ORIGINAL ARTICLE
Journal Section

Information theoretic inference of magnitude and direction of gene flow in metapopulation networks using `nyemtaay`, with potential for applications in metastasizing cancer clonal cell origin analysis

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Funding information
This work was possible due to support from the National Science Foundation grant to author JS: NSF-DEB 1937725 "COLLABORATIVE RESEARCH: Phylogenomics, spatial phylogenetics and conservation prioritization in trapdoor spiders (and kin) of the California Floristic Province".

We introduce `nyemtaay`, a Python package for the calculation of classical population genetic statistics and inference of gene flow network connections and directionality in metapopulation networks using information theory. This genetic information flow network inference approach is applicable not only to ecological and evolutionary organism and landscape scale studies, but also has potential applications in, for example, cancer biology for analyzing clonal cell origins in metastasizing tumors. We demonstrate this potential through simulations and an analysis of metastasizing cancer cell lineages, showcasing its ability to identify the tissue site of origin in cancer networks. This work highlights the importance of considering demographic history and founder effects in interpreting gene flow directionality, and the benefits of this understanding in allowing application of this approach to gene flow network modeling to reach a broader range of domains.

Abbreviations: JSD, Jensen-Shannon divergence; KL, Kullback-Leibler (divergence).

[*] AOV: developed the `nyemtaay` code, including native Python implementations of all statistics; identified, downloaded, curated, and analyzed all the empirical datasets; contributed to the writing, ideas, and discussion. JS: conceived of, planned, and mentored the project; analyzed the models and theory; contributed to the writing, ideas, and discussion.

KEYWORDS
gene flow, directionality, network analysis, population genetics, information theory, cancer ecology

1 | INTRODUCTION

Here, we present `nyemtaay`[1], a Python package that in addition to providing a suite of ## traditional population genetic metrics such as nucleotide diversity, F_{st}, etc., also provides a novel implementation of information theoretic divergence statistics [1, 2] that support inference of gene flow direction in networks of genetically-related populations [3]. As with all information theoretic approaches, the metric extracts signal from patterns in the data without reference to any mechanistic or phenomenological processes, models, statistics or assumptions. This provides potential broad applicability to many different systems, with previous applications to networks of populations related through concurrent gene exchange at classical population genetic landscape scales [4] as well as in other information spaces with similar architectures, biomedical applications at microbiotic scales (cancer clonal systems), as well as to populations distributed in time and/or space, such as those related by historical gene exchange relationships (e.g., Neanderthals and humans). While pattern-based approaches do not have any particular model or generative process assumptions, however, the expressions that we use to extract information from data, and the interpretation of various measures based on the information, may require evaluation and possibly modification in applications where other processes may generate patterns that also structure the data. In the example here, we show that, while the statistic is effective in diagnosing asymmetry in general in the context in which it was developed, correctly interpreting the specific directionality requires taking into consideration of the demographic history of the populations in addition to their relationships, specifically with respect to processes or mechanisms by which genetic diversity can be reduced such as bottlenecks, founder effects or genetic drift. We demonstrate this using simulations, and demonstrate usage of the site frequency spectrum as a heuristic tool to identify a reduction of genetic diversity in founder effect populations. We then provide a sample analysis of a published known network of metastasizing cancer cell lineages to identify the tissue site from which the network originated and compare the results.

2 | MATERIALS AND METHODS

2.1 | Package description

`nyemtaay` is a pure Python package for the analysis of relationships of genetic samples in a population genetic framework that features the ability infer the gene flow network connectivity between sampling demes and any directionality in the connections.

2.2 | Classical population genetics analyses

The classical population genetic statistics provided by `nyemtaay` are described in detail in the appendix. While these statistics are available in a variety of other packages in other languages, `nyemtaay` provides independent implementation which are useful for testing/referencing purposes, as well as simplifying dependency stacks.

[1] "mountain lion" in Kumeyaay; San Diego State University is built on Kumeyaay land.

2.3 | Information theoretic directed gene flow network inference

`nyemtaay` organizes information extracted from a collection of genetic samples into a *directed genetic information flow network*, using an approach described by [4, 3], in two phases: by first (a) inferring the network structure in terms of pairwise node connections and the relative magnitude of the information flow between them based on entropic measures of genetic differences; followed by, (b) inferring a net directionality for each pair of connected nodes based on calculating and then interpreting an entropic index of segregation.

2.3.1 | Information flow network inference

Following [3, 4], given a collection of samples that can be organized into nominal clusters based on some *a priori* understanding of affinities (for e.g., the samples are associated with particular geographical or tissue sites), `nyemtaay` implements the calculation of the normalized Jensen-Shannon divergence (JSD) [5] between each distinct pair of clusters based on measures of information [1] extracted from genetic sequences in the samples from each of the clusters, and then constructs a gene flow network by connecting nodes representing the clusters based on the percolation threshold of the network [3, 6].

