

A Comprehensive Analysis of Static Word Embeddings for Turkish

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Detailed Intrinsic Analysis Results

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| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|------------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.288 | 0.439 | 0.339 | 29.68% |
| 2. tekil kiři çekimi.txt | 946 | 0.411 | 0.323 | 0.365 | -11.48% |
| 2. çoęul kiři çekimi.txt | 946 | 0.349 | 0.398 | 0.327 | 21.94% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.419 | 0.372 | 0.42 | -11.22% |
| emir kipi.txt | 1176 | 0.187 | 0.632 | 0.465 | 36.06% |
| gelecek zaman kipi.txt | 1176 | 0.105 | 0.801 | 0.707 | 13.37% |
| gereklilik kipi.txt | 1128 | 0.232 | 0.561 | 0.467 | 20.19% |
| geçmiş zaman eki (-di).txt | 1176 | 0.225 | 0.622 | 0.535 | 16.25% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.088 | 0.799 | 0.774 | 3.32% |
| istek kipi.txt | 1176 | 0.249 | 0.582 | 0.534 | 8.97% |
| olumsuzluk eki.txt | 1176 | 0.137 | 0.642 | 0.67 | -4.08% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.132 | 0.749 | 0.646 | 15.99% |
| şimdiki zaman eki (-yor).txt | 861 | 0.077 | 0.874 | 0.847 | 3.26% |
| Overall | 14231 | 0.220 | 0.604 | 0.549 | 10.02% |

Table 1: *Fil çekim ekleri*: MRR Result Comparison for **Word2Vec** with 5 epochs

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| Aile | 90 | 0.289 | 0.526 |
| Para birimi | 156 | 0.730 | 0.149 |
| Şehir-bölge | 1344 | 0.092 | 0.605 |
| Ülke-başkent | 506 | 0.081 | 0.656 |
| Eş anlamlılar | 600 | 0.4 | 0.467 |
| Zıt anlamlılar | 600 | 0.336 | 0.448 |
| Overall | 3296 | 0.226 | 0.535 |

Table 2: *Semantic categories*: MRR Results of **Word2Vec** with 5 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 83.80 | p-value: 6.83×10^{-21} |
| | Spearman Result: 82.57 | p-value: 7.98×10^{-20} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 70.72 | p-value: 6.38×10^{-57} |
| | Spearman Result: 74.33 | p-value: 9.93×10^{-66} |
| | OOV Ratio: 26.6 | |

Table 3: Similarity test results for **Word2Vec** with 5 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|----------------------------|--------------------|------------------|-------|---------------|---------------------------------------|
| Şimdiki zaman eki (-yor) | 861 | 0.067 | 0.884 | 0.847 | 4.37% |
| geçmiş zaman eki (-miş) | 1176 | 0.086 | 0.808 | 0.774 | 4.39% |
| Gelecek zaman eki | 1176 | 0.109 | 0.792 | 0.707 | 12.05% |
| Olumsuzluk eki | 1176 | 0.136 | 0.651 | 0.67 | -2.83% |
| Şimdiki zaman eki (-mekte) | 1176 | 0.115 | 0.760 | 0.646 | 17.65% |
| Geçmiş zaman eki (-di) | 1176 | 0.220 | 0.633 | 0.535 | 18.32% |
| İstek kipi | 1176 | 0.237 | 0.593 | 0.534 | 11.02% |
| Gereklilik kipi | 1128 | 0.238 | 0.575 | 0.467 | 23.10% |
| Emir kipi | 1176 | 0.193 | 0.643 | 0.465 | 38.29% |
| 3. çoęul kiři çekimi | 1128 | 0.392 | 0.388 | 0.42 | -7.61% |
| 2. tekil kiři çekimi | 946 | 0.426 | 0.315 | 0.365 | -13.70% |
| 1. tekil kiři çekimi | 990 | 0.311 | 0.426 | 0.339 | 25.66% |
| 2. çoęul kiři çekimi | 946 | 0.358 | 0.380 | 0.327 | 16.20% |
| Overall | 14231 | 0.219 | 0.609 | 0.549 | 10.96% |

Table 4: *Fil çekim ekleri*: MRR Result Comparison for **Word2Vec** with 10 epochs

| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|------------------|--------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.502 | 0.30 | 0.238 | 26.26% |
| -e eki.txt | 1176 | 0.516 | 0.271 | 0.236 | 14.92% |
| 1. tekil kişi iyelik.txt | 1128 | 0.640 | 0.221 | 0.148 | 49.60% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.505 | 0.343 | 0.25 | 37.44% |
| 2. tekil kişi iyelik.txt | 1176 | 0.568 | 0.317 | 0.321 | -1.13% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.555 | 0.299 | 0.196 | 52.75% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.321 | 0.437 | 0.448 | -2.37% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.484 | 0.228 | 0.178 | 28.40% |
| eşitlik eki (-ce).txt | 276 | 0.945 | 0.0345 | 0.027 | 27.84% |
| ismin -de hali.txt | 1128 | 0.709 | 0.137 | 0.136 | 0.83% |
| ismin -i hali.txt | 1176 | 0.337 | 0.439 | 0.439 | 0.18% |
| tamlayan eki.txt | 1176 | 0.275 | 0.539 | 0.488 | 10.61% |
| vasıta eki (-le).txt | 1128 | 0.454 | 0.337 | 0.253 | 33.32% |
| Overall | 14005 | 0.510 | 0.318 | 0.274 | 16.11% |

Table 5: *İsim çekim ekleri*: MRR Result Comparison for **Word2Vec** with 5 epochs

| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------|--------------------|------------------|-------|---------------|---------------------------------------|
| Tamlayan eki | 1176 | 0.252 | 0.548 | 0.488 | 12.30% |
| 3. tekil kişi iyelik eki | 1176 | 0.292 | 0.467 | 0.448 | 4.24% |
| İsmin -i hali | 1176 | 0.325 | 0.454 | 0.439 | 3.42% |
| 2. tekil kişi iyelik eki | 1176 | 0.552 | 0.322 | 0.321 | 0.31% |
| Vasıta eki (-le) | 1128 | 0.437 | 0.355 | 0.253 | 40.16% |
| 1. çoğul kişi iyelik eki | 1128 | 0.498 | 0.358 | 0.25 | 43.2% |
| -den eki | 1128 | 0.481 | 0.316 | 0.238 | 32.77% |
| -e eki | 1176 | 0.480 | 0.293 | 0.236 | 23.98% |
| 2. çoğul kişi iyelik eki | 1081 | 0.546 | 0.288 | 0.196 | 46.88% |
| 3. çoğul kişi iyelik eki | 1128 | 0.466 | 0.245 | 0.178 | 37.64% |
| 1. tekil kişi iyelik eki | 1128 | 0.654 | 0.216 | 0.148 | 45.95% |
| İsmin -de hali | 1128 | 0.683 | 0.148 | 0.136 | 8.70% |
| Eşitlik eki (-ce) | 276 | 0.956 | 0.028 | 0.027 | 3.70% |
| Overall | 14005 | 0.479 | 0.329 | 0.273 | 20.51% |

Table 6: *İsim çekim ekleri*: MRR Result Comparison for **Word2Vec** with 10 epochs

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| Aile | 90 | 0.256 | 0.571 |
| Para birimi | 156 | 0.724 | 0.181 |
| Şehir-bölge | 1344 | 0.083 | 0.622 |
| Ülke-başkent | 506 | 0.045 | 0.683 |
| Eş anlamlılar | 600 | 0.385 | 0.476 |
| Zıt anlamlılar | 600 | 0.323 | 0.452 |
| Overall | 3296 | 0.210 | 0.551 |

Table 7: *Semantic categories*: MRR Results of **Word2Vec** with 10 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 82.53 | p-value: 8.56×10^{-20} |
| | Spearman Result: 81.68 | p-value: 4.11×10^{-19} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 70.77 | p-value: 4.77×10^{-57} |
| | Spearman Result: 74.57 | p-value: 2.36×10^{-66} |
| | OOV Ratio: 26.6 | |

