# Supplementary Materials for How Correlated are Community-aware and Classical Network Centrality Measures

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**Abstract.** Community structure has a tremendous effect on identifying influential nodes in complex networks. Unlike classical centrality measures, recently developed community-aware centrality measures make use of a network's community structure. This paper investigates the relationship between both types of measures on a set of fifty real-world networks originating from various domains. Results show that classical and community-aware centrality measures generally exhibit a medium to low correlation across the networks. Additionally, transitivity, efficiency are the most influential macroscopic features while the mixing parameter, modularity, and Max-ODF are the most influential mesoscopic features affecting the correlation between classical and community-aware centrality measures.

**Table 1.** Macroscopic topological properties of real-world networks. $N$ is the total number of nodes. $E$ is the number of edges. $< k >$ is the average degree. $< d >$ is the average distance. $\nu$ is the density. $\zeta$ is the transitivity. $k_{nn}(k)$ is the assortativity. $D$ is the diameter. $\epsilon$ is the efficiency. $\gamma_{pred}$ is the estimated exponent of the degree distribution. * indicates the largest connected component if the network is disconnected.

| Network | $N$ | $E$ | $< k >$ | $< d >$ | $\nu$ | $\zeta$ | $k_{nn}(k)$ | $D$ | $\epsilon$ | $\gamma_{pred}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Zachary Karate Club | 34 | 78 | 4.58 | 2.40 | 0.139 | 0.255 | -0.475 | 5 | 0.492 | 2.094 |
| U.S. States | 49 | 107 | 4.36 | 4.16 | 0.090 | 0.406 | 0.233 | 11 | 0.388 | 1.478 |
| Dolphins | 62 | 159 | 5.12 | 3.35 | 0.084 | 0.308 | -0.043 | 8 | 0.379 | 1.470 |
| Madrid Train Bombings | 64 | 243 | 7.59 | 2.69 | 0.120 | 0.561 | 0.029 | 6 | 0.448 | 1.425 |
| Blumenau Drug | 75 | 181 | 4.83 | 2.81 | 0.065 | 0.108 | -0.314 | 6 | 0.407 | 2.437 |
| Les Misérables | 77 | 254 | 6.59 | 2.64 | 0.086 | 0.498 | -0.165 | 5 | 0.435 | 1.689 |
| PolBooks | 105 | 441 | 8.40 | 3.07 | 0.080 | 0.348 | -0.127 | 7 | 0.397 | 2.600 |
| Game of Thrones | 107 | 352 | 6.58 | 2.90 | 0.062 | 0.328 | -0.130 | 6 | 0.398 | 2.022 |
| Movie Galaxies | 109 | 326 | 5.98 | 2.06 | 0.055 | 0.162 | -0.360 | 3 | 0.508 | 2.392 |
| Football | 115 | 613 | 10.66 | 2.50 | 0.093 | 0.407 | 0.162 | 4 | 0.450 | 1.327 |
| Marvel Partnerships* | 181 | 224 | 2.48 | 7.92 | 0.014 | 0.216 | -0.207 | 21 | 0.166 | 1.724 |
| Mouse Visual Cortex | 193 | 214 | 2.21 | 4.27 | 0.015 | 0.004 | -0.844 | 8 | 0.271 | 2.060 |
| Internet Topology Cogentco | 197 | 243 | 2.47 | 10.51 | 0.013 | 0.019 | 0.027 | 28 | 0.137 | 1.660 |
| Jazz | 198 | 2,742 | 27.69 | 2.23 | 0.140 | 0.520 | 0.020 | 6 | 0.513 | 1.477 |
| Malaria Genes | 307 | 2,812 | 18.32 | 3.52 | 0.060 | 0.587 | 0.599 | 8 | 0.349 | 2.443 |
| E. coli Transcription* | 329 | 456 | 2.77 | 4.84 | 0.008 | 0.023 | -0.263 | 13 | 0.245 | 2.295 |
| Facebook Friends* | 329 | 1,954 | 11.88 | 3.58 | 0.036 | 0.512 | 0.074 | 9 | 0.326 | 2.015 |