The entropy and mutual information [2] of the clusters are extracted from the genetic sequences based on patterns of relative frequencies of shared vs. exclusive alleles in the samples from both clusters [3, 4]. These measures of information facilitate the calculation of relative entropy, also known as the Kullback-Leibler (KL) divergence [7], between any two clusters. The Jensen-Shannon Divergence (JSD) between any pair of clusters is then given by the weighted average of the KL divergences of each cluster from their mutual mean, $\mathrm{JSD}(P\|Q) = \frac{1}{2}\mathrm{KL}(P\|M) + \frac{1}{2}\mathrm{KL}(Q\|M)$, where $M = \frac{1}{2}(P+Q)$ is a mixture distribution that is the average of the distributions P and Q (in this context, the pooled allele frequencies). The JSD is an entropy-based [1] measure of difference between two probability distributions, as is the KL divergence on which it is based. Unlike the KL divergence, however, the JSD is bounded between 0 and 1, and is symmetric (though still not a metric or true distance due to not fulfilling the triangle inequality axiom; the square root of this, however, does fulfill this and is a true distance). The JSD can be use to compare probability distributions with non matching supports [8, 4]. The JSD can be interpreted as providing a measure of divergence between the allele frequencies of each of the clusters being compared, taking into account patterns of alleles that are shared across clusters as well as those that are unique to one or the other cluster. These JSD values are then normalized to account for varying population size [3]. The normalized JSD values between each distinct pair of clusters are used to construct a gene flow network between the clusters. Each pair of clusters are connected to each other with the a direct gene flow path if their a mutual JSD value is equal to or below the percolation threshold value for the system. The percolation threshold describes the point at which a system transitions from a state where there are small isolated clusters to one where there exists at least one spanning cluster, i.e., a connected component that provides a continuous path across the system [9]. In this application, as we increase the divergence value below above which we assume clusters are isolated, the percolation threshold is the minimum divergence value at which a path emerges through the network that spans the entire area [3]. All distinct pairs of clusters that have JSD values below this threshold are considered to have sufficient convergence in genetic information to indicate gene flow, while those above the threshold are considered to be sufficiently divergent in genetic information to indicate lack of direct gene flow.

This approach to gene flow network inference — with direct connections between clusters indicated by entropy-based divergence values equal to or below the percolation threshold, with divergence values on the basis of differences in information measurements of allele frequency patterns — has been shown to effectively replicate population and

metapopulation structure [3, 6].

2.3.2 | Information flow direction inference and interpretation

The JSD value between the two clusters, normalized or otherwise, gives a measure of the magnitude of (genetic) information flow between any two sampling clusters, but as a symmetric value, not any indication of direction. [3] proposed a novel index of information flow between two populations that calculates and takes the difference in the entropies of the allele frequency distributions of each population, but measured and normalized over the joint dominium of their individual distributions. This allows the populations to be ranked in terms of the entropies of their distribution of their allele frequencies, but adjusted so as to only consider shared alleles. The index $I(P \rightarrow Q) = +1$ indicates that the information carried by population P in the joint allele distribution dominium of P is greater than that of the joint dominium of Q, and vice versa, if $I(P \rightarrow Q) = -1$. These values are taken to be indicative of gene flow from P to Q and vice versa on the reasoning that information flows from the distribution which has the lower entropy:"The idea is that the net flow of gametes is from the less entropic (i.e., less diverse, more segregated) populations towards the more entropic, properly adjusting for the different sizes and fraction of common alleles" [3]. The significance of the information flow indication is then tested by randomization approaches [3].

2.4 | Application to colonization and founder effect demographic history

We are excited about the potential for application of the approaches to gene flow network inference provided by `nyemtaay` not only within the ecological genetics context in which it was developed, but, more broadly, in any context where information flow between populations structures the information within them. Indeed, it has been successfully applied in other domains such as [10, 11], demonstrating the advantages of the model-free and pattern-based approaches that characterizes information theoretic methods in general. However, nonetheless, it is important to ensure that some of the information extraction principles (e.g., the expectation of a symbol against which the information gained by observing it is measured) and interpretive reasoning (e.g. where source populations are identified on the basis of having a lower entropy), are still valid when applied to these other contexts.

Demographic history: founder effect information flow direction inference inversion

While successfully providing insight regarding gene flow direction in some very useful applications [3, 6], as noted by [3], there are contexts in which the assumptions underlying the intepretation of result (rather than the assumptions of the calculations) may be violated, leading to incorrect reasoning regarding direction of the gene flow. For example, if an external event or process reduces the genetic diversity in one population, the population will be diagnosed the source population of assymetric gene flow, even when it is in fact the sink [3]. There are a number of processes or mechanisms by which a sink population might present reduced genetic information and thereby require inverted interpretation of the relationship of lower vs higher joint-domina normalized relative entropies of each pair of populations under consideration: bottleneck or founder effects, or more generally any reduction in population sizes such that genetic drift might dominate. One area concern here would be founder effects which would characterize population in systems with recent colonizations or invasion events, as these are very often systems in which gene flow directionality might be important evolutionary biology, conservation, or medical concern — to identify invasive population origins for management or further study, for example — and yet are precisely the systems prone to misinterpretation due to the lower diversity of the derived (founded) populations.