Table 8: Similarity test results for **Word2Vec** with 10 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.797 | 0.105 | 0.339 | -69.03% |
| 2. tekil kiři çekimi.txt | 946 | 0.877 | 0.059 | 0.365 | -83.84% |
| 2. çoęul kiři çekimi.txt | 946 | 0.851 | 0.085 | 0.327 | -74.01% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.803 | 0.105 | 0.42 | -75.0% |
| emir kipi.txt | 1176 | 0.656 | 0.21 | 0.465 | -54.84% |
| gelecek zaman kipi.txt | 1176 | 0.39 | 0.437 | 0.707 | -38.19% |
| gereklilik kipi.txt | 1128 | 0.632 | 0.212 | 0.467 | -54.6% |
| geçmiş zaman eki (-di).txt | 1176 | 0.4 | 0.428 | 0.535 | -20.0% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.332 | 0.483 | 0.774 | -37.6% |
| istek kipi.txt | 1176 | 0.577 | 0.235 | 0.534 | -55.99% |
| olumsuzluk eki.txt | 1176 | 0.578 | 0.248 | 0.67 | -62.99% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.431 | 0.328 | 0.646 | -49.23% |
| şimdiki zaman eki (-yor).txt | 861 | 0.084 | 0.806 | 0.847 | -4.84% |
| Overall | 14231 | 0.567 | 0.287 | 0.549 | -47.81% |

Table 9: *Fiil çekim ekleri*: MRR Result Comparison for **left-aligned Word2Vec** with 10 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.727 | 0.148 | 0.238 | -37.82% |
| -e eki.txt | 1176 | 0.708 | 0.143 | 0.236 | -39.41% |
| 1. tekil kiři iyelik.txt | 1128 | 0.768 | 0.123 | 0.148 | -16.89% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.596 | 0.254 | 0.25 | 1.6% |
| 2. tekil kiři iyelik.txt | 1176 | 0.634 | 0.229 | 0.321 | -28.66% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.693 | 0.182 | 0.196 | -7.14% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.268 | 0.507 | 0.448 | 13.17% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.549 | 0.196 | 0.178 | 10.11% |
| eşitlik eki (-ce).txt | 276 | 0.967 | 0.018 | 0.027 | -33.33% |
| ismin -de hali.txt | 1128 | 0.832 | 0.073 | 0.136 | -46.32% |
| ismin -i hali.txt | 1176 | 0.341 | 0.431 | 0.439 | -1.82% |
| tamlayan eki.txt | 1176 | 0.352 | 0.411 | 0.488 | -15.78% |
| vasıta eki (-le).txt | 1128 | 0.679 | 0.164 | 0.253 | -35.18% |
| Overall | 14005 | 0.6 | 0.236 | 0.275 | -14.09% |

Table 10: *İsim çekim ekleri*: MRR Result Comparison for **left-aligned Word2Vec** with 10 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.311 | 0.544 |
| es-anlamlılar.txt | 600 | 0.417 | 0.408 |
| para-birimi.txt | 156 | 0.788 | 0.157 |
| sehir-bolge.txt | 1344 | 0.085 | 0.617 |
| zit-anlamlılar.txt | 600 | 0.363 | 0.432 |
| ülke-başkent.txt | 506 | 0.067 | 0.703 |
| Overall | 3296 | 0.233 | 0.535 |

Table 11: *Semantic categories*: MRR Results of **left-aligned Word2Vec** with 10 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 79.05 | p-value: 3.31×10^{-17} |
| | Spearman Result: 79.42 | p-value: 1.85×10^{-17} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 69.85 | p-value: 5.20×10^{-55} |
| | Spearman Result: 73.98 | p-value: 8.60×10^{-65} |
| | OOV Ratio: 26.6 | |

Table 12: Similarity test results for **left-aligned Word2Vec** with 10 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.323 | 0.418 | 0.339 | 23.3% |
| 2. tekil kiři çekimi.txt | 946 | 0.426 | 0.31 | 0.365 | -15.07% |
| 2. çoęul kiři çekimi.txt | 946 | 0.316 | 0.41 | 0.327 | 25.38% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.394 | 0.412 | 0.42 | -1.9% |
| emir kipi.txt | 1176 | 0.183 | 0.634 | 0.465 | 36.34% |
| gelecek zaman kipi.txt | 1176 | 0.116 | 0.733 | 0.707 | 3.68% |
| gereklilik kipi.txt | 1128 | 0.227 | 0.572 | 0.467 | 22.48% |
| geçmiş zaman eki (-di).txt | 1176 | 0.242 | 0.586 | 0.535 | 9.53% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.117 | 0.677 | 0.774 | -12.53% |
| istek kipi.txt | 1176 | 0.319 | 0.477 | 0.534 | -10.67% |
| olumsuzluk eki.txt | 1176 | 0.122 | 0.668 | 0.67 | -0.3% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.334 | 0.391 | 0.646 | -39.47% |
| şimdiki zaman eki (-yor).txt | 861 | 0.072 | 0.863 | 0.847 | 1.89% |
| Overall | 14231 | 0.244 | 0.551 | 0.549 | 0.43% |

Table 13: *Fil çekim ekleri*: MRR Result Comparison for **right-aligned Word2Vec** with 10 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.588 | 0.163 | 0.238 | -31.51% |
| -e eki.txt | 1176 | 0.361 | 0.317 | 0.236 | 34.32% |
| 1. tekil kiři iyelik.txt | 1128 | 0.738 | 0.154 | 0.148 | 4.05% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.559 | 0.293 | 0.25 | 17.2% |
| 2. tekil kiři iyelik.txt | 1176 | 0.581 | 0.303 | 0.321 | -5.61% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.699 | 0.173 | 0.196 | -11.73% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.298 | 0.394 | 0.448 | -12.05% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.579 | 0.148 | 0.178 | -16.85% |
| eşitlik eki (-ce).txt | 276 | 0.957 | 0.021 | 0.027 | -22.22% |
| ismin -de hali.txt | 1128 | 0.649 | 0.137 | 0.136 | 0.74% |
| ismin -i hali.txt | 1176 | 0.262 | 0.421 | 0.439 | -4.1% |
| tamlayan eki.txt | 1176 | 0.259 | 0.513 | 0.488 | 5.12% |
| vasıta eki (-le).txt | 1128 | 0.547 | 0.206 | 0.253 | -18.58% |
| Overall | 14005 | 0.515 | 0.266 | 0.275 | -3.19% |

Table 14: *İsim çekim ekleri*: MRR Result Comparison for **right-aligned Word2Vec** with 10 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.367 | 0.454 |
| es-anlamlılar.txt | 600 | 0.492 | 0.348 |
| para-birimi.txt | 156 | 0.75 | 0.18 |
| sehir-bolge.txt | 1344 | 0.158 | 0.51 |
| zit-anlamlılar.txt | 600 | 0.39 | 0.457 |
| ülke-başkent.txt | 506 | 0.16 | 0.572 |
| Overall | 3296 | 0.295 | 0.463 |

Table 15: *Semantic categories*: MRR Results of **right-aligned Word2Vec** with 10 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 79.02 | p-value: 3.50×10^{-17} |
| | Spearman Result: 76.72 | p-value: 9.95×10^{-16} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 70.11 | p-value: 1.47×10^{-55} |
| | Spearman Result: 73.17 | p-value: 9.61×10^{-63} |
| | OOV Ratio: 26.6 | |

