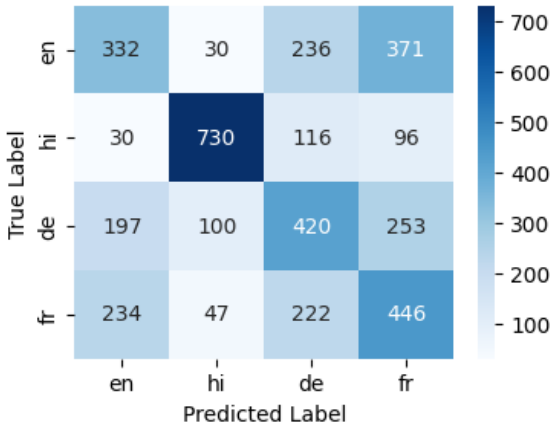
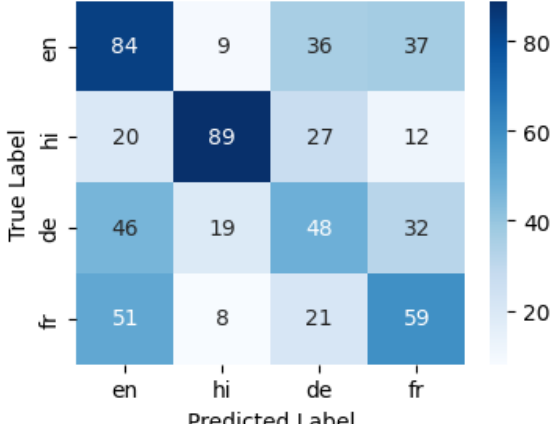
Original	English BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>415</td><td>257</td><td>288</td><td>171</td></tr><tr><td>hi</td><td>121</td><td>717</td><td>189</td><td>96</td></tr><tr><td>de</td><td>216</td><td>287</td><td>427</td><td>150</td></tr><tr><td>fr</td><td>226</td><td>323</td><td>383</td><td>192</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	415	257	288	171	hi	121	717	189	96	de	216	287	427	150	fr	226	323	383	192	Accuracy: 0.39277703 Precision: 0.7942529 Recall: 0.8307785
en	415	257	288	171																				
hi	121	717	189	96																				
de	216	287	427	150																				
fr	226	323	383	192																				
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en	460	194	196	119																				
hi	103	632	119	118																				
de	197	234	363	176																				
fr	287	253	254	155																				
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hi	36	85	15	12																				
de	24	41	32	48																				
fr	27	38	31	43																				

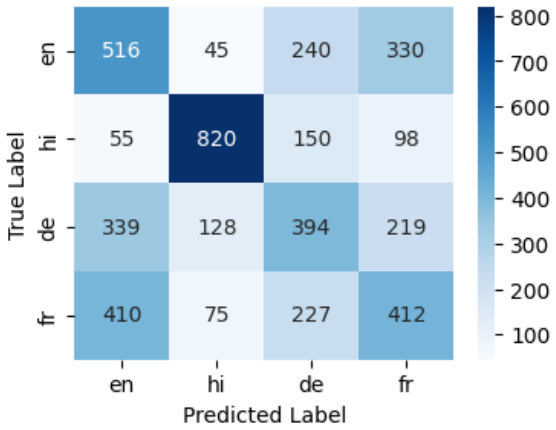
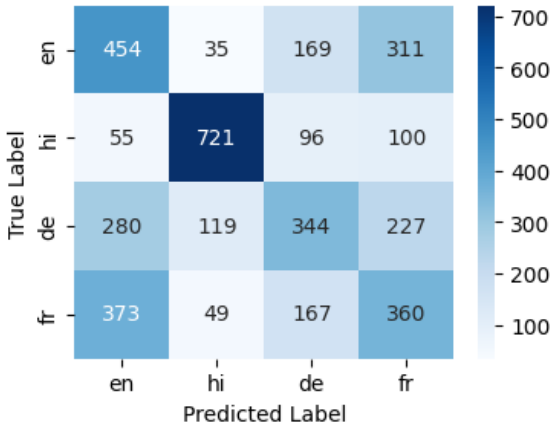
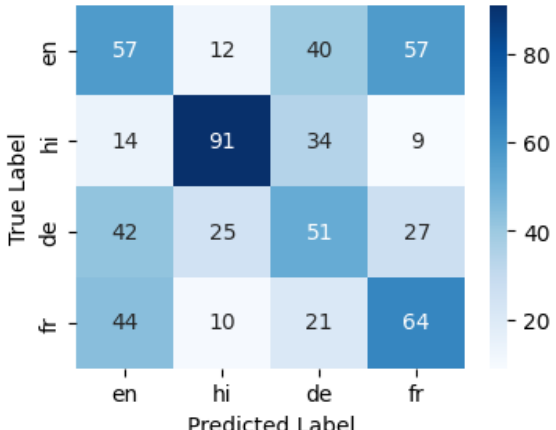
Original	Hindi BERT	GRU	<div><p>Confusion Matrix</p><table><tr><td>en</td><td>347</td><td>334</td><td>202</td><td>248</td></tr><tr><td>hi</td><td>248</td><td>615</td><td>138</td><td>122</td></tr><tr><td>de</td><td>261</td><td>180</td><td>344</td><td>295</td></tr><tr><td>fr</td><td>238</td><td>196</td><td>323</td><td>367</td></tr></table><p>True Label</p><p>Predicted Label</p></div>	en	347	334	202	248	hi	248	615	138	122	de	261	180	344	295	fr	238	196	323	367	Accuracy: 0.37528038 Precision: 0.7669441 Recall: 0.7754734
en	347	334	202	248																				
hi	248	615	138	122																				
de	261	180	344	295																				
fr	238	196	323	367																				
Ham	Hindi BERT	GRU	<div><p>Confusion Matrix</p><table><tr><td>en</td><td>325</td><td>282</td><td>152</td><td>210</td></tr><tr><td>hi</td><td>218</td><td>580</td><td>68</td><td>106</td></tr><tr><td>de</td><td>259</td><td>198</td><td>248</td><td>265</td></tr><tr><td>fr</td><td>227</td><td>211</td><td>218</td><td>293</td></tr></table><p>True Label</p><p>Predicted Label</p></div>	en	325	282	152	210	hi	218	580	68	106	de	259	198	248	265	fr	227	211	218	293	Accuracy: 0.3746114 Precision: 0.7725185 Recall: 0.75648564
en	325	282	152	210																				
hi	218	580	68	106																				
de	259	198	248	265																				
fr	227	211	218	293																				
Spam	Hindi BERT	GRU	<div><p>Confusion Matrix</p><table><tr><td>en</td><td>78</td><td>22</td><td>30</td><td>36</td></tr><tr><td>hi</td><td>20</td><td>102</td><td>8</td><td>18</td></tr><tr><td>de</td><td>23</td><td>10</td><td>58</td><td>54</td></tr><tr><td>fr</td><td>27</td><td>8</td><td>37</td><td>67</td></tr></table><p>True Label</p><p>Predicted Label</p></div>	en	78	22	30	36	hi	20	102	8	18	de	23	10	58	54	fr	27	8	37	67	Accuracy: 0.5100334 Precision: 0.80444443 Recall: 0.837963
en	78	22	30	36																				
hi	20	102	8	18																				
de	23	10	58	54																				
fr	27	8	37	67																				