Evolutionary vs. ecological gene flow patterns

The *current* theoretical framework for this approach to gene flow network inference was developed in the context of spatial ecological genetics, where all populations are exchanging genes in continuous ongoing gene flow, with no consideration of the evolutionary history of the populations. There has not been any evaluation of the performance of this approach in the latter context, which would characterize a number of systems for potential application.

2.4.1 | Baseline case: "historyless" fully-contemporaneous purely-spatial "spanning" gene flow

The original context in which the gene flow network in which the information theory measures were formulated — i.e., how a particular distribution of alleles maps to a quantification of the system's entropy and the background expected value against which this is measured — as well the interpretation of direction of gene flow based on the differences of entropy was that of a set of distinct contemporaneous populations continuously exchanging genes through migration with no evolutionary or demographic history – a "spanning" rather than "branching" gene flow pattern. The *only* relationships connecting the populations in these contexts are these current, ongoing, and contemporary ones, gene flow through continuous ongoing migration, in contrast to, for e.g., models that include demographic events such as population fragmentation, isolation, or splitting. In contrast to the experimental treatments considered in the next section, the populations have no historical relationship to each other in the sense that one was the ancestral or origin population of the other: a "source" population here is exclusively in terms of current ongoing migration in space, rather than an ancestor in time.

To demonstrate efficacy and assess baseline performance in this case, we simulated data sampled from three populations, A, B, and C, under two scenarios: (1) a (spatial) "spanning radiation" and a (2) (spatial) "spanning stepping-stone".

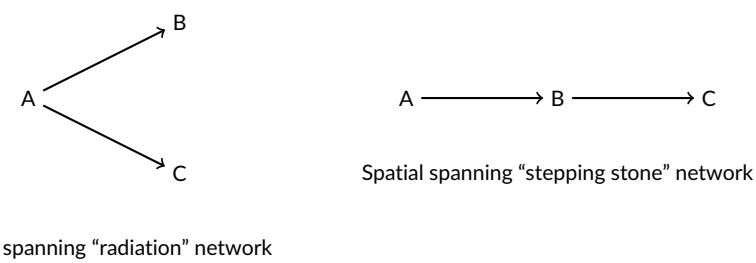

FIGURE 1 Gene flow scenarios for populations A, B, and C. Left: Spanning radiation scenario with direct flows from A to both B and C. Right: Spanning stepping stone scenario with sequential flow from A to B, then B to C.

Population sizes in all cases were fixed at $N_A = N_B = B_C = 10000$, migration rates systematically varied over $1e-4$, $1e-5$, and $1e-6$ per base pair per generation, with 100 sequences of length 1000 each sampled from each of the populations. The `DEMES` [12] package in conjunction with `msprime` [13] was used to generate the data, driven by custom scripts available as part of the `nyemtaay` distribution.

The resulting data was analyzed in `nyemtaay`, with following expected results:

- In the spatial radiation cases, we expect the inferred gene flow network to have paths $A \rightarrow B$ and $A \rightarrow C$ and not have any other path, in particular not have path $B \rightarrow C$.

- In the stepping stone cases, we expect the inferred gene flow network to have paths $A \rightarrow B$ and $B \rightarrow C$ and not have any other path, in particular not have path $A \rightarrow C$.

2.4.2 | Demonstration of performance under confounding processes

To evaluate the applicability of this approach of estimating gene flow relationships along a temporal axis (ancestor-descendent), and demonstrate the impact of founder effects of on the analysis, we present a simulation study as shown in Figure 2.

A *full* assessment of this approach will require far more comprehensive and rigorous experiment design. We could in principle locate regions of parameter space or an experiment design in which this approach succeeds rather than fails, but that will not help any researcher with the particular case than the demonstrative analysis we present here, and moreover, may detract from the message that researcher are obliged to test the approach with simulated data calibrated on their own system before proceeding (a protocol that really should be adopted for *any* method). Our purpose here is to demonstrate to researchers, that, while we advocate application of this approach to other useful problems, until future work develops modifications to the theory and statistics, this broader application calls for case-by-case pre-analytical assessments of suitability using simulation-based performance test calibrated to the systems of interest. The current directionality indicator statistic is one of the simplest possible out of a range of segregation indices, and numerous potential avenues for other quantifiers or indiciators for this remain to be explored, and this should be the focus of future work rather than exhaustively stress-testing a directionality indicator that works well enough when given the context and assumptions under which it was developed. Future work should be directed toward developing a suite of directionality indicators with known behaviorial characteristics that can either be insensitive to unknown evolutionary or demographic effects, or otherwise explicitly take into account these effects.

The basic experimental design involves three populations related through: (a) a “branching radiation“ model of evolution, with ancestral population “A“ giving rise to population “B“ and later on “C“, with all populations surviving to and sampled in the present day; and (b) a “branching stepping-stone” model of evolution, with an ancestral population “A” giving rising to “B“, and “B“ later on to “C“, with all populations surviving to and sampled in the present day.