| London Transport | 369 | 430 | 2.33 | 13.73 | 0.006 | 0.051 | 0.137 | 39 | 0.101 | 1.682 |
| NetSci | 379 | 914 | 4.83 | 6.04 | 0.012 | 0.430 | -0.081 | 17 | 0.203 | 2.386 |
| EU Airlines | 417 | 2,953 | 14.16 | 2.76 | 0.034 | 0.304 | -0.152 | 7 | 0.400 | 2.061 |
| Reptiles* | 496 | 984 | 3.96 | 7.93 | 0.008 | 0.419 | 0.345 | 21 | 0.155 | 2.120 |
| U.S. Airports | 500 | 2,980 | 11.92 | 2.99 | 0.023 | 0.351 | -0.267 | 7 | 0.371 | 1.702 |
| Retweets Copenhagen | 761 | 1,029 | 2.70 | 5.35 | 0.003 | 0.060 | -0.099 | 14 | 0.208 | 2.178 |
| Caltech* | 762 | 16,651 | 43.70 | 2.23 | 0.057 | 0.291 | -0.066 | 6 | 0.461 | 3.005 |
| DNC Emails* | 849 | 10,384 | 24.46 | 2.76 | 0.029 | 0.548 | -0.133 | 8 | 0.399 | 1.417 |
| Board of Directors* | 854 | 2,745 | 6.43 | 6.67 | 0.008 | 0.624 | 0.051 | 17 | 0.176 | 2.150 |
| Yeast Collins* | 1,004 | 8,319 | 16.57 | 5.55 | 0.016 | 0.617 | 0.556 | 15 | 0.220 | 2.120 |
| Budapest Connectome | 1,015 | 70,654 | 139.22 | 2.22 | 0.137 | 0.558 | 0.215 | 5 | 0.510 | 1.696 |
| CS Ph.D.* | 1,025 | 1,043 | 2.03 | 11.74 | 0.001 | 0.002 | -0.253 | 28 | 0.105 | 1.928 |
| EuroRoad* | 1,039 | 1,305 | 2.51 | 18.39 | 0.002 | 0.035 | 0.090 | 62 | 0.077 | 1.660 |
| Yeast Protein* | 1,458 | 1,993 | 2.73 | 6.81 | 0.001 | 0.051 | -0.207 | 19 | 0.163 | 2.185 |
| New Zealand Collaboration* | 1,463 | 4,246 | 5.80 | 2.75 | 0.003 | 0.063 | -0.340 | 6 | 0.381 | 2.112 |
| Bible Nouns* | 1,707 | 9,059 | 10.61 | 3.38 | 0.006 | 0.162 | -0.052 | 8 | 0.320 | 2.134 |
| Hamsterster* | 1,788 | 12,476 | 13.49 | 3.45 | 0.007 | 0.090 | -0.088 | 14 | 0.317 | 1.868 |
| Kegg Metabolic* | 1,865 | 5,769 | 6.19 | 3.12 | 0.003 | 0.030 | -0.224 | 8 | 0.342 | 2.331 |
| Human Protein* | 2,217 | 6,418 | 5.78 | 3.84 | 0.002 | 0.007 | -0.331 | 10 | 0.281 | 2.240 |
| Adolescent Health | 2,539 | 10,455 | 8.23 | 4.55 | 0.003 | 0.141 | 0.251 | 10 | 0.234 | 1.876 |
| Interactome Vidal* | 2,783 | 6,007 | 4.32 | 4.84 | 0.002 | 0.035 | -0.137 | 13 | 0.223 | 2.192 |
| Ego Facebook | 4,039 | 88,234 | 43.69 | 3.69 | 0.010 | 0.519 | 0.063 | 8 | 0.306 | 2.291 |
| GrQc | 4,158 | 13,422 | 6.45 | 6.04 | 0.001 | 0.628 | 0.639 | 17 | 0.179 | 2.042 |
| U.S. Power Grid | 4,941 | 6,594 | 2.66 | 18.98 | 0.005 | 0.103 | 0.003 | 46 | 0.062 | 1.669 |
| Facebook Organizations | 5,524 | 94,219 | 34.11 | 3.50 | 0.006 | 0.222 | 0.103 | 9 | 0.313 | 2.279 |
| Facebook Politician Pages | 5,908 | 41,729 | 14.12 | 4.66 | 0.002 | 0.301 | 0.018 | 14 | 0.231 | 2.664 |
| Internet Autonomous Systems | 6,474 | 12,572 | 3.88 | 3.70 | 0.0006 | 0.009 | -0.181 | 9 | 0.290 | 2.356 |
| Princeton* | 6,575 | 293,307 | 89.21 | 2.67 | 0.013 | 0.163 | 0.090 | 9 | 0.400 | 3.046 |
| PGP | 10,680 | 24,316 | 4.55 | 7.48 | 0.0004 | 0.378 | 0.238 | 24 | 0.147 | 2.804 |
| DBLP* | 12,494 | 49,579 | 7.94 | 4.42 | 0.0006 | 0.062 | -0.046 | 10 | 0.240 | 2.324 |
| 911AllWords | 13,308 | 148,035 | 22.25 | 3.12 | 0.0016 | 0.106 | -0.108 | 10 | 0.334 | 2.023 |
| AstroPh* | 17,903 | 196,972 | 22.00 | 4.19 | 0.001 | 0.317 | 0.201 | 14 | 0.255 | 2.891 |
| DeezerEU | 28,281 | 92,752 | 6.55 | 6.44 | 0.002 | 0.095 | 0.104 | 21 | 0.169 | 2.273 |