Table 16: Similarity test results for **right-aligned Word2Vec** with 10 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.293 | 0.432 | 0.339 | 27.43% |
| 2. tekil kiři çekimi.txt | 946 | 0.452 | 0.298 | 0.365 | -18.36% |
| 2. çoęul kiři çekimi.txt | 946 | 0.364 | 0.386 | 0.327 | 18.04% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.375 | 0.394 | 0.42 | -6.19% |
| emir kipi.txt | 1176 | 0.193 | 0.627 | 0.465 | 34.84% |
| gelecek zaman kipi.txt | 1176 | 0.105 | 0.781 | 0.707 | 10.47% |
| gereklilik kipi.txt | 1128 | 0.247 | 0.561 | 0.467 | 20.13% |
| geçmiş zaman eki (-di).txt | 1176 | 0.218 | 0.629 | 0.535 | 17.57% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.088 | 0.805 | 0.774 | 4.01% |
| istek kipi.txt | 1176 | 0.22 | 0.599 | 0.534 | 12.17% |
| olumsuzluk eki.txt | 1176 | 0.139 | 0.647 | 0.67 | -3.43% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.116 | 0.769 | 0.646 | 19.04% |
| şimdiki zaman eki (-yor).txt | 861 | 0.064 | 0.889 | 0.847 | 4.96% |
| Overall | 14231 | 0.217 | 0.606 | 0.549 | 10.44% |

Table 17: *Fiil çekim ekleri*: MRR Results of **Word2Vec** with 15 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.473 | 0.335 | 0.238 | 40.76% |
| -e eki.txt | 1176 | 0.458 | 0.307 | 0.236 | 30.08% |
| 1. tekil kiři iyelik.txt | 1128 | 0.614 | 0.24 | 0.148 | 62.16% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.481 | 0.361 | 0.25 | 44.4% |
| 2. tekil kiři iyelik.txt | 1176 | 0.552 | 0.32 | 0.321 | -0.31% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.551 | 0.283 | 0.196 | 44.39% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.27 | 0.484 | 0.448 | 8.04% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.477 | 0.235 | 0.178 | 32.02% |
| eşitlik eki (-ce).txt | 276 | 0.949 | 0.031 | 0.027 | 14.81% |
| ismin -de hali.txt | 1128 | 0.65 | 0.162 | 0.136 | 19.12% |
| ismin -i hali.txt | 1176 | 0.313 | 0.464 | 0.439 | 5.69% |
| tamlayan eki.txt | 1176 | 0.256 | 0.547 | 0.488 | 12.09% |
| vasıta eki (-le).txt | 1128 | 0.427 | 0.361 | 0.253 | 42.69% |
| Overall | 14005 | 0.468 | 0.337 | 0.275 | 22.67% |

Table 18: *İsim çekim ekleri*: MRR Results of **Word2Vec** with 15 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.244 | 0.59 |
| es-anlamlılar.txt | 600 | 0.382 | 0.468 |
| para-birimi.txt | 156 | 0.692 | 0.2 |
| sehir-bolge.txt | 1344 | 0.089 | 0.617 |
| zit-anlamlılar.txt | 600 | 0.332 | 0.458 |
| ülke-başkent.txt | 506 | 0.04 | 0.712 |
| Overall | 3296 | 0.212 | 0.555 |

Table 19: *Semantic categories*: MRR Results of **Word2Vec** with 15 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 81.54 | p-value: 5.29×10^{-19} |
| | Spearman Result: 81.83 | p-value: 3.14×10^{-19} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 70.67 | p-value: 5.33×10^{-57} |
| | Spearman Result: 74.53 | p-value: 2.98×10^{-66} |
| | OOV Ratio: 26.6 | |

Table 20: Similarity test results for **Word2Vec** with 15 epochs

| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|------------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.087 | 0.675 | 0.339 | 99.16% |
| 2. tekil kiři çekimi.txt | 946 | 0.086 | 0.718 | 0.365 | 96.66% |
| 2. çoęul kiři çekimi.txt | 946 | 0.076 | 0.763 | 0.327 | 133.39% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.277 | 0.621 | 0.42 | 47.99% |
| emir kipi.txt | 1176 | 0.219 | 0.622 | 0.465 | 33.81% |
| gelecek zaman kipi.txt | 1176 | 0.034 | 0.883 | 0.707 | 24.89% |
| gereklilik kipi.txt | 1128 | 0.192 | 0.640 | 0.467 | 37.12% |
| geçmiş zaman eki (-di).txt | 1176 | 0.256 | 0.589 | 0.535 | 10.16% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.080 | 0.759 | 0.774 | -1.83% |
| istek kipi.txt | 1176 | 0.161 | 0.559 | 0.534 | 4.76% |
| olumsuzluk eki.txt | 1176 | 0.108 | 0.776 | 0.67 | 15.86% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.058 | 0.884 | 0.646 | 36.91% |
| şimdiki zaman eki (-yor).txt | 861 | 0.059 | 0.883 | 0.847 | 4.33% |
| Overall | 14231 | 0.133 | 0.718 | 0.549 | 30.78% |

Table 21: *Fiil çekim ekleri*: MRR Result Comparison for **FastText** with 5 epochs

| Morphological Categories | Number of examples | Top-N Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|------------------|--------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.453 | 0.331 | 0.238 | 39.11% |
| -e eki.txt | 1176 | 0.553 | 0.251 | 0.236 | 6.60% |
| 1. tekil kiři iyelik.txt | 1128 | 0.432 | 0.349 | 0.148 | 136.31% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.295 | 0.512 | 0.25 | 105.19% |
| 2. tekil kiři iyelik.txt | 1176 | 0.482 | 0.339 | 0.321 | 5.91% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.218 | 0.594 | 0.196 | 203.54% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.468 | 0.312 | 0.448 | -30.20% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.483 | 0.257 | 0.178 | 44.40% |
| eşitlik eki (-ce).txt | 276 | 0.822 | 0.0747 | 0.027 | 176.77% |
| ismin -de hali.txt | 1128 | 0.605 | 0.188 | 0.136 | 38.93% |
| ismin -i hali.txt | 1176 | 0.458 | 0.332 | 0.439 | -24.28% |
| tamlayan eki.txt | 1176 | 0.276 | 0.515 | 0.488 | 5.56% |
| vasıta eki (-le).txt | 1128 | 0.356 | 0.425 | 0.253 | 68.20% |
| Overall | 14005 | 0.432 | 0.360 | 0.27 | 33.33% |

Table 22: *İsim çekim ekleri*: MRR Result Comparison for **FastText** with 5 epochs

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| Aile | 90 | 0.422 | 0.312 |
| Para birimi | 156 | 0.852 | 0.055 |
| Şehir-bölge | 1344 | 0.645 | 0.186 |
| Ülke-başkent | 506 | 0.193 | 0.548 |
| Eş anlamlılar | 600 | 0.611 | 0.243 |
| Zıt anlamlılar | 600 | 0.575 | 0.233 |
| Overall | 3296 | 0.560 | 0.258 |

Table 23: *Semantic categories*: MRR Results of **FastText** with 5 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 61.12 | p-value: 5.70×10^{-9} |
| | Spearman Result: 62.55 | p-value: 1.97×10^{-9} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 67.45 | p-value: 4.83×10^{-50} |
| | Spearman Result: 70.37 | p-value: 3.82×10^{-56} |
| | OOV Ratio: 26.6 | |

Table 24: Similarity test results for **FastText** with 5 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.111 | 0.600 | 0.339 | 77.16% |
| 2. tekil kiři çekimi.txt | 946 | 0.096 | 0.671 | 0.365 | 83.91% |
| 2. çoęul kiři çekimi.txt | 946 | 0.104 | 0.713 | 0.327 | 118.16% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.286 | 0.581 | 0.42 | 38.42% |
| emir kipi.txt | 1176 | 0.222 | 0.588 | 0.465 | 26.62% |
| gelecek zaman kipi.txt | 1176 | 0.036 | 0.871 | 0.707 | 23.26% |
| gereklilik kipi.txt | 1128 | 0.189 | 0.647 | 0.467 | 38.58% |
| geçmiş zaman eki (-di).txt | 1176 | 0.255 | 0.599 | 0.535 | 11.96% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.084 | 0.782 | 0.774 | 1.09% |
| istek kipi.txt | 1176 | 0.182 | 0.534 | 0.534 | 0.11% |
| olumsuzluk eki.txt | 1176 | 0.097 | 0.773 | 0.67 | 15.40% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.063 | 0.850 | 0.64 | 31.65% |
| şimdiki zaman eki (-yor).txt | 861 | 0.066 | 0.880 | 0.847 | 3.94% |
| Overall | 14231 | 0.141 | 0.697 | 0.549 | 26.95% |