In the “branching radiation” branching model, a sequential series of population “budding” or spawning events connects both “B” and “C” populations as descendent as well as gene flow sinks of population “A”: at time $t = T1$ generations in the past population B originates as a colony of population A, followed by, at time $t = T2$ generations in the past, population C originates as a colony of population A. (2 The “branching stepping-stone“ model is similar, except that population “C” arises as a a descendent and persists as a gene flow sink of population “B“ rather than “A“: at time $t = T1$ generations in the past population B originates as a colony of population A, followed by, at time $t = T2$ generations in the past, population C originates as a colony of population B. (2.

The effective population size of population “A“ remains stable through its history at N_e. The population sizes of B and C experience a founder effect at colonization of N_f, with growth such that the original population size of N_e is reached in $g_R = 1000$ generations. Values of N_f include not only extreme cases (e.g., a single individual, but also control, i.e., when it is equal to the full population size and is effectively a null case of no founder effect).

Migration was included in the systems to reinforce the relationship signal (i.e., from “A” to “B” and “C” in the radiation case and from “A” to “B” and “A” to “C” in the stepping stone case) to see if this dynamic, as part of the original context in which this approach was developed will improve performance, with a migration rate of 0.0 as a control (i.e., the only gene flow is the from the migrants of the initial colonization pulse) and with separate migration rate treatements of $1e-4$, $1e-5$, and $1e-6$.

A total of 100 replicates were run under each experimental design (i.e., all distinct combination of parameters and

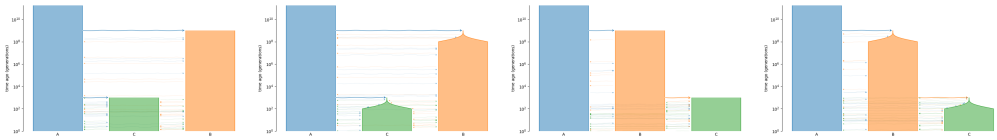

FIGURE 2 Experimental design to demonstrate impact of demographic founder effects on gene flow network directionality inference using the approach of [3]: (a) the radiation model without founder structuring effects; (b) the radiation model with founder structuring effects; (c) the stepping stone model without founder structuring effects; and (d) the stepping stone model with founder structuring effects. These diagrams are provide the general experimental scenarios, but parameter details (divergence times, founder population sizes, migration rates, etc.) varied across experiment treatment. See text for details.

scenarios), and each dataset was analyzed separately using `nyemtaay`.

Expected results are shown in the table below:

Path	Splitting Model	Exp $I_{ij} > 0$	Exp $I_{ij} < 0$	Exp $I_{ij} = 0$
I_AB	Branching-radiation	1.0	0.0	0.0
I_AC	Branching-radiation	1.0	0.0	0.0
I_BC	Branching-radiation	0.0	0.0	1.0
I_AB	Branching-stepping-stone	1.0	0.0	0.0
I_AC	Branching-stepping-stone	0.0	0.0	1.0
I_BC	Branching-stepping-stone	1.0	0.0	0.0

TABLE 1 Comparison of expected proportion of counts in each category of directionality indicator values: positive (indicating flow from i to j, e.g. A to B if I_{AB}), negative (indicating flow from j to i, e.g. B to A if I_{AB}), or zero (path not inferred).

2.5 | Metastatizing cancer information network flow analysis

Here a demonstrate the *potential* for novel application of this informational theoretic spatial ecological gene flow network inference in the biomedical domain to tracing the origin tissue site of metasizing subclonal cell network. While gene flow analysis has traditionally been considered in the context of collections of reproductive organisms, we can apply the `nyemtaay` approaches at this suborganismal scale of metastasizing clonal and subclonal cell relationships by modeling a metastasizing cell line gene flow network that connects tissues sampling sites to each other, with each tissue sampling site corresponding to a distinct population of genetic information, and genetic information exchanged along the network connections through metasizing cell migration between tissue sites. We can view the trajectory of cancer cell metastasis and spread as establishing a gene flow network connecting the various cancer sites (Quinn et al. 2021, El-Kebir et al. 2018, Lote et al. 2017, Zhao et al. 2016). Each tumor in a metastasizing cancer system, as a colony or population of cells, can be represented as a distinct node in a genetic information flow network network, connected to other such nodes by asymmetrical information flow in time representing the colonization history connecting primary, secondary, tertiary, etc. tumor sites. As the primary tumor initially seeds secondary tumors at other

sites in the host through direct movement of cells from the site of origin to other locations in the body, and these in turn each potentially seed their own tumors, an information flow network mapping these dynamics would reflect the primary tumor population as a source and its immediate secondaries as sinks, and so on for the relationship between the secondaries as the source of information for *their* secondary sinks. Following the initial seeding, there might of course be multiple other information flow paths connecting any two of the tumors, including not just bidirectional flow between descendents, but also more complex "backflow" cycles. Theses metastatic and post-metastasis cell movement historoies create the information flow paths connecting the tumor nodes in the cancer metastatic migration network graph. An advantage of using gene flow networks as opposed to phylogenetic approaches to analyzing these relationships is the relatively simplicity of accommodating post metastatic colonization gene flow, while an advantage of using information theoretic approaches is the computational efficiency as well as lack of model or process assumptions.