Original	Hindi BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>393</td><td>382</td><td>164</td><td>192</td></tr><tr><td>hi</td><td>220</td><td>654</td><td>123</td><td>126</td></tr><tr><td>de</td><td>262</td><td>268</td><td>316</td><td>234</td></tr><tr><td>fr</td><td>241</td><td>259</td><td>303</td><td>321</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	393	382	164	192	hi	220	654	123	126	de	262	268	316	234	fr	241	259	303	321	Accuracy: 0.37774786 Precision: 0.77917415 Recall: 0.7826871
en	393	382	164	192																				
hi	220	654	123	126																				
de	262	268	316	234																				
fr	241	259	303	321																				
Ham	Hindi BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>292</td><td>268</td><td>255</td><td>154</td></tr><tr><td>hi</td><td>184</td><td>567</td><td>119</td><td>102</td></tr><tr><td>de</td><td>219</td><td>186</td><td>359</td><td>206</td></tr><tr><td>fr</td><td>196</td><td>188</td><td>322</td><td>243</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	292	268	255	154	hi	184	567	119	102	de	219	186	359	206	fr	196	188	322	243	Accuracy: 0.37849742 Precision: 0.77197707 Recall: 0.79280525
en	292	268	255	154																				
hi	184	567	119	102																				
de	219	186	359	206																				
fr	196	188	322	243																				
Spam	Hindi BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>98</td><td>21</td><td>18</td><td>29</td></tr><tr><td>hi</td><td>48</td><td>82</td><td>6</td><td>12</td></tr><tr><td>de</td><td>33</td><td>21</td><td>49</td><td>42</td></tr><tr><td>fr</td><td>34</td><td>16</td><td>33</td><td>56</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	98	21	18	29	hi	48	82	6	12	de	33	21	49	42	fr	34	16	33	56	Accuracy: 0.47658864 Precision: 0.8233766 Recall: 0.7337963
en	98	21	18	29																				
hi	48	82	6	12																				
de	33	21	49	42																				
fr	34	16	33	56																				

Original	French BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>383</td><td>286</td><td>254</td><td>208</td></tr><tr><td>hi</td><td>237</td><td>438</td><td>207</td><td>241</td></tr><tr><td>de</td><td>297</td><td>260</td><td>281</td><td>242</td></tr><tr><td>fr</td><td>281</td><td>310</td><td>234</td><td>299</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	383	286	254	208	hi	237	438	207	241	de	297	260	281	242	fr	281	310	234	299	Accuracy: 0.31426647 Precision: 0.77055216 Recall: 0.75503457
en	383	286	254	208																				
hi	237	438	207	241																				
de	297	260	281	242																				
fr	281	310	234	299																				
Ham	French BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>328</td><td>243</td><td>239</td><td>159</td></tr><tr><td>hi</td><td>207</td><td>435</td><td>182</td><td>148</td></tr><tr><td>de</td><td>266</td><td>258</td><td>301</td><td>145</td></tr><tr><td>fr</td><td>249</td><td>271</td><td>233</td><td>196</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	328	243	239	159	hi	207	435	182	148	de	266	258	301	145	fr	249	271	233	196	Accuracy: 0.32642487 Precision: 0.7718861 Recall: 0.7502594
en	328	243	239	159																				
hi	207	435	182	148																				
de	266	258	301	145																				