Table 25: *Fiil çekim ekleri*: MRR Result Comparison for **FastText** with 10 epochs

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.443 | 0.332 | 0.238 | 39.78% |
| -e eki.txt | 1176 | 0.520 | 0.282 | 0.236 | 19.53% |
| 1. tekil kiři iyelik.txt | 1128 | 0.469 | 0.321 | 0.148 | 117.29% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.300 | 0.487 | 0.25 | 94.96% |
| 2. tekil kiři iyelik.txt | 1176 | 0.466 | 0.371 | 0.321 | 15.85% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.248 | 0.561 | 0.196 | 186.27% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.393 | 0.372 | 0.448 | -16.80% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.469 | 0.259 | 0.178 | 45.95% |
| eşitlik eki (-ce).txt | 276 | 0.884 | 0.054 | 0.027 | 103.33% |
| ismin -de hali.txt | 1128 | 0.607 | 0.204 | 0.136 | 50.0% |
| ismin -i hali.txt | 1176 | 0.406 | 0.382 | 0.439 | -12.82% |
| tamlayan eki.txt | 1176 | 0.256 | 0.549 | 0.488 | 12.62% |
| vasıta eki (-le).txt | 1128 | 0.356 | 0.418 | 0.253 | 65.57% |
| Overall | 14005 | 0.421 | 0.371 | 0.274 | 35.40% |

Table 26: *İsim çekim ekleri*: MRR Result Comparison for **FastText** with 10 epochs

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| Aile | 90 | 0.333 | 0.412 |
| Para birimi | 156 | 0.827 | 0.079 |
| Şehir-bölge | 1344 | 0.553 | 0.232 |
| Ülke-başkent | 506 | 0.138 | 0.583 |
| Eş anlamlılar | 600 | 0.573 | 0.276 |
| Zıt anlamlılar | 600 | 0.52 | 0.296 |
| Overall | 3296 | 0.493 | 0.303 |

Table 27: *Semantic categories*: MRR Results of **FastText** with 10 epochs

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 66.51 | p-value: 7.58×10^{-11} |
| | Spearman Result: 68.16 | p-value: 1.67×10^{-11} |
| | OOV Ratio: 46.42 | |
| Semantic Similarity | Pearson Result: 67.35 | p-value: 7.74×10^{-50} |
| | Spearman Result: 70.53 | p-value: 1.71×10^{-56} |
| | OOV Ratio: 26.6 | |

Table 28: Similarity test results for **FastText** with 10 epochs ($p \times 100$)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.031 | 0.829 | 0.339 | 144.54% |
| 2. tekil kiři çekimi.txt | 946 | 0.045 | 0.787 | 0.365 | 115.62% |
| 2. çoęul kiři çekimi.txt | 946 | 0.056 | 0.793 | 0.327 | 142.51% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.309 | 0.587 | 0.42 | 39.76% |
| emir kipi.txt | 1176 | 0.165 | 0.701 | 0.465 | 50.75% |
| gelecek zaman kipi.txt | 1176 | 0.017 | 0.921 | 0.707 | 30.27% |
| gereklilik kipi.txt | 1128 | 0.117 | 0.754 | 0.467 | 61.46% |
| geçmiş zaman eki (-di).txt | 1176 | 0.077 | 0.778 | 0.535 | 45.42% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.076 | 0.856 | 0.774 | 10.59% |
| istek kipi.txt | 1176 | 0.104 | 0.712 | 0.534 | 33.33% |
| olumsuzluk eki.txt | 1176 | 0.032 | 0.885 | 0.67 | 32.09% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.052 | 0.9 | 0.646 | 39.32% |
| şimdiki zaman eki (-yor).txt | 861 | 0.039 | 0.928 | 0.847 | 9.56% |
| Overall | 14231 | 0.088 | 0.801 | 0.549 | 45.81% |

Table 29: *Fiil çekim ekleri*: MRR Results of **FastText** word embeddings prepared by Facebook AI

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.302 | 0.476 | 0.238 | 100.0% |
| -e eki.txt | 1176 | 0.336 | 0.464 | 0.236 | 96.61% |
| 1. tekil kiři iyelik.txt | 1128 | 0.35 | 0.462 | 0.148 | 212.16% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.254 | 0.547 | 0.25 | 118.8% |
| 2. tekil kiři iyelik.txt | 1176 | 0.392 | 0.464 | 0.321 | 44.55% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.188 | 0.65 | 0.196 | 231.63% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.25 | 0.562 | 0.448 | 25.45% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.24 | 0.553 | 0.178 | 210.67% |
| eşitlik eki (-ce).txt | 276 | 0.873 | 0.061 | 0.027 | 125.93% |
| ismin -de hali.txt | 1128 | 0.374 | 0.333 | 0.136 | 144.85% |
| ismin -i hali.txt | 1176 | 0.283 | 0.512 | 0.439 | 16.63% |
| tamlayan eki.txt | 1176 | 0.15 | 0.726 | 0.488 | 48.77% |
| vasıta eki (-le).txt | 1128 | 0.277 | 0.534 | 0.253 | 111.07% |
| Overall | 14005 | 0.295 | 0.514 | 0.275 | 87.21% |

Table 30: *İsim çekim ekleri*: MRR Results of **FastText** word embeddings prepared by Facebook AI

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.211 | 0.564 |
| es-anlamlılar.txt | 600 | 0.392 | 0.398 |
| para-birimi.txt | 156 | 0.801 | 0.094 |
| sehir-bolge.txt | 1344 | 0.365 | 0.339 |
| zit-anlamlılar.txt | 600 | 0.428 | 0.4 |
| ülke-başkent.txt | 506 | 0.316 | 0.277 |
| Overall | 3296 | 0.39 | 0.346 |

Table 31: *Semantic categories*: MRR Results of **FastText** word embeddings prepared by Facebook AI

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 76.92 | p-value: 4.64×10^{-15} |
| | Spearman Result: 80.28 | p-value: 3.76×10^{-17} |
| | OOV Ratio: 49.28 | |
| Semantic Similarity | Pearson Result: 65.12 | p-value: 1.72×10^{-43} |
| | Spearman Result: 68.92 | p-value: 1.72×10^{-50} |
| | OOV Ratio: 30.2 | |

Table 32: Similarity test results for **FastText** word embeddings prepared by Facebook AI

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.193 | 0.486 | 0.339 | 43.36% |
| 2. tekil kiři çekimi.txt | 946 | 0.184 | 0.525 | 0.365 | 43.84% |
| 2. çoęul kiři çekimi.txt | 946 | 0.172 | 0.555 | 0.327 | 69.72% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.294 | 0.51 | 0.42 | 21.43% |
| emir kipi.txt | 1176 | 0.194 | 0.631 | 0.465 | 35.7% |
| gelecek zaman kipi.txt | 1176 | 0.078 | 0.832 | 0.707 | 17.68% |
| gereklilik kipi.txt | 1128 | 0.209 | 0.63 | 0.467 | 34.9% |
| geçmiş zaman eki (-di).txt | 1176 | 0.231 | 0.618 | 0.535 | 15.51% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.104 | 0.791 | 0.774 | 2.2% |
| istek kipi.txt | 1176 | 0.204 | 0.577 | 0.534 | 8.05% |
| olumsuzluk eki.txt | 1176 | 0.111 | 0.679 | 0.67 | 1.34% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.08 | 0.807 | 0.646 | 24.92% |
| şimdiki zaman eki (-yor).txt | 861 | 0.042 | 0.892 | 0.847 | 5.31% |
| Overall | 14231 | 0.162 | 0.658 | 0.549 | 19.8% |