Here we apply `nyemtaay` to the finer-scale primary tumor data from (Yang et al. 2022). In this study, cell lineage histories within a genetically engineered mouse model are tracked through inheritable indel patterns introduced by the CRISPR-Cas9 system. These indels act as unique barcodes that are transcribed, enabling their detection via single-cell RNA sequencing (scRNA-seq). Phylogenetic approaches were used to construct detailed evolutionary trees of cancer cell populations within tumors, based on inheritable indel patterns introduced via the CRISPR-Cas9 system and captured through single-cell RNA sequencing (scRNA-seq).

Our objective is to demonstrate as proof-of-concept, the applicability of `nyemtaay` to reconstruct the information flow network that connects six tumor sites from which the data were sample: the primary tumor ($T1$), a soft tissue metastatic site (ST), and three liver metastatic sites ($L1$, $L2$, and $L3$). Recognizing *a priori* that the demographic dynamics of the metasizing cell lineage networks not only typically include multiple founder effects or bottlenecks, but with rapid proliferation of single cell lineages present extreme founder or bottleneck effects on the genetic information, we predict that the polarity of the interpretation of gene flow direction to be inverted, as discussed above. We note that, a general understanding of the system dynamics is sufficient basis for such a prediction ina proof-of-concept work such as this, in practical applications to new datasets, secondary analyses should applied to determine this, as suggested by [3, 4], and, in cases where some of the information flow processes may be more complex, new theory might need to be developed as well.

3 | RESULTS

3.1 | Information flow analysis of baseline spatial population gene flow with no demographic structuring

The results are summarized in Table 2 and Table 3 (appendix), with the first breaking down the analysis by migration rates and the second average over all migration rates. In the case of the spatial radiation ($A \rightarrow B$, $A \rightarrow C$) the gene flow inference approach provided by `nyemtaay` recovered the true paths with correct structure and directionality ($I_{AB} > 0, I_{AC} > 0, I_{BC} = 0$) with accuracy rates ranging from around 0.3 proportion of replicates in the low end (at the higher migration rate of $1e-4$) to over excellent performance of 0.8 and 0.9 proportion correct at the lower migration rates of $1e-5$ and $1e-6$. In the case of the spatial stepping stone ($A \rightarrow B$, $B \rightarrow C$) scenarios, performance was generally better across the board, though peak performance was not as high as the radiation case, and the true structure and directionality ($I_{AB} > 0, I_{BC} > 0, I_{AC} = 0$) was recovered with rates ranging from 0.5 in the low case ($I_{BC} > 0$, migration rate $1e-4$), and up to 0.86 and 0.89 in the best results ($I_{AB} > 0$, with migration rate of $1e-5$, and $I_{AC} = 0$, with migration rate of $1e-6$).

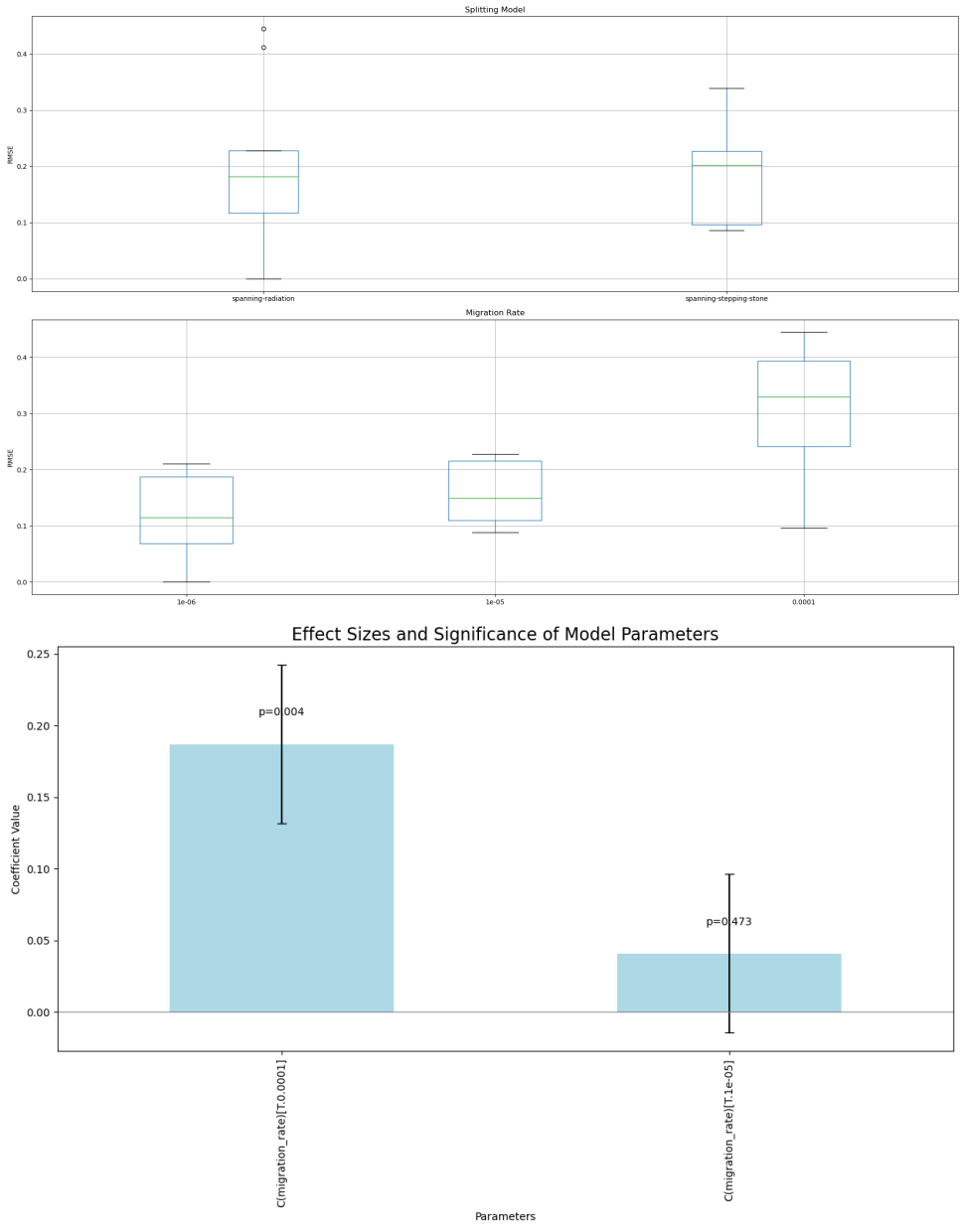
Splitting Model
RMSE
0.0
0.1
0.2
0.3
0.4
spanning-radiation
spanning-stepping-stone
Migration Rate
RMSE
0.0
0.1
0.2
0.3
0.4
1e-06
1e-05
0.0001
Effect Sizes and Significance of Model Parameters
Coefficient Value
0.25
0.20
0.15
0.10
0.05
0.00
p=0.004
p=0.473
C(migration_rate)[T.0.0001]
C(migration_rate)[T.1e-05]
Parameters