fr	249	271	233	196																				
Spam	French BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>43</td><td>38</td><td>26</td><td>59</td></tr><tr><td>hi</td><td>13</td><td>65</td><td>38</td><td>32</td></tr><tr><td>de</td><td>16</td><td>38</td><td>35</td><td>56</td></tr><tr><td>fr</td><td>17</td><td>25</td><td>39</td><td>58</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	43	38	26	59	hi	13	65	38	32	de	16	38	35	56	fr	17	25	39	58	Accuracy: 0.3361204 Precision: 0.7583497 Recall: 0.8935185
en	43	38	26	59																				
hi	13	65	38	32																				
de	16	38	35	56																				
fr	17	25	39	58																				

Original	French BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>330</td><td>297</td><td>324</td><td>180</td></tr><tr><td>hi</td><td>246</td><td>450</td><td>251</td><td>176</td></tr><tr><td>de</td><td>298</td><td>275</td><td>344</td><td>163</td></tr><tr><td>fr</td><td>308</td><td>355</td><td>270</td><td>191</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	330	297	324	180	hi	246	450	251	176	de	298	275	344	163	fr	308	355	270	191	Accuracy: 0.2949753 Precision: 0.75549453 Recall: 0.7439134
en	330	297	324	180																				
hi	246	450	251	176																				
de	298	275	344	163																				
fr	308	355	270	191																				
Ham	French BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>332</td><td>197</td><td>231</td><td>209</td></tr><tr><td>hi</td><td>207</td><td>367</td><td>182</td><td>216</td></tr><tr><td>de</td><td>295</td><td>187</td><td>230</td><td>258</td></tr><tr><td>fr</td><td>242</td><td>230</td><td>205</td><td>272</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	332	197	231	209	hi	207	367	182	216	de	295	187	230	258	fr	242	230	205	272	Accuracy: 0.31113988 Precision: 0.77119255 Recall: 0.7426496
en	332	197	231	209																				
hi	207	367	182	216																				
de	295	187	230	258																				
fr	242	230	205	272																				
Spam	French BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>47</td><td>27</td><td>59</td><td>33</td></tr><tr><td>hi</td><td>22</td><td>53</td><td>41</td><td>32</td></tr><tr><td>de</td><td>18</td><td>28</td><td>60</td><td>39</td></tr><tr><td>fr</td><td>16</td><td>21</td><td>64</td><td>38</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	47	27	59	33	hi	22	53	41	32	de	18	28	60	39	fr	16	21	64	38	Accuracy: 0.33110368 Precision: 0.75959593 Recall: 0.8703704
en	47	27	59	33																				
hi	22	53	41	32																				
de	18	28	60	39																				
fr	16	21	64	38																				

Original	German BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>575</td><td>40</td><td>266</td><td>250</td></tr><tr><td>hi</td><td>77</td><td>824</td><td>144</td><td>78</td></tr><tr><td>de</td><td>369</td><td>129</td><td>427</td><td>155</td></tr><tr><td>fr</td><td>405</td><td>60</td><td>285</td><td>374</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	575	40	266	250	hi	77	824	144	78	de	369	129	427	155	fr	405	60	285	374	Accuracy: 0.49349484 Precision: 0.8166227 Recall: 0.744214
en	575	40	266	250																				
hi	77	824	144	78																				
de	369	129	427	155																				