Table 33: *Fiil çekim ekleri*: MRR Results of word vectors generated by averaging **Word2Vec** and **FastText** word vectors (10 epochs)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.45 | 0.33 | 0.238 | 38.66% |
| -e eki.txt | 1176 | 0.487 | 0.299 | 0.236 | 26.69% |
| 1. tekil kiři iyelik.txt | 1128 | 0.534 | 0.287 | 0.148 | 93.92% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.404 | 0.427 | 0.25 | 70.8% |
| 2. tekil kiři iyelik.txt | 1176 | 0.499 | 0.341 | 0.321 | 6.23% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.396 | 0.425 | 0.196 | 116.84% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.335 | 0.448 | 0.448 | 0.0% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.475 | 0.247 | 0.178 | 38.76% |
| eşitlik eki (-ce).txt | 276 | 0.942 | 0.037 | 0.027 | 37.04% |
| ismin -de hali.txt | 1128 | 0.637 | 0.177 | 0.136 | 30.15% |
| ismin -i hali.txt | 1176 | 0.336 | 0.451 | 0.439 | 2.73% |
| tamlayan eki.txt | 1176 | 0.246 | 0.548 | 0.488 | 12.3% |
| vasıta eki (-le).txt | 1128 | 0.405 | 0.386 | 0.253 | 52.57% |
| çoęul eki.txt | 1128 | 0.322 | 0.496 | 1.0 | -50.4% |
| Overall | 15133 | 0.434 | 0.368 | 0.329 | 12.02% |

Table 34: *İsim çekim ekleri*: MRR Results of word vectors generated by averaging **Word2Vec** and **FastText** word vectors (10 epochs)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.222 | 0.597 |
| es-anlamlılar.txt | 600 | 0.44 | 0.395 |
| para-birimi.txt | 156 | 0.731 | 0.144 |
| şehir-bölge.txt | 1344 | 0.196 | 0.508 |
| zıt-anlamlılar.txt | 600 | 0.402 | 0.396 |
| ölke-başkent.txt | 506 | 0.113 | 0.625 |
| Overall | 3296 | 0.291 | 0.470 |

Table 35: *Semantic categories*: MRR Results of word vectors generated by averaging **Word2Vec** and **FastText** word vectors (10 epochs)

| Similarity Task | Statistics | |
|----------------------|------------------------|---------------------------------|
| Syntactic Similarity | Pearson Result: 79.12 | p-value: 1.98×10^{-51} |
| | Spearman Result: 79.19 | p-value: 7.97×10^{-60} |
| | OOV Ratio: 46.43 | |
| Semantic Similarity | Pearson Result: 68.15 | p-value: 2.97×10^{-17} |
| | Spearman Result: 71.98 | p-value: 2.67×10^{-17} |
| | OOV Ratio: 26.60 | |

Table 36: Similarity test results for word vectors generated by averaging **Word2Vec** and **FastText** word vectors (10 epochs)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.851 | 0.061 | 0.339 | -82.01% |
| 2. tekil kiři çekimi.txt | 946 | 0.93 | 0.033 | 0.365 | -90.96% |
| 2. çoęul kiři çekimi.txt | 946 | 0.925 | 0.028 | 0.327 | -91.44% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.717 | 0.117 | 0.42 | -72.14% |
| emir kipi.txt | 1176 | 0.563 | 0.266 | 0.465 | -42.8% |
| gelecek zaman kipi.txt | 1176 | 0.237 | 0.606 | 0.707 | -14.29% |
| gereklilik kipi.txt | 1128 | 0.673 | 0.158 | 0.467 | -66.17% |
| geçmiş zaman eki (-di).txt | 1176 | 0.273 | 0.48 | 0.535 | -10.28% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.204 | 0.596 | 0.774 | -23.0% |
| istek kipi.txt | 1176 | 0.622 | 0.214 | 0.534 | -59.93% |
| olumsuzluk eki.txt | 1176 | 0.27 | 0.509 | 0.67 | -24.03% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.407 | 0.408 | 0.646 | -36.84% |
| şimdiki zaman eki (-yor).txt | 861 | 0.108 | 0.753 | 0.847 | -11.1% |
| Overall | 14231 | 0.512 | 0.33 | 0.549 | -39.88% |

Table 37: *Fiil çekim ekleri*: MRR Results of **GloVe** word vectors (100 iterations, window size 5)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.832 | 0.092 | 0.238 | -61.34% |
| -e eki.txt | 1176 | 0.746 | 0.117 | 0.236 | -50.42% |
| 1. tekil kiři iyelik.txt | 1128 | 0.965 | 0.013 | 0.148 | -91.22% |
| 1. çoęul kiři iyelik.txt | 1128 | 0.907 | 0.038 | 0.25 | -84.8% |
| 2. tekil kiři iyelik.txt | 1176 | 0.721 | 0.166 | 0.321 | -48.29% |
| 2. çoęul kiři iyelik.txt | 1081 | 0.99 | 0.003 | 0.196 | -98.47% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.409 | 0.319 | 0.448 | -28.79% |
| 3. çoęul kiři iyelik.txt | 1128 | 0.732 | 0.097 | 0.178 | -45.51% |
| eşitlik eki (-ce).txt | 276 | 0.989 | 0.006 | 0.027 | -77.78% |
| ismin -de hali.txt | 1128 | 0.856 | 0.057 | 0.136 | -58.09% |
| ismin -i hali.txt | 1176 | 0.434 | 0.317 | 0.439 | -27.79% |
| tamlayan eki.txt | 1176 | 0.466 | 0.333 | 0.488 | -31.76% |
| vasıta eki (-le).txt | 1128 | 0.881 | 0.062 | 0.253 | -75.49% |
| çoęul eki.txt | 1128 | 0.538 | 0.266 | 1.0 | -73.4% |
| Overall | 15133 | 0.73 | 0.144 | 0.329 | -56.15% |

Table 38: *İsim çekim ekleri*: MRR Results of **GloVe** word vectors (100 iterations, window size 5)

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| aile.txt | 90 | 0.356 | 0.423 |
| es-anlamlılar.txt | 600 | 0.522 | 0.271 |
| para-birimi.txt | 156 | 0.923 | 0.037 |
| sehir-bolge.txt | 1344 | 0.141 | 0.53 |
| zit-anlamlılar.txt | 600 | 0.368 | 0.385 |
| ülke-başkent.txt | 506 | 0.081 | 0.722 |
| Overall | 3296 | 0.285 | 0.46 |

Table 39: *Semantic categories*: MRR Results of **GloVe** word vectors (100 iterations, window size 5)

| Similarity Task | Statistics | |
|----------------------|------------------------|--------------------|
| Syntactic Similarity | Pearson Result: 73.45 | p-value: 0.00 x 10 |
| | Spearman Result: 74.13 | p-value: 0.00 x 10 |
| | OOV Ratio: 39.29 | |
| Semantic Similarity | Pearson Result: 61.59 | p-value: 0.00 x 10 |
| | Spearman Result: 64.33 | p-value: 0.00 x 10 |
| | OOV Ratio: 23.60 | |

Table 40: Similarity test results for **GloVe** word vectors (100 iterations, window size 5)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.787 | 0.092 | 0.339 | -72.86% |
| 2. tekil kiři çekimi.txt | 946 | 0.875 | 0.051 | 0.365 | -86.03% |
| 2. çođul kiři çekimi.txt | 946 | 0.86 | 0.058 | 0.327 | -82.26% |
| 3. çođul kiři çekimi.txt | 1128 | 0.658 | 0.157 | 0.42 | -62.62% |
| emir kipi.txt | 1176 | 0.529 | 0.309 | 0.465 | -33.55% |
| gelecek zaman kipi.txt | 1176 | 0.213 | 0.634 | 0.707 | -10.33% |
| gereklilik kipi.txt | 1128 | 0.598 | 0.222 | 0.467 | -52.46% |
| geçmiş zaman eki (-di).txt | 1176 | 0.297 | 0.467 | 0.535 | -12.71% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.19 | 0.611 | 0.774 | -21.06% |
| istek kipi.txt | 1176 | 0.591 | 0.251 | 0.534 | -53.0% |
| olumsuzluk eki.txt | 1176 | 0.209 | 0.566 | 0.67 | -15.52% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.349 | 0.489 | 0.646 | -24.3% |
| şimdiki zaman eki (-yor).txt | 861 | 0.093 | 0.73 | 0.847 | -13.81% |
| Overall | 14231 | 0.472 | 0.363 | 0.549 | -33.92% |