FIGURE 3

3.2 | Information flow analysis of serial ancestor-descendent population evolution with founder effects

The results are summarized in Table 4 and Table 5 (appendix), again, with the first breaking down the analysis by migration rates and the second average over all migration rates. A visualization of key parameters of interest (splitting model, $T1$, N_f, and migration rate) in terms of their correlation to the RMSE (measured against the predicted indicator values of I_{AB}, I_{AC}, and I_{BC}) as well as an ANOVA analysis in terms of parameter impact is shown in Figure 4. The RMSE of the gene flow network inference in evolutionary branching cases, with or without outer founder effect, was generally worse than the spanning cases, with the best performing of branching cases (RMSE of ~ 2.5 to ~ 4, at the deepest time for the $T1$ split, $T1 = 1e9$), just overlapping the worst the spanning system cases (RMSE of ~ 2.5 to ~ 4, at highest migration rates in the latter, $1e-4$). Non-founder effect population sizes ($N_f = 100000$) contributed significantly ($p \leq 0.0001$) to lower the RMSE, as did deeper time (e.g, $T1 \geq 10000$), both with the strongest effect sizes of reducing the RMSE by 0.15 Migration was non-signficant ($p = 0.124$ at its strongest impact level, $1e-5$), but generally supported rather than confounded the analysis as suggested by the associated effect sizes.

3.3 | Information flow analysis of metastasizing cancer clonal cell network

The original analysis of mouse model cancer system reported two large metastatic expansion events from the primary tumor site $T1$, with the first to the soft tissue site ST, and the second to the three liver site $L1$, $L2$, and $L3$. The information flow network inferred by `nyemtaay` recovered this fundamental structure, with one difference: while the primary tumor was linked to both subclonal expansionsand two subclonal expansions had no edges connecting them, instead of a direct connection between the primary tumor and liver site $L3$, `nyemtaay` inferred a secondary spread from $L2$ to $L3$. As noted in the original paper, and as discussed and demonstrated here, bottleneck or founder effects resulting in lowered diversity in the derived sink populations will invert the entropy based index relationships, and, indeed, the directionality indicator recovered exactly the opposite direction in every single edge for which previous edge information was available.

4 | DISCUSSION

4.1 | Information flow in spanning vs. branching networks

We showed that, in one particular region of parameter space, across the two basic contrasting 3-node network stuctures examined, the performance of information flow network inference approach provided by `nyemtaay` was degraded when applied to networks with ancestor-descendent relationships between nodes. We have no doubt that we might be able to locate some other equally plausible experimental design in which the performance may be improved or further degraded, but rather than focusing on the performance envelope of the current approach, we adopt the view that a more productive course would be to instead focus future work on identifying the aspects or components of the current approach that need to be adapted.