**Table 2.** Mesoscopic topological properties of real-world networks with community structure unveiled using Infomap. $\mu$ is the mixing parameter. $Q$ is the modularity. $\chi$ is the internal degree. $\varphi$ is the internal distance. $\psi$ is the internal density. $\eta$ is the Max-ODF. $\iota$ is the Average-ODF. $\kappa$ is the Flake-ODF. $\backepsilon$ is the embeddedness. $\hbar$ is the hub dominance.

| Network | $\mu$ | $Q$ | $\chi$ | $\varphi$ | $\psi$ | $\eta$ | $\iota$ | $\kappa$ | $\backepsilon$ | $\hbar$ |
|---|---|---|---|---|---|---|---|---|---|---|
| EU Airlines | 0.073 | 0.109 | 3.97 | 1.49 | 0.596 | 0.559 | 0.266 | 0.388 | 0.734 | 0.874 |
| Ego Facebook | 0.077 | 0.814 | 14.69 | 1.53 | 0.538 | 0.457 | 0.244 | 0.176 | 0.755 | 0.872 |
| U.S. Airports | 0.084 | 0.161 | 2.30 | 1.37 | 0.701 | 0.508 | 0.347 | 0.530 | 0.652 | 0.918 |
| Budapest Connectome | 0.088 | 0.525 | 90.75 | 1.22 | 0.295 | 0.412 | 0.070 | 0.009 | 0.680 | 0.921 |
| Facebook Politician Pages | 0.111 | 0.836 | 5.33 | 1.85 | 0.402 | 0.466 | 0.180 | 0.199 | 0.819 | 0.756 |
| Facebook Friends | 0.112 | 0.688 | 5.17 | 1.54 | 0.554 | 0.486 | 0.231 | 0.286 | 0.769 | 0.838 |
| Madrid Train Bombings | 0.115 | 0.309 | 4.25 | 1.59 | 0.526 | 0.440 | 0.280 | 0.328 | 0.719 | 0.865 |
| Yeast Collins | 0.122 | 0.747 | 6.99 | 1.52 | 0.618 | 0.431 | 0.136 | 0.129 | 0.864 | 0.868 |
| Malaria Genes | 0.128 | 0.625 | 10.42 | 1.47 | 0.601 | 0.538 | 0.188 | 0.146 | 0.812 | 0.825 |
| CS Ph.D. | 0.128 | 0.859 | 1.70 | 1.97 | 0.306 | 0.307 | 0.068 | 0.068 | 0.931 | 0.793 |
| Reptiles | 0.145 | 0.811 | 2.77 | 1.85 | 0.443 | 0.400 | 0.133 | 0.127 | 0.866 | 0.722 |
| PolBooks | 0.145 | 0.522 | 5.39 | 1.57 | 0.511 | 0.516 | 0.245 | 0.177 | 0.754 | 0.769 |
| NetSci | 0.147 | 0.810 | 3.69 | 1.53 | 0.537 | 0.320 | 0.114 | 0.083 | 0.885 | 0.914 |
| Marvel Partnerships | 0.147 | 0.808 | 2.01 | 1.86 | 0.408 | 0.423 | 0.121 | 0.141 | 0.879 | 0.755 |
| 911AllWords | 0.153 | 0.052 | 1.72 | 1.63 | 0.603 | 0.699 | 0.548 | 0.834 | 0.452 | 0.820 |
| Mouse Visual Cortex | 0.154 | 0.740 | 1.84 | 1.84 | 0.161 | 0.345 | 0.090 | 0.144 | 0.909 | 1 |
| U.S. Power Grid | 0.166 | 0.830 | 2.08 | 2.56 | 0.242 | 0.435 | 0.130 | 0.140 | 0.869 | 0.475 |
| Board of Directors | 0.167 | 0.817 | 5.16 | 1.49 | 0.578 | 0.459 | 0.141 | 0.118 | 0.859 | 0.904 |
| PGP | 0.172 | 0.813 | 2.40 | 1.97 | 0.388 | 0.381 | 0.097 | 0.102 | 0.902 | 0.727 |
| Zachary Karate Club | 0.179 | 0.402 | 3.47 | 1.66 | 0.404 | 0.294 | 0.163 | 0.027 | 0.836 | 0.844 |
| London Transport | 0.198 | 0.779 | 1.83 | 2.49 | 0.313 | 0.497 | 0.170 | 0.273 | 0.830 | 0.452 |
| GrQc | 0.200 | 0.779 | 3.73 | 1.87 | 0.394 | 0.461 | 0.155 | 0.151 | 0.844 | 0.765 |
| EuroRoad | 0.202 | 0.786 | 1.94 | 2.70 | 0.254 | 0.463 | 0.161 | 0.205 | 0.838 | 0.398 |
| Internet Topology Cogentco | 0.206 | 0.751 | 1.91 | 2.23 | 0.326 | 0.487 | 0.179 | 0.199 | 0.821 | 0.473 |
| DNC Emails | 0.211 | 0.416 | 5.70 | 1.40 | 0.633 | 0.561 | 0.323 | 0.466 | 0.677 | 0.925 |
| Dolphins | 0.213 | 0.525 | 3.41 | 1.75 | 0.467 | 0.532 | 0.292 | 0.312 | 0.707 | 0.695 |
| U.S. States | 0.224 | 0.596 | 3.35 | 1.64 | 0.479 | 0.475 | 0.180 | 0.144 | 0.819 | 0.767 |
| Yeast Protein | 0.240 | 0.749 | 1.94 | 2.04 | 0.324 | 0.432 | 0.149 | 0.173 | 0.850 | 0.728 |
| E. coli Transcription | 0.250 | 0.687 | 1.69 | 1.66 | 0.466 | 0.464 | 0.208 | 0.315 | 0.791 | 0.883 |
| Game of Thrones | 0.267 | 0.482 | 3.80 | 1.63 | 0.421 | 0.503 | 0.214 | 0.207 | 0.786 | 0.937 |
| Jazz | 0.267 | 0.443 | 15.51 | 1.51 | 0.540 | 0.612 | 0.280 | 0.268 | 0.719 | 0.835 |
| Les Misérables | 0.267 | 0.551 | 4.30 | 1.45 | 0.584 | 0.441 | 0.178 | 0.141 | 0.821 | 0.938 |
| Retweets Copenhagen | 0.287 | 0.695 | 1.80 | 1.93 | 0.338 | 0.433 | 0.129 | 0.160 | 0.870 | 0.778 |
| Football | 0.293 | 0.604 | 7.58 | 1.27 | 0.751 | 0.435 | 0.293 | 0.056 | 0.293 | 0.821 |
| Hamsterster | 0.298 | 0.391 | 3.52 | 1.86 | 0.369 | 0.623 | 0.317 | 0.417 | 0.682 | 0.746 |
| Blumenau Drug | 0.337 | 0.441 | 2.58 | 1.845 | 0.326 | 0.571 | 0.246 | 0.279 | 0.754 | 0.705 |
| Human Protein | 0.360 | 0.466 | 2.03 | 2.06 | 0.253 | 0.595 | 0.281 | 0.399 | 0.718 | 0.786 |
| Princeton | 0.365 | 0.417 | 15.74 | 1.77 | 0.480 | 0.708 | 0.459 | 0.584 | 0.540 | 0.725 |
| Facebook Organizations | 0.366 | 0.585 | 15.09 | 1.95 | 0.267 | 0.716 | 0.461 | 0.517 | 0.539 | 0.633 |
| Interactome Vidal | 0.405 | 0.576 | 2.08 | 2.20 | 0.297 | 0.559 | 0.252 | 0.344 | 0.748 | 0.648 |
| Caltech | 0.410 | 0.389 | 13.35 | 1.79 | 0.427 | 0.657 | 0.425 | 0.488 | 0.574 | 0.731 |
| AstroPh | 0.420 | 0.563 | 6.62 | 1.89 | 0.410 | 0.627 | 0.302 | 0.324 | 0.697 | 0.740 |
| Internet Autonomous Systems | 0.428 | 0.547 | 1.78 | 1.94 | 0.350 | 0.508 | 0.312 | 0.480 | 0.687 | 0.810 |
| DeezerEU | 0.429 | 0.565 | 2.59 | 2.48 | 0.223 | 0.573 | 0.321 | 0.423 | 0.678 | 0.570 |
| Movie Galaxies | 0.429 | 0.401 | 2.89 | 1.57 | 0.498 | 0.547 | 0.379 | 0.382 | 0.621 | 0.919 |
| Adolescent Health | 0.431 | 0.566 | 3.47 | 2.29 | 0.284 | 0.704 | 0.473 | 0.582 | 0.526 | 0.511 |
| DBLP | 0.433 | 0.546 | 2.54 | 2.26 | 0.195 | 0.583 | 0.257 | 0.358 | 0.743 | 0.696 |
| Kegg Metabolic | 0.466 | 0.437 | 1.77 | 1.79 | 0.529 | 0.592 | 0.427 | 0.697 | 0.573 | 0.736 |
| Bible Nouns | 0.496 | 0.460 | 4.00 | 1.88 | 0.358 | 0.663 | 0.343 | 0.416 | 0.657 | 0.757 |
| New Zealand Collaboration | 0.564 | 0.401 | 2.28 | 1.73 | 0.386 | 0.645 | 0.384 | 0.552 | 0.616 | 0.891 |