Table 41: *Fil çekim ekleri*: MRR Results of **GloVe** word vectors (100 iterations, window size 10)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.782 | 0.112 | 0.238 | -52.94% |
| -e eki.txt | 1176 | 0.71 | 0.123 | 0.236 | -47.88% |
| 1. tekil kiři iyelik.txt | 1128 | 0.95 | 0.022 | 0.148 | -85.14% |
| 1. çođul kiři iyelik.txt | 1128 | 0.862 | 0.069 | 0.25 | -72.4% |
| 2. tekil kiři iyelik.txt | 1176 | 0.697 | 0.185 | 0.321 | -42.37% |
| 2. çođul kiři iyelik.txt | 1081 | 0.975 | 0.01 | 0.196 | -94.9% |
| 3. tekil kiři iyelik eki.txt | 1176 | 0.367 | 0.388 | 0.448 | -13.39% |
| 3. çođul kiři iyelik.txt | 1128 | 0.713 | 0.12 | 0.178 | -32.58% |
| eşitlik eki (-ce).txt | 276 | 0.989 | 0.008 | 0.027 | -70.37% |
| ismin -de hali.txt | 1128 | 0.833 | 0.065 | 0.136 | -52.21% |
| ismin -i hali.txt | 1176 | 0.386 | 0.384 | 0.439 | -12.53% |
| tamlayan eki.txt | 1176 | 0.425 | 0.361 | 0.488 | -26.02% |
| vasıta eki (-le).txt | 1128 | 0.828 | 0.088 | 0.253 | -65.22% |
| çođul eki.txt | 1128 | 0.506 | 0.301 | 1.0 | -69.9% |
| Overall | 15133 | 0.697 | 0.171 | 0.329 | -48.07% |

Table 42: *İsim çekim ekleri*: MRR Results of **GloVe** word vectors (100 iterations, window size 10)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.344 | 0.49 |
| es-anlamlılar.txt | 600 | 0.528 | 0.278 |
| para-birimi.txt | 156 | 0.878 | 0.071 |
| sehir-bolge.txt | 1344 | 0.092 | 0.614 |
| zit-anlamlılar.txt | 600 | 0.367 | 0.404 |
| ülke-başkent.txt | 506 | 0.061 | 0.712 |
| Overall | 3296 | 0.261 | 0.501 |

Table 43: *Semantic categories*: MRR Results of **GloVe** word vectors (100 iterations, window size 10)

| Similarity Task | Statistics | |
|----------------------|------------------------|--------------------|
| Syntactic Similarity | Pearson Result: 69.87 | p-value: 0.00 x 10 |
| | Spearman Result: 72.33 | p-value: 0.00 x 10 |
| | OOV Ratio: 47.14 | |
| Semantic Similarity | Pearson Result: 67.93 | p-value: 0.00 x 10 |
| | Spearman Result: 70.89 | p-value: 0.00 x 10 |
| | OOV Ratio: 26.60 | |

Table 44: Similarity test results for **GloVe** word vectors (100 iterations, window size 10)

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.666 | 0.103 | 0.339 | -69.62% |
| 2. tekil kiři çekimi.txt | 946 | 0.573 | 0.125 | 0.365 | -65.75% |
| 2. çoęul kiři çekimi.txt | 946 | 0.548 | 0.193 | 0.327 | -40.98% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.715 | 0.076 | 0.42 | -81.9% |
| emir kipi.txt | 1176 | 0.804 | 0.047 | 0.465 | -89.89% |
| gelecek zaman kipi.txt | 1176 | 0.405 | 0.329 | 0.707 | -53.47% |
| gereklilik kipi.txt | 1128 | 0.568 | 0.216 | 0.467 | -53.75% |
| geçmiş zaman eki (-di).txt | 1176 | 0.481 | 0.304 | 0.535 | -43.18% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.444 | 0.374 | 0.774 | -51.68% |
| istek kipi.txt | 1176 | 0.542 | 0.198 | 0.534 | -62.92% |
| olumsuzluk eki.txt | 1176 | 0.545 | 0.211 | 0.67 | -68.51% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.279 | 0.51 | 0.646 | -21.05% |
| şimdiki zaman eki (-yor).txt | 861 | 0.365 | 0.373 | 0.847 | -55.96% |
| Overall | 14231 | 0.534 | 0.237 | 0.549 | -56.82% |

Table 45: *Fiil çekim ekleri*: MRR Results of static word vectors generated by **ELMo** trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kiři çekimi.txt | 990 | 0.266 | 0.461 | 0.339 | 35.99% |
| 2. tekil kiři çekimi.txt | 946 | 0.374 | 0.418 | 0.365 | 14.52% |
| 2. çoęul kiři çekimi.txt | 946 | 0.376 | 0.407 | 0.327 | 24.46% |
| 3. çoęul kiři çekimi.txt | 1128 | 0.373 | 0.4 | 0.42 | -4.76% |
| emir kipi.txt | 1176 | 0.231 | 0.593 | 0.465 | 27.53% |
| gelecek zaman kipi.txt | 1176 | 0.094 | 0.83 | 0.707 | 17.4% |
| gereklilik kipi.txt | 1128 | 0.267 | 0.509 | 0.467 | 8.99% |
| geçmiş zaman eki (-di).txt | 1176 | 0.223 | 0.637 | 0.535 | 19.07% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.122 | 0.763 | 0.774 | -1.42% |
| istek kipi.txt | 1176 | 0.23 | 0.62 | 0.534 | 16.1% |
| olumsuzluk eki.txt | 1176 | 0.21 | 0.58 | 0.67 | -13.43% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.103 | 0.826 | 0.646 | 27.86% |
| şimdiki zaman eki (-yor).txt | 861 | 0.067 | 0.869 | 0.847 | 2.6% |
| Overall | 14231 | 0.223 | 0.612 | 0.549 | 11.51% |

Table 46: *Fiil Çekim Ekleri*: MRR Results of **Word2Vec CBOW** with 10 epoch

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR |
|--------------------------|--------------------|-----------------|-------|
| aile.txt | 90 | 0.856 | 0.066 |
| es-anlamlılar.txt | 600 | 0.928 | 0.029 |
| para-birimi.txt | 156 | 0.571 | 0.001 |
| sehir-bolge.txt | 1344 | 0.755 | 0.077 |
| zit-anlamlılar.txt | 600 | 0.657 | 0.214 |
| ülke-başkent.txt | 506 | 0.259 | 0.001 |
| Overall | 3296 | 0.687 | 0.078 |

Table 51: *Semantic categories*: MRR Results of static word vectors generated by **ELMo** trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.479 | 0.349 | 0.238 | 46.64% |
| -e eki.txt | 1176 | 0.412 | 0.417 | 0.236 | 76.69% |
| 1. tekil kişi iyelik.txt | 1128 | 0.585 | 0.254 | 0.148 | 71.62% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.449 | 0.374 | 0.25 | 49.6% |
| 2. tekil kişi iyelik.txt | 1176 | 0.535 | 0.377 | 0.321 | 17.45% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.492 | 0.317 | 0.196 | 61.73% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.38 | 0.418 | 0.448 | -6.7% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.432 | 0.316 | 0.178 | 77.53% |
| eşitlik eki (-ce).txt | 276 | 0.946 | 0.036 | 0.027 | 33.33% |
| ismin -de hali.txt | 1128 | 0.516 | 0.289 | 0.136 | 112.5% |
| ismin -i hali.txt | 1176 | 0.381 | 0.42 | 0.439 | -4.33% |
| tamlayan eki.txt | 1176 | 0.241 | 0.629 | 0.488 | 28.89% |
| vasıta eki (-le).txt | 1128 | 0.399 | 0.45 | 0.253 | 77.87% |
| çoğul eki.txt | 1128 | 0.316 | 0.53 | 1.0 | -47.0% |
| Overall | 15133 | 0.441 | 0.39 | 0.329 | 18.59% |