fr	405	60	285	374																				
Ham	German BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>332</td><td>30</td><td>236</td><td>371</td></tr><tr><td>hi</td><td>30</td><td>730</td><td>116</td><td>96</td></tr><tr><td>de</td><td>197</td><td>100</td><td>420</td><td>253</td></tr><tr><td>fr</td><td>234</td><td>47</td><td>222</td><td>446</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	332	30	236	371	hi	30	730	116	96	de	197	100	420	253	fr	234	47	222	446	Accuracy: 0.49948186 Precision: 0.7923052 Recall: 0.84053963
en	332	30	236	371																				
hi	30	730	116	96																				
de	197	100	420	253																				
fr	234	47	222	446																				
Spam	German BERT	GRU	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>84</td><td>9</td><td>36</td><td>37</td></tr><tr><td>hi</td><td>20</td><td>89</td><td>27</td><td>12</td></tr><tr><td>de</td><td>46</td><td>19</td><td>48</td><td>32</td></tr><tr><td>fr</td><td>51</td><td>8</td><td>21</td><td>59</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	84	9	36	37	hi	20	89	27	12	de	46	19	48	32	fr	51	8	21	59	Accuracy: 0.46822742 Precision: 0.7934509 Recall: 0.7291667
en	84	9	36	37																				
hi	20	89	27	12																				
de	46	19	48	32																				
fr	51	8	21	59																				

Original	German BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>516</td><td>45</td><td>240</td><td>330</td></tr><tr><td>hi</td><td>55</td><td>820</td><td>150</td><td>98</td></tr><tr><td>de</td><td>339</td><td>128</td><td>394</td><td>219</td></tr><tr><td>fr</td><td>410</td><td>75</td><td>227</td><td>412</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	516	45	240	330	hi	55	820	150	98	de	339	128	394	219	fr	410	75	227	412	Accuracy: 0.48048452 Precision: 0.8040153 Recall: 0.75834084
en	516	45	240	330																				
hi	55	820	150	98																				
de	339	128	394	219																				
fr	410	75	227	412																				
Ham	German BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>454</td><td>35</td><td>169</td><td>311</td></tr><tr><td>hi</td><td>55</td><td>721</td><td>96</td><td>100</td></tr><tr><td>de</td><td>280</td><td>119</td><td>344</td><td>227</td></tr><tr><td>fr</td><td>373</td><td>49</td><td>167</td><td>360</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	454	35	169	311	hi	55	721	96	100	de	280	119	344	227	fr	373	49	167	360	Accuracy: 0.48678756 Precision: 0.80911785 Recall: 0.75510204
en	454	35	169	311																				
hi	55	721	96	100																				
de	280	119	344	227																				
fr	373	49	167	360																				
Spam	German BERT	LSTM	<p>Confusion Matrix</p>  <table><tr><td>en</td><td>57</td><td>12</td><td>40</td><td>57</td></tr><tr><td>hi</td><td>14</td><td>91</td><td>34</td><td>9</td></tr><tr><td>de</td><td>42</td><td>25</td><td>51</td><td>27</td></tr><tr><td>fr</td><td>44</td><td>10</td><td>21</td><td>64</td></tr></table> <p>True Label</p> <p>Predicted Label</p>	en	57	12	40	57	hi	14	91	34	9	de	42	25	51	27	fr	44	10	21	64	Accuracy: 0.43979934 Precision: 0.75283444 Recall: 0.7685185
en	57	12	40	57																				
hi	14	91	34	9																				
de	42	25	51	27																				
fr	44	10	21	64																				