**Table 3.** Simple linear regression estimates using ordinary least squares for Mean($\alpha_i, \beta_{CHB}$) as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \lvert T \rvert$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| Density | 0.146 | 0.423 | 0.345 | 0.731 | [-0.705; 0.997] | 0.002 |
| Transitivity | 0.031 | 0.085 | 0.361 | 0.720 | [-0.141; 0.202] | 0.003 |
| Assortativity | 0.074 | 0.065 | 1.138 | 0.261 | [-0.057; 0.206] | 0.026 |
| Average distance | -0.003 | 0.005 | -0.660 | 0.512 | [-0.013; 0.006] | 0.009 |
| Diameter | -0.001 | 0.002 | -0.484 | 0.631 | [-0.004; 0.002] | 0.005 |
| Efficiency | 0.014 | 0.144 | 0.100 | 0.921 | [-0.275; 0.303] | 0.001 |
| Degree distribution exponent | 0.066 | 0.043 | 1.553 | 0.127 | [-0.020; 0.152] | 0.049 |
| Modularity | 0.110 | 0.088 | 1.250 | 0.218 | [-0.067; 0.288] | 0.032 |
| **Mixing parameter*** | 0.392 | 0.124 | 3.171 | 0.003 | [0.144; 0.641] | 0.173 |
| Internal distance | 0.074 | 0.052 | 1.43 | 0.159 | [-0.030; 0.179] | 0.041 |
| Internal density | -0.233 | 0.124 | -1.882 | 0.066 | [-0.481; 0.016] | 0.069 |
| Max-ODF | 0.228 | 0.164 | 1.390 | 0.171 | [-0.102; 0.557] | 0.039 |
| Average-ODF | -0.003 | 0.153 | -0.017 | 0.986 | [-0.310; 0.305] | 0.0001 |
| Flake-ODF | -0.055 | 0.096 | -0.571 | 0.571 | [-0.247; 0.138] | 0.007 |
| Embeddedness | 0.065 | 0.156 | 0.413 | 0.681 | [-0.250; 0.379] | 0.004 |
| Hub dominance | -0.125 | 0.127 | -0.985 | 0.330 | [-0.381; 0.130] | 0.020 |

**Table 4.** Simple linear regression estimates using ordinary least squares for Mean($\alpha_i, \beta_{PC}$) as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \lvert T \rvert$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| Density | -0.866 | 0.486 | -1.780 | 0.081 | [-1.844; 0.112] | 0.062 |
| **Transitivity*** | -0.351 | 0.088 | -4.00 | 0.0001 | [-0.527; -0.175] | 0.250 |
| **Assortativity** | -0.193 | 0.073 | -2.628 | 0.012 | [-0.341; -0.045] | 0.126 |
| Average distance | 0.005 | 0.006 | 0.857 | 0.395 | [-0.006; 0.016] | 0.015 |
| Diameter | 0.002 | 0.002 | 0.886 | 0.380 | [-0.002; 0.005] | 0.016 |
| Efficiency | -0.282 | 0.165 | -1.707 | 0.094 | [-0.615; 0.050] | 0.057 |
| Degree distribution exponent | 0.001 | 0.052 | 0.021 | 0.983 | [-0.103; 0.105] | 0.0001 |
| Modularity | 0.071 | 0.106 | 0.673 | 0.504 | [-0.141; 0.284] | 0.009 |
| **Mixing parameter*** | 0.523 | 0.142 | 3.67 | 0.001 | [0.237; 0.809] | 0.219 |
| **Internal distance*** | 0.160 | 0.058 | 2.733 | 0.009 | [0.042; 0.277] | 0.135 |
| **Internal density*** | -0.554 | 0.129 | -4.293 | 0.0001 | [-0.813; -0.294] | 0.277 |
| Max-ODF | -0.060 | 0.198 | -0.305 | 0.762 | [-0.458; 0.337] | 0.002 |
| Average-ODF | -0.263 | 0.177 | -1.486 | 0.144 | [-0.619; 0.093] | 0.044 |
| Flake-ODF | -0.010 | 0.114 | -0.086 | 0.932 | [-0.238; 0.219] | 0.0001 |
| Embeddedness | 0.306 | 0.180 | 1.697 | 0.096 | [-0.057; 0.668] | 0.057 |
| Hub dominance | -0.054 | 0.152 | -0.357 | 0.722 | [-0.360; 0.251] | 0.003 |