Table 47: *İsim Çekim Ekleri*: MRR Results of **Word2Vec CBOW** with 10 epoch

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| aile.txt | 90 | 0.289 | 0.499 | 1.0 | -50.1% |
| es-anlamlılar.txt | 600 | 0.422 | 0.405 | 1.0 | -59.5% |
| para-birimi.txt | 156 | 0.724 | 0.158 | 1.0 | -84.2% |
| sehir-bolge.txt | 1344 | 0.222 | 0.425 | 1.0 | -57.5% |
| zit-anlamlılar.txt | 600 | 0.367 | 0.374 | 1.0 | -62.6% |
| ülke-başkent.txt | 506 | 0.249 | 0.504 | 1.0 | -49.6% |
| Overall | 3296 | 0.315 | 0.414 | 1.0 | -58.64% |

Table 48: *Semantic categories*: MRR Results of **Word2Vec CBOW** with 10 epoch

| Similarity Task | Statistics | |
|----------------------|------------------------|--------------------|
| Syntactic Similarity | Pearson Result: 77.62 | p-value: 0.00 x 10 |
| | Spearman Result: 76.90 | p-value: 0.00 x 10 |
| | OOV Ratio: 46.43 | |
| Semantic Similarity | Pearson Result: 66.16 | p-value: 0.00 x 10 |
| | Spearman Result: 68.77 | p-value: 0.00 x 10 |
| | OOV Ratio: 26.60 | |

Table 49: Similarity test results of static word vectors generated by **Word2Vec CBOW** with 10 epoch

| Similarity Task | Statistics | |
|----------------------|------------------------|----------------------------------|
| Syntactic Similarity | Pearson Result: 39.11 | p-value: 2.00 x 10 ⁻³ |
| | Spearman Result: 39.43 | p-value: 1.00 x 10 ⁻³ |
| | OOV Ratio: 55.00 | |
| Semantic Similarity | Pearson Result: 35.18 | p-value: 0.00 x 10 |
| | Spearman Result: 36.77 | p-value: 0.00 x 10 |
| | OOV Ratio: 28.20 | |

Table 52: Similarity test results of static word vectors generated by **ELMo** trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.687 | 0.151 | 0.238 | -36.55% |
| -e eki.txt | 1176 | 0.635 | 0.23 | 0.236 | -2.54% |
| 1. tekil kişi iyelik.txt | 1128 | 0.699 | 0.082 | 0.148 | -44.59% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.643 | 0.117 | 0.25 | -53.2% |
| 2. tekil kişi iyelik.txt | 1176 | 0.665 | 0.14 | 0.321 | -56.39% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.461 | 0.077 | 0.196 | -60.71% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.623 | 0.213 | 0.448 | -52.46% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.694 | 0.171 | 0.178 | -3.93% |
| eşitlik eki (-ce).txt | 276 | 0.511 | 0.009 | 0.027 | -66.67% |
| ismin -de hali.txt | 1128 | 0.666 | 0.116 | 0.136 | -14.71% |
| ismin -i hali.txt | 1176 | 0.677 | 0.178 | 0.439 | -59.45% |
| tamlayan eki.txt | 1176 | 0.498 | 0.3 | 0.488 | -38.52% |
| vasıta eki (-le).txt | 1128 | 0.612 | 0.191 | 0.253 | -24.51% |
| çoğul eki.txt | 1128 | 0.69 | 0.169 | 1.0 | -83.1% |
| Overall | 15133 | 0.633 | 0.162 | 0.329 | -50.6% |

Table 50: *İsim çekim ekleri*: MRR Results of static word vectors generated by **ELMo** trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kişi çekimi.txt | 990 | 0.97 | 0.018 | 0.339 | -94.69% |
| 2. tekil kişi çekimi.txt | 946 | 0.932 | 0.033 | 0.365 | -90.96% |
| 2. çoğul kişi çekimi.txt | 946 | 0.928 | 0.04 | 0.327 | -87.77% |
| 3. çoğul kişi çekimi.txt | 1128 | 0.961 | 0.019 | 0.42 | -95.48% |
| emir kipi.txt | 1176 | 0.959 | 0.016 | 0.465 | -96.56% |
| gelecek zaman kipi.txt | 1176 | 0.872 | 0.068 | 0.707 | -90.38% |
| gereklik kipi.txt | 1128 | 0.946 | 0.026 | 0.467 | -94.43% |
| geçmiş zaman eki (-di).txt | 1176 | 0.966 | 0.02 | 0.535 | -96.26% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.88 | 0.087 | 0.774 | -88.76% |
| istek kipi.txt | 1176 | 0.963 | 0.022 | 0.534 | -95.88% |
| olumsuzluk eki.txt | 1176 | 0.91 | 0.041 | 0.67 | -93.88% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.962 | 0.018 | 0.646 | -97.21% |
| şimdiki zaman eki (-yor).txt | 861 | 0.855 | 0.091 | 0.847 | -89.26% |
| Overall | 14231 | 0.932 | 0.038 | 0.549 | -93.14% |

Table 53: *Fil çekim ekleri*: MRR Results of static word vectors generated by **Bert**.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.938 | 0.027 | 0.238 | -88.66% |
| -e eki.txt | 1176 | 0.95 | 0.019 | 0.236 | -91.95% |
| 1. tekil kişi iyelik.txt | 1128 | 0.968 | 0.014 | 0.148 | -90.54% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.965 | 0.013 | 0.25 | -94.8% |
| 2. tekil kişi iyelik.txt | 1176 | 0.954 | 0.027 | 0.321 | -91.59% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.986 | 0.009 | 0.196 | -95.41% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.895 | 0.059 | 0.448 | -86.83% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.938 | 0.027 | 0.178 | -84.83% |
| eşitlik eki (-ce).txt | 276 | 0.946 | 0.009 | 0.027 | -66.67% |
| ismin -de hali.txt | 1128 | 0.931 | 0.028 | 0.136 | -79.41% |
| ismin -i hali.txt | 1176 | 0.883 | 0.078 | 0.439 | -82.23% |
| tamlayan eki.txt | 1176 | 0.937 | 0.038 | 0.488 | -92.21% |
| vasıta eki (-le).txt | 1128 | 0.98 | 0.009 | 0.253 | -96.44% |
| çoğul eki.txt | 1128 | 0.812 | 0.123 | 1.0 | -87.7% |
| Overall | 15133 | 0.934 | 0.036 | 0.329 | -89.07% |

Table 54: *İsim çekim ekleri*: MRR Results of static word vectors generated by **Bert**.

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| aile.txt | 90 | 0.767 | 0.137 |
| es-anlamlilar.txt | 600 | 0.848 | 0.072 |
| para-birimi.txt | 156 | 0.987 | 0.003 |
| sehir-bolge.txt | 1344 | 0.947 | 0.032 |
| zit-anlamlilar.txt | 600 | 0.968 | 0.017 |
| ülke-başkent.txt | 506 | 0.978 | 0.007 |
| Overall | 3296 | 0.935 | 0.034 |

Table 55: *Semantic categories*: MRR Results of static word vectors generated by **Bert**.

| Similarity Task | Statistics | |
|----------------------|------------------------|--------------------------------|
| Syntactic Similarity | Pearson Result: 25.17 | p-value: 2.00×10^{-2} |
| | Spearman Result: 28.45 | p-value: 8.00×10^{-3} |
| | OOV Ratio: 39.29 | |
| Semantic Similarity | Pearson Result: 10.65 | p-value: 3.70×10^{-2} |
| | Spearman Result: 12.63 | p-value: 1.30×10^{-2} |
| | OOV Ratio: 23.60 | |