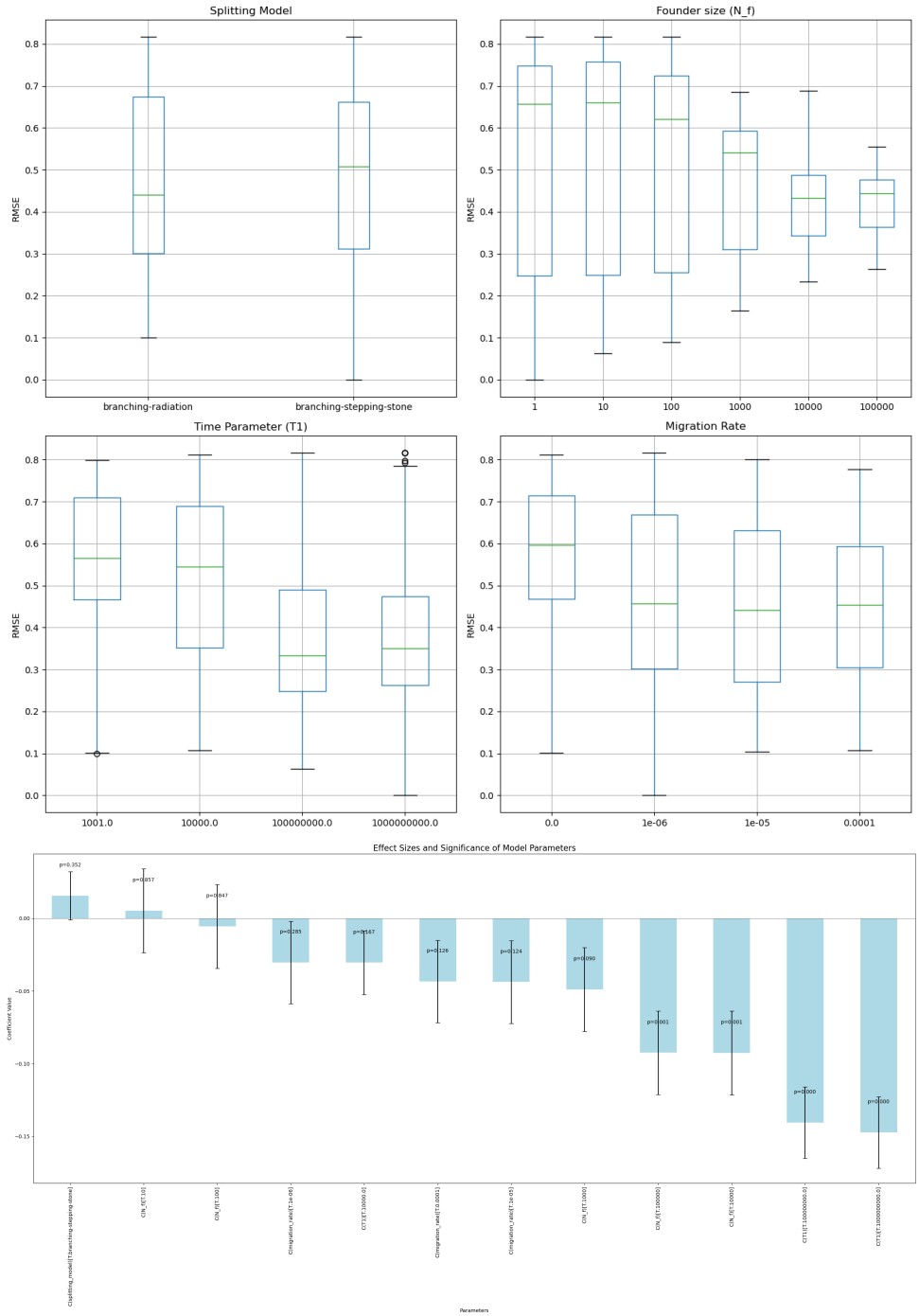
Splitting Model
RMSE
branching-radiation
branching-stepping-stone
Founder size (N_f)
1
10
100
1000
10000
100000
Time Parameter (T1)
1001.0
10000.0
100000000.0
1000000000.0
Migration Rate
0.0
1e-06
1e-05
0.0001
Effect Sizes and Significance of Model Parameters
Coefficient Value
Parameters

FIGURE 4

4.2 | Ecological and evolutionary biological analysis of cancer: relative new frontiers in medicine

`nyemtaay` successfully recovered the information flow connections in a metastatic subclonal expansion network of cancer cells, and, with *a priori* understanding of the founder effect characterizing the dynamics of this system, we were able to correctly infer the directionality of the gene flow. We recognize that this understanding may not apply with a range of other systems, whether in macro-, meso-, or microecological domains, and, furthermore, may not even be so simply characterized as either/or — in some systems we might expect some population events to be structured one way while others another. Our contribution toward this direction is, we hope, just part of a growing trend of cross-application of tools developed to study biological processes at one scale being applied to another. There remains much work to be done to support these transitions, and less to do with adapting to the different scale as much as to the greater prominence of confounding signals in the patterns. While in some systems tests for founder effects or bottleneck effects are available, these are only some of the processes that might be involved, and some of the model assumptions might not be applicable or desirable in the contexts, e.g. in metastatic cell network evolution. In this particular case, the simple directionality indexes is based on comparing allele frequencies, and when the genetic diversity of a population is dramatically restructured by drift, as occurs during bottleneck dynamics or founder effects, this reverses the apparent information flow in the system. This is particularly problematical in a number of application domains in which direction of information flow is of special interest, such as invasive or colonization ecological biology, infectious disease dynamics, or, as demonstrated here, in identifying metastatic information flow paths connecting tumors to identify the tumor or tissue sites in which the origin cell is located. More work is needed to: (a) improving the directionality index to account for potential drift effects, alongside (b) understand applicability of population genetic founder effect/bottleneck detection approaches to microecological spaces and systems such as cancer, and adapting them as needed. The benefits of being able to apply these approaches in domains such as these are clear, and development of further theory and statistics to facilitate these remains in the future.