**Table 5.** Simple linear regression estimates using ordinary least squares for Mean$(\alpha_i, \beta_{CBM})$ as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \|T\|$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| Density | -0.239 | 0.450 | -0.531 | 0.598 | [-1.145; 0.666] | 0.006 |
| **Transitivity*** | -0.264 | 0.083 | -3.188 | 0.003 | [-0.430; -0.097] | 0.175 |
| **Assortativity** | -0.170 | 0.066 | -2.570 | 0.013 | [-0.303; -0.037] | 0.121 |
| Average distance | -0.008 | 0.005 | -1.690 | 0.098 | [-0.018; 0.002] | 0.056 |
| Diameter | -0.002 | 0.002 | -1.413 | 0.164 | [-0.006; 0.001] | 0.040 |
| Efficiency | 0.245 | 0.149 | 1.640 | 0.108 | [-0.055; 0.545] | 0.053 |
| Degree distribution exponent | 0.086 | 0.045 | 1.898 | 0.064 | [-0.005; 0.177] | 0.071 |
| **Modularity** | -0.187 | 0.092 | -2.043 | 0.047 | [-0.371; -0.003] | 0.080 |
| **Mixing parameter*** | 0.757 | 0.095 | 7.946 | 0.0001 | [0.566; 0.949] | 0.568 |
| Internal distance | 0.089 | 0.055 | 1.617 | 0.112 | [-0.022; 0.200] | 0.052 |
| **Internal density** | -0.309 | 0.129 | -2.392 | 0.021 | [-0.568; -0.049] | 0.107 |
| **Max-ODF*** | 0.539 | 0.160 | 3.365 | 0.002 | [0.217; 0.861] | 0.191 |
| **Average-ODF*** | 0.444 | 0.150 | 2.960 | 0.005 | [0.142; 0.745] | 0.154 |
| **Flake-ODF*** | 0.268 | 0.095 | 2.835 | 0.007 | [0.078; 0.458] | 0.143 |
| **Embeddedness*** | -0.405 | 0.156 | -2.593 | 0.013 | [-0.719; -0.091] | 0.123 |
| Hub dominance | -0.042 | 0.137 | -0.309 | 0.759 | [-0.317; 0.233] | 0.002 |

**Table 6.** Simple linear regression estimates using ordinary least squares for Mean$(\alpha_i, \beta_{Comm})$ as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \|T\|$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| **Density*** | 1.516 | 0.430 | 3.524 | 0.001 | [0.651; 2.381] | 0.206 |
| Transitivity | 0.153 | 0.095 | 1.615 | 0.113 | [-0.038; 0.344] | 0.052 |
| Assortativity | 0.069 | 0.075 | 0.922 | 0.361 | [-0.081; 0.219] | 0.017 |
| Average distance | -0.004 | 0.005 | -0.826 | 0.413 | [-0.015; 0.006] | 0.014 |
| Diameter | -0.001 | 0.002 | -0.692 | 0.492 | [-0.005; 0.002] | 0.010 |
| **Efficiency** | 0.389 | 0.154 | 2.529 | 0.015 | [0.080; 0.698] | 0.118 |
| Degree distribution exponent | -0.017 | 0.050 | -0.341 | 0.735 | [-0.118; 0.084] | 0.002 |
| Modularity | -0.129 | 0.100 | -1.284 | 0.205 | [-0.331; 0.073] | 0.033 |
| Mixing parameter | 0.073 | 0.155 | 0.474 | 0.638 | [-0.237; 0.384] | 0.005 |
| Internal distance | -0.037 | 0.060 | -0.609 | 0.546 | [-0.158; 0.084] | 0.008 |
| Internal density | 0.006 | 0.146 | 0.043 | 0.966 | [-0.287; 0.299] | 0.0001 |
| Max-ODF | 0.219 | 0.188 | 1.169 | 0.248 | [-0.158; 0.597] | 0.028 |
| Average-ODF | 0.048 | 0.174 | 0.274 | 0.785 | [-0.302; 0.398] | 0.002 |
| Flake-ODF | -0.076 | 0.109 | -0.704 | 0.485 | [-0.295; 0.142] | 0.010 |
| Embeddedness | -0.121 | 0.177 | -0.680 | 0.500 | [-0.477; 0.236] | 0.010 |
| Hub dominance | -0.073 | 0.146 | -0.498 | 0.620 | [-0.366; 0.221] | 0.005 |

**Table 7.** Simple linear regression estimates using ordinary least squares for Mean($\alpha_i, \beta_{MV}$) as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \lvert T \rvert$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| Density | -0.861 | 0.673 | -1.280 | 0.207 | [-2.214; 0.492] | 0.033 |
| Transitivity | 0.074 | 0.138 | 0.539 | 0.592 | [-0.203; 0.351] | 0.052 |
| Assortativity | 0.124 | 0.106 | 1.172 | 0.247 | [-0.089; 0.336] | 0.028 |
| Average distance | 0.010 | 0.007 | 1.383 | 0.173 | [-0.005; 0.025] | 0.038 |
| Diameter | 0.004 | 0.002 | 1.474 | 0.147 | [-0.001; 0.009] | 0.043 |
| Efficiency | -0.349 | 0.227 | -1.541 | 0.130 | [-0.805; 0.106] | 0.047 |
| Degree distribution exponent | 0.072 | 0.071 | 1.018 | 0.314 | [-0.070; 0.215] | 0.022 |
| Modularity | 0.230 | 0.141 | 1.634 | 0.109 | [-0.053; 0.513] | 0.053 |
| Mixing parameter | -0.238 | 0.217 | -1.099 | 0.277 | [-0.674; 0.198] | 0.025 |
| Internal distance | 0.009 | 0.086 | 0.106 | 0.916 | [-0.163; 0.181] | 0.0001 |
| Internal density | 0.156 | 0.206 | 0.759 | 0.452 | [-0.257; 0.569] | 0.012 |
| Max-ODF | -0.120 | 0.269 | -0.447 | 0.657 | [-0.662; 0.421] | 0.004 |
| Average-ODF | -0.005 | 0.247 | -0.018 | 0.985 | [-0.501; 0.492] | 0.0001 |
| Flake-ODF | -0.042 | 0.155 | -0.270 | 0.788 | [-0.353; 0.269] | 0.002 |
| Embeddedness | 0.040 | 0.253 | 0.160 | 0.874 | [-0.468; 0.549] | 0.001 |
| Hub dominance | -0.078 | 0.207 | -0.378 | 0.707 | [-0.495; 0.338] | 0.003 |