Table 56: Similarity test results of static word vectors generated by **Bert** trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kişi çekimi.txt | 990 | 0.914 | 0.041 | 0.339 | -87.91% |
| 2. tekil kişi çekimi.txt | 946 | 0.849 | 0.079 | 0.365 | -78.36% |
| 2. çoğul kişi çekimi.txt | 946 | 0.885 | 0.058 | 0.327 | -82.26% |
| 3. çoğul kişi çekimi.txt | 1128 | 0.919 | 0.051 | 0.42 | -87.86% |
| emir kipi.txt | 1176 | 0.872 | 0.064 | 0.465 | -86.24% |
| gelecek zaman kipi.txt | 1176 | 0.849 | 0.097 | 0.707 | -86.28% |
| gereklilik kipi.txt | 1128 | 0.874 | 0.073 | 0.467 | -84.37% |
| geçmiş zaman eki (-di).txt | 1176 | 0.92 | 0.036 | 0.535 | -93.27% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.869 | 0.081 | 0.774 | -89.53% |
| istek kipi.txt | 1176 | 0.935 | 0.031 | 0.534 | -94.19% |
| olumsuzluk eki.txt | 1176 | 0.816 | 0.119 | 0.67 | -82.24% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.928 | 0.046 | 0.646 | -92.88% |
| şimdiki zaman eki (-yor).txt | 861 | 0.843 | 0.088 | 0.847 | -89.61% |
| Overall | 14231 | 0.883 | 0.066 | 0.549 | -87.93% |

Table 57: *Fil çekim ekleri*: MRR Results of static word vectors generated by aggregating **Bert** embeddings.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.934 | 0.025 | 0.238 | -89.5% |
| -e eki.txt | 1176 | 0.883 | 0.061 | 0.236 | -74.15% |
| 1. tekil kişi iyelik.txt | 1128 | 0.98 | 0.009 | 0.148 | -93.92% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.931 | 0.04 | 0.25 | -84.0% |
| 2. tekil kişi iyelik.txt | 1176 | 0.908 | 0.046 | 0.321 | -85.67% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.935 | 0.031 | 0.196 | -84.18% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.781 | 0.117 | 0.448 | -73.88% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.939 | 0.026 | 0.178 | -85.39% |
| eşitlik eki (-ce).txt | 276 | 0.996 | 0.004 | 0.027 | -85.19% |
| ismin -de hali.txt | 1128 | 0.951 | 0.02 | 0.136 | -85.29% |
| ismin -i hali.txt | 1176 | 0.726 | 0.145 | 0.439 | -66.97% |
| tamlayan eki.txt | 1176 | 0.822 | 0.083 | 0.488 | -82.99% |
| vasıta eki (-le).txt | 1128 | 0.94 | 0.028 | 0.253 | -88.93% |
| çoğul eki.txt | 1128 | 0.848 | 0.081 | 1.0 | -91.9% |
| Overall | 15133 | 0.891 | 0.054 | 0.329 | -83.43% |

Table 58: *İsim çekim ekleri*: MRR Results of static word vectors generated by aggregating **Bert** embeddings.

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| aile.txt | 90 | 0.889 | 0.067 |
| es-anlamlilar.txt | 600 | 0.995 | 0.001 |
| para-birimi.txt | 156 | 0.968 | 0.024 |
| sehir-bolge.txt | 1344 | 0.562 | 0.264 |
| zit-anlamlilar.txt | 600 | 0.873 | 0.067 |
| ülke-başkent.txt | 506 | 0.583 | 0.249 |
| Overall | 3296 | 0.729 | 0.161 |

Table 59: *Semantic categories*: MRR Results of static word vectors generated by aggregating **Bert** embeddings.

| Similarity Task | Statistics | |
|----------------------|------------------------|--------------------------------|
| Syntactic Similarity | Pearson Result: 24.76 | p-value: 3.50×10^{-2} |
| | Spearman Result: 31.05 | p-value: 8.00×10^{-3} |
| | OOV Ratio: 47.86 | |
| Semantic Similarity | Pearson Result: 26.58 | p-value: 0.00×10 |
| | Spearman Result: 32.14 | p-value: 0.00×10 |
| | OOV Ratio: 28.60 | |

Table 60: Similarity test results of static word vectors generated by aggregating **Bert** embeddings trained on Turkish CoNLL17 corpus.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|--------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| 1. tekil kişi çekimi.txt | 990 | 0.116 | 0.684 | 0.339 | 101.77% |
| 2. tekil kişi çekimi.txt | 946 | 0.093 | 0.733 | 0.365 | 100.82% |
| 2. çoğul kişi çekimi.txt | 946 | 0.075 | 0.713 | 0.327 | 118.04% |
| 3. çoğul kişi çekimi.txt | 1128 | 0.273 | 0.541 | 0.42 | 28.81% |
| emir kipi.txt | 1176 | 0.069 | 0.779 | 0.465 | 67.53% |
| gelecek zaman kipi.txt | 1176 | 0.025 | 0.882 | 0.707 | 24.75% |
| gereklilik kipi.txt | 1128 | 0.121 | 0.71 | 0.467 | 52.03% |
| geçmiş zaman eki (-di).txt | 1176 | 0.105 | 0.75 | 0.535 | 40.19% |
| geçmiş zaman eki (-miş).txt | 1176 | 0.043 | 0.887 | 0.774 | 14.6% |
| istek kipi.txt | 1176 | 0.079 | 0.819 | 0.534 | 53.37% |
| olumsuzluk eki.txt | 1176 | 0.046 | 0.751 | 0.67 | 12.09% |
| şimdiki zaman eki (-mekte).txt | 1176 | 0.044 | 0.843 | 0.646 | 30.5% |
| şimdiki zaman eki (-yor).txt | 861 | 0.015 | 0.924 | 0.847 | 9.09% |
| Overall | 14231 | 0.085 | 0.771 | 0.549 | 40.37% |

Table 61: *Fül çekim ekleri*: MRR Results of static word vectors generated with **X2Static** from BERT model.

| Morphological Categories | Number of examples | Topn Miss Ratio | MRR | Reference MRR | Improvement with respect to reference |
|------------------------------|--------------------|-----------------|-------|---------------|---------------------------------------|
| -den eki.txt | 1128 | 0.171 | 0.491 | 0.238 | 106.3% |
| -e eki.txt | 1176 | 0.194 | 0.502 | 0.236 | 112.71% |
| 1. tekil kişi iyelik.txt | 1128 | 0.362 | 0.39 | 0.148 | 163.51% |
| 1. çoğul kişi iyelik.txt | 1128 | 0.233 | 0.498 | 0.25 | 99.2% |
| 2. tekil kişi iyelik.txt | 1176 | 0.407 | 0.449 | 0.321 | 39.88% |
| 2. çoğul kişi iyelik.txt | 1081 | 0.241 | 0.527 | 0.196 | 168.88% |
| 3. tekil kişi iyelik eki.txt | 1176 | 0.099 | 0.59 | 0.448 | 31.7% |
| 3. çoğul kişi iyelik.txt | 1128 | 0.271 | 0.327 | 0.178 | 83.71% |
| eşitlik eki (-ce).txt | 276 | 0.663 | 0.096 | 0.027 | 255.56% |
| ismin -de hali.txt | 1128 | 0.376 | 0.291 | 0.136 | 113.97% |
| ismin -i hali.txt | 1176 | 0.102 | 0.646 | 0.439 | 47.15% |
| tamlayan eki.txt | 1176 | 0.093 | 0.721 | 0.488 | 47.75% |
| vasıta eki (-le).txt | 1128 | 0.185 | 0.544 | 0.253 | 115.02% |
| çoğul eki.txt | 1128 | 0.196 | 0.599 | 1.0 | -40.1% |
| Overall | 15133 | 0.233 | 0.499 | 0.329 | 51.88% |

Table 62: *İsim çekim ekleri*: MRR Results of static word vectors generated with **X2Static** from BERT model.

| Semantic Categories | Number of examples | Top-N Miss Ratio | MRR |
|---------------------|--------------------|------------------|-------|
| aile.txt | 90 | 0.244 | 0.546 |
| es-anlamlilar.txt | 600 | 0.402 | 0.39 |
| para-birimi.txt | 156 | 0.673 | 0.141 |
| sehir-bolge.txt | 1344 | 0.249 | 0.439 |
| zit-anlamlilar.txt | 600 | 0.372 | 0.437 |
| ülke-başkent.txt | 506 | 0.342 | 0.258 |
| Overall | 3296 | 0.333 | 0.391 |

Table 63: *Semantic Categories*: MRR Results of static word vectors generated with **X2Static** from BERT model.