**Table 8.** Simple linear regression estimates using ordinary least squares for Mean($\alpha_i, \beta_{CBC}$) as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \lvert T \rvert$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| **Density** | 1.016 | 0.406 | 2.502 | 0.016 | [0.200; 1.833] | 0.115 |
| **Transitivity** | 0.173 | 0.083 | 2.070 | 0.044 | [0.005; 0.341] | 0.082 |
| Assortativity | -0.042 | 0.067 | -0.629 | 0.532 | [-0.178; 0.093] | 0.008 |
| **Average distance*** | -0.015 | 0.004 | -3.418 | 0.001 | [-0.023; -0.006] | 0.196 |
| **Diameter*** | -0.004 | 0.001 | -2.961 | 0.005 | [-0.007; -0.001] | 0.154 |
| **Efficiency*** | 0.524 | 0.126 | 4.173 | 0.0001 | [0.271; 0.776] | 0.266 |
| Degree distribution exponent | 0.013 | 0.038 | 0.328 | 0.744 | [-0.064; 0.089] | 0.002 |
| **Modularity*** | -0.344 | 0.077 | -4.486 | 0.0001 | [-0.498; -0.190] | 0.295 |
| Mixing parameter | 0.007 | 0.139 | 0.049 | 0.961 | [-0.272; 0.285] | 0.0001 |
| **Internal distance** | -0.120 | 0.051 | -2.34 | 0.024 | [-0.223; -0.017] | 0.102 |
| Internal density | 0.196 | 0.127 | 1.543 | 0.129 | [-0.060; 0.452] | 0.047 |
| **Max-ODF** | 0.342 | 0.163 | 2.100 | 0.041 | [0.015; 0.670] | 0.084 |
| Average-ODF | 0.259 | 0.151 | 1.713 | 0.093 | [-0.045; 0.563] | 0.058 |
| Flake-ODF | 0.181 | 0.094 | 1.922 | 0.061 | [-0.008; 0.370] | 0.071 |
| Embeddedness | -0.281 | 0.154 | -1.823 | 0.074 | [-0.591; 0.029] | 0.065 |
| **Hub dominance** | 0.307 | 0.123 | 2.493 | 0.016 | [0.059; 0.554] | 0.115 |

**Table 9.** Simple linear regression estimates using ordinary least squares for Mean($\alpha_i, \beta_{ks}$) as the dependent variable. Independent variables are the macroscopic and mesoscopic properties considered individually. $\omega$ is the estimated coefficient. $\epsilon$ is the standard error. The confidence interval is based on 95% likelihood. $R^2$ is the coefficient of determination. * indicates $p \leq 0.05$. A bold font and * indicate $p \leq 0.01$.

| Independent Variable | $\omega$ | $\epsilon$ | $T$ | $p > \|T\|$ | Confidence Interval | $R^2$ |
|---|---|---|---|---|---|---|
| Density | 0.333 | 0.350 | 0.952 | 0.346 | [-0.370; 1.036] | 0.019 |
| Transitivity | 0.081 | 0.070 | 1.145 | 0.258 | [-0.061; 0.222] | 0.027 |
| Assortativity | -0.052 | 0.055 | -0.942 | 0.351 | [-0.162; 0.058] | 0.018 |
| **Average distance*** | -0.015 | 0.003 | -4.490 | 0.0001 | [-0.021; -0.008] | 0.296 |
| **Diameter*** | -0.004 | 0.001 | -3.871 | 0.0001 | [-0.007; -0.002] | 0.238 |
| **Efficiency*** | 0.407 | 0.104 | 3.897 | 0.0001 | [0.197; 0.617] | 0.240 |
| Degree distribution exponent | 0.048 | 0.030 | 1.583 | 0.120 | [-0.013; 0.109] | 0.051 |
| **Modularity*** | -0.316 | 0.059 | -5.334 | 0.0001 | [-0.435; -0.197] | 0.372 |
| Mixing parameter | 0.152 | 0.111 | 1.369 | 0.177 | [-0.071; 0.376] | 0.038 |
| Internal distance | -0.069 | 0.043 | -1.593 | 0.118 | [-0.155; 0.018] | 0.050 |
| Internal density | 0.004 | 0.106 | 0.431 | 0.668 | [-0.168; 0.260] | 0.004 |
| **Max-ODF*** | 0.463 | 0.122 | 3.793 | 0.0001 | [0.218; 0.709] | 0.231 |
| **Average-ODF*** | 0.382 | 0.115 | 3.328 | 0.002 | [0.151; 0.613] | 0.187 |
| **Flake-ODF*** | 0.250 | 0.071 | 3.511 | 0.001 | [0.107; 0.393] | 0.204 |
| **Embeddedness*** | -0.415 | 0.116 | -3.580 | 0.001 | [-0.648; -0.182] | 0.211 |
| **Hub dominance** | 0.229 | 0.102 | 2.248 | 0.029 | [0.024; 0.433] | 0.095 |

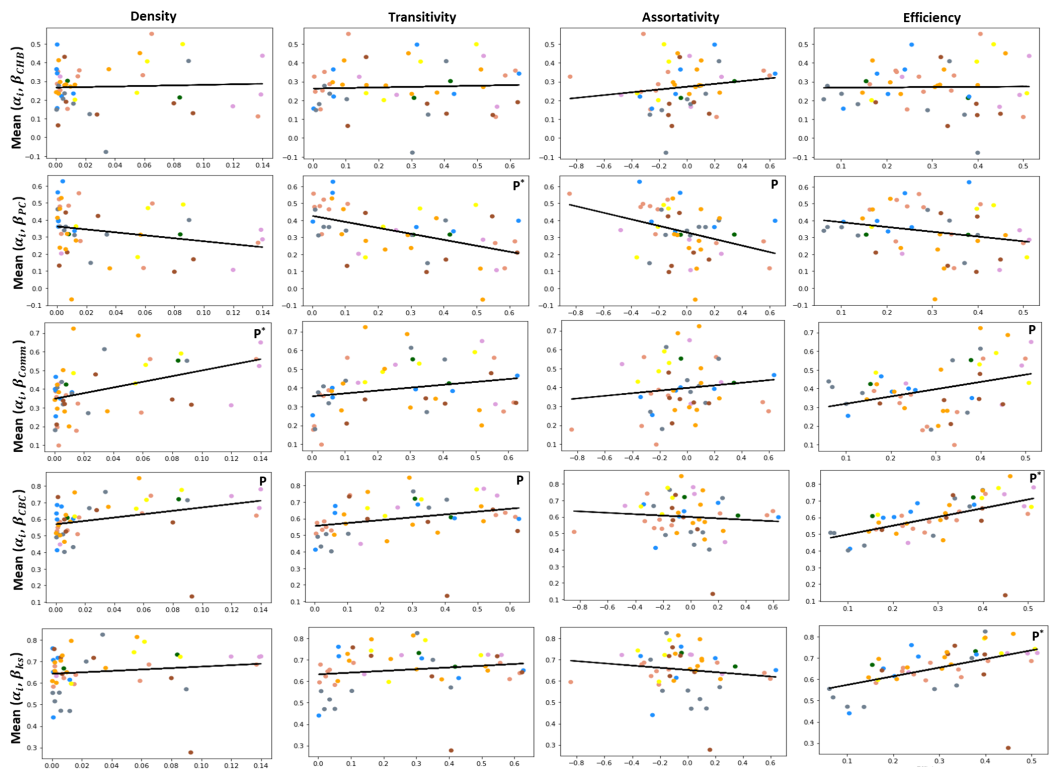


**Fig. 1.** Relationship of the mean of the correlation between each community-aware centrality measure combined with all classical centrality measures as a function of the topological properties of real-world networks. The line is fitted by linear regression using ordinary least squares. "P" indicates $p \leq 0.05$. "P" and * indicate $p \leq 0.01$. Colors represent the network's domain. Green color refers to animal networks. Pink color refers to biological networks. Blue color refers to collaboration networks. Violet color refers to human (offline) social networks. Grey color refers to infrastructural networks. Yellow color refers to actor networks. Brown colors refers to miscellaneous networks. Orange color refers to online social networks.

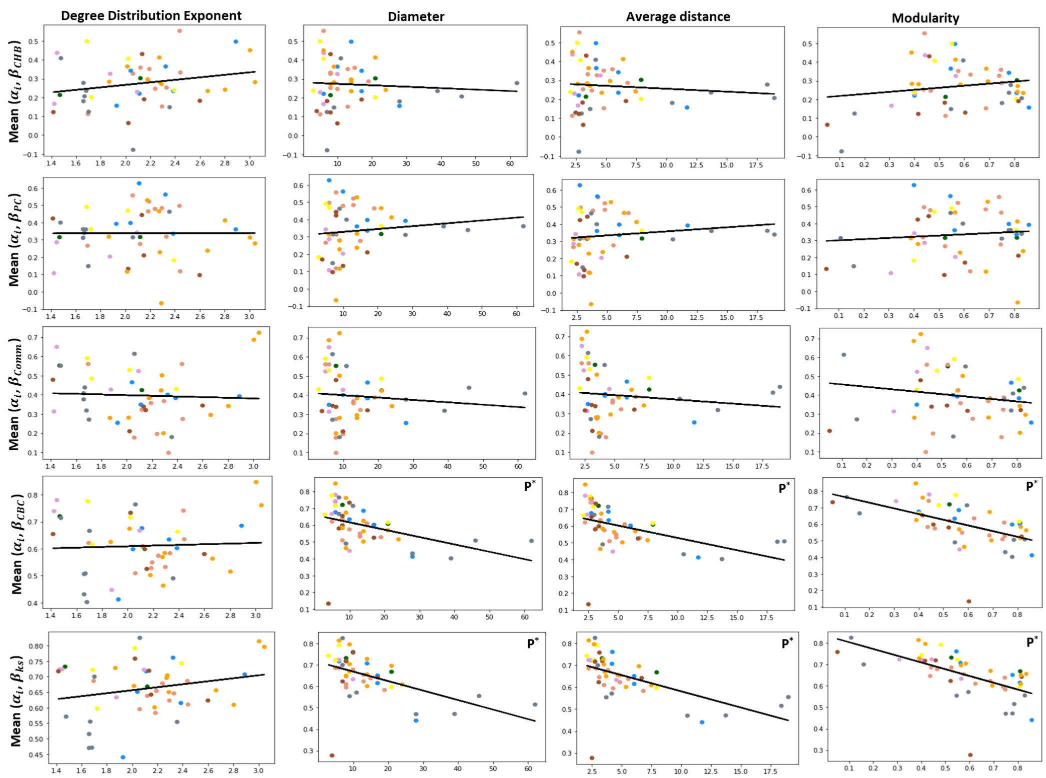


**Fig. 2.** Relationship of the mean of the correlation between each community-aware centrality measure combined with all classical centrality measures as a function of the topological properties of real-world networks. The line is fitted by linear regression using ordinary least squares. "P" indicates $p \leq 0.05$. "P" and * indicate $p \leq 0.01$. Colors represent the network's domain. Green color refers to animal networks. Pink color refers to biological networks. Blue color refers to collaboration networks. Violet color refers to human (offline) social networks. Grey color refers to infrastructural networks. Yellow color refers to actor networks. Brown colors refers to miscellaneous networks. Orange color refers to online social networks.

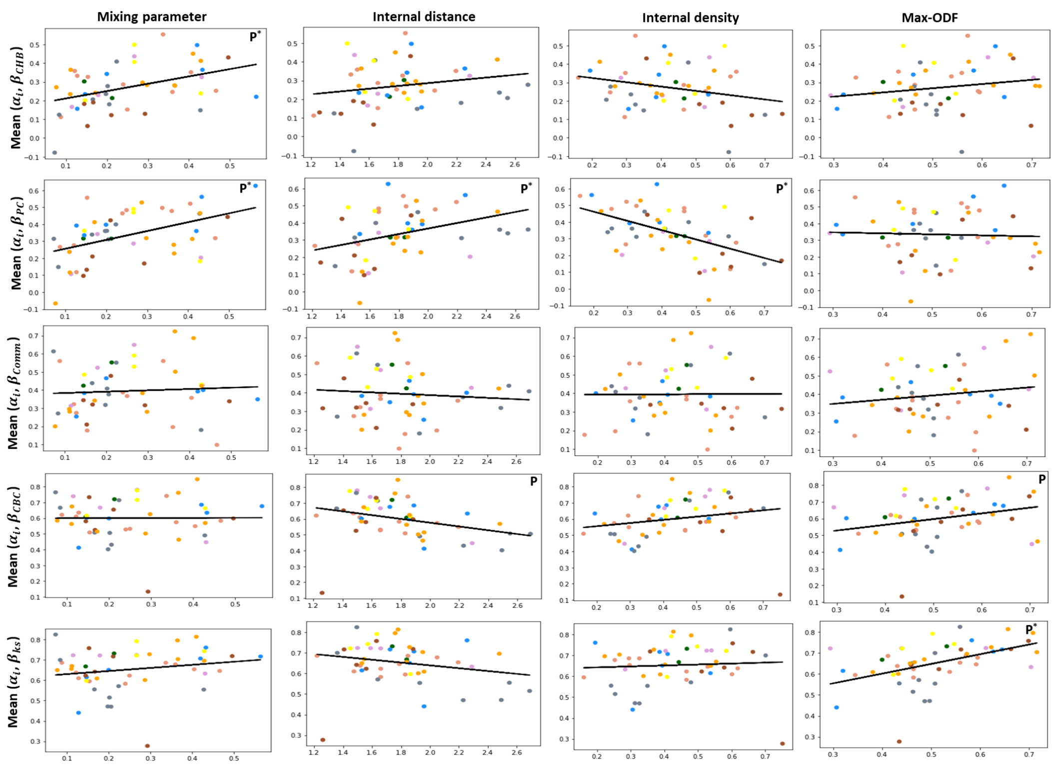


**Fig. 3.** Relationship of the mean of the correlation between each community-aware centrality measure combined with all classical centrality measures as a function of the topological properties of real-world networks. The line is fitted by linear regression using ordinary least squares. "P" indicates $p \leq 0.05$. "P" and * indicate $p \leq 0.01$. Colors represent the network's domain. Green color refers to animal networks. Pink color refers to biological networks. Blue color refers to collaboration networks. Violet color refers to human (offline) social networks. Grey color refers to infrastructural networks. Yellow color refers to actor networks. Brown colors refers to miscellaneous networks. Orange color refers to online social networks.

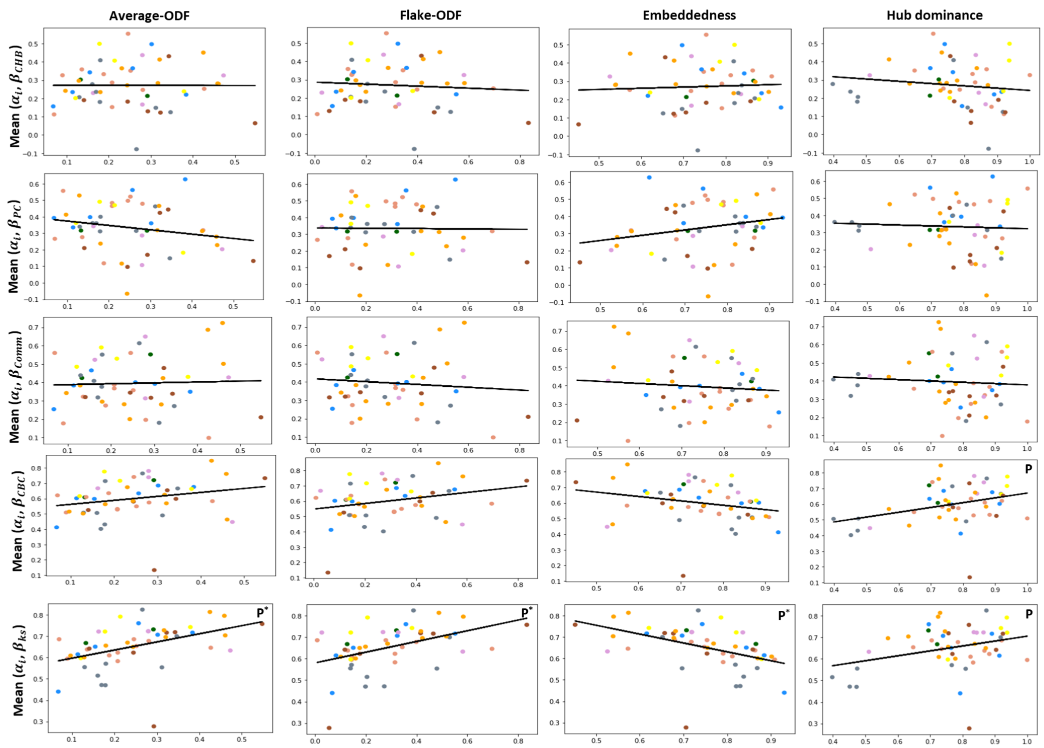


**Fig. 4.** Relationship of the mean of the correlation between each community-aware centrality measure combined with all classical centrality measures as a function of the topological properties of real-world networks. The line is fitted by linear regression using ordinary least squares. "P" indicates $p \leq 0.05$. "P" and * indicate $p \leq 0.01$. Colors represent the network's domain. Green color refers to animal networks. Pink color refers to biological networks. Blue color refers to collaboration networks. Violet color refers to human (offline) social networks. Grey color refers to infrastructural networks. Yellow color refers to actor networks. Brown colors refers to miscellaneous networks. Orange color refers to online social networks.