4.3 | Comparable approaches

`nyemtaay` offers a pattern-based approach to estimation of an important parameter in a number of studies that complements existing methods, sophisticated and powerful as they are. BAYESASS [14], for example, offers many advantages over previous approaches gene flow network inference and analysis, being not constrained by the unrealistically restrictive assumptions of most classical population genetic statistics; in particular, in this case, the Hardy-Weinberg equilibrium. However, due traditional challenges of computational Bayesian inference such as MCMC convergence and mixing [15] and sensitivity to model misspecification [16], as well as the computational expense of a full-likelihood Bayesian approach, there will no doubt be cases where an information theoretic pattern-based such as that provided by `nyemtaay` might be useful for comparison.

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5 | APPENDICES

5.1 | Tables

5.1.1 | Results: Baseline continuous contemporaneous gene flow with no demographi structuring

ID	Splitting Model	Mig	Mean	$I_{ij} > 0$	$I_{ij} < 0$	$I_{ij} = 0$	Mean_ij	Mean_ji	Mean_0
I_AB	radiation	1e-06	0.8462	12	1	0	0.9231	0.0769	0.0000
I_AB	radiation	1e-05	0.5357	38	8	10	0.6757	0.1429	0.1814
I_AB	radiation	1e-4	0.1250	21	14	21	0.3333	0.2222	0.4444
I_BC	radiation	1e-06	0.0000	0	0	17	0.0000	0.0000	1.0000
I_BC	radiation	1e-05	-0.0206	7	9	81	0.0625	0.0804	0.8571
I_BC	radiation	1e-4	0.0465	15	11	60	0.1596	0.1170	0.7234
I_AC	radiation	1e-06	0.7333	12	1	2	0.8000	0.0667	0.1333
I_AC	radiation	1e-05	0.6143	52	9	9	0.7432	0.1286	0.1286
I_AC	radiation	1e-4	0.1194	28	20	19	0.3933	0.2800	0.3267
I_AB	stepping-stone	1e-06	0.5714	5	1	1	0.7143	0.1429	0.1429
I_AB	stepping-stone	1e-05	0.7400	43	6	1	0.8600	0.1200	0.0200
I_AB	stepping-stone	1e-4	0.2391	26	15	5	0.5652	0.3261	0.1087
I_BC	stepping-stone	1e-06	0.6429	10	1	3	0.7143	0.0714	0.2143
I_BC	stepping-stone	1e-05	0.4933	51	14	10	0.6800	0.1867	0.1333
I_BC	stepping-stone	1e-4	0.2317	43	24	15	0.5122	0.2927	0.1951
I_AC	stepping-stone	1e-06	0.1053	2	0	17	0.1053	0.0000	0.8947
I_AC	stepping-stone	1e-05	0.0928	10	1	86	0.1031	0.0103	0.8866
I_AC	stepping-stone	1e-4	0.0652	9	3	80	0.1000	0.0333	0.8667

TABLE 2

ID	Splitting Model	Avg. Mean	Avg. Mean_ij	Avg. Mean_ji	Avg. Mean_0
I_AB	radiation	0.5023	0.6440	0.1474	0.2086
I_BC	radiation	0.0086	0.0740	0.0658	0.8601
I_AC	radiation	0.4893	0.5738	0.1667	0.2595
I_AB	stepping-stone	0.5167	0.7132	0.1963	0.0905
I_BC	stepping-stone	0.4559	0.6355	0.1836	0.1809
I_AC	stepping-stone	0.0878	0.0748	0.0045	0.9207

TABLE 3

5.1.2 | Results: Branching demography and founder effects

Path	splitting_model	N_f	T1	mig	$I_{ij} > 0$	$I_{ij} < 0$	$I_{ij} = 0$	Mean_ij	Mean_ji	Mean_0
I_AB	radiation	1	1.00E+03	0.00E+00	0	87	8	0.000000	0.915789	0.084211
I_AB	radiation	1	1.00E+03	1.00E-06	0	82	12	0.000000	0.872340	0.127660
I_AB	radiation	1	1.00E+03	1.00E-05	0	90	6	0.000000	0.937500	0.062500
I_AB	radiation	1	1.00E+03	1.00E-04	1	83	16	0.010000	0.830000	0.160000
I_AB	radiation	1	1.00E+04	0.00E+00	0	57	24	0.000000	0.703704	0.296296
I_AB	radiation	1	1.00E+04	1.00E-06	3	60	25	0.034091	0.681818	0.284091
I_AB	radiation	1	1.00E+04	1.00E-05	2	79	15	0.020833	0.822917	0.156250
I_AB	radiation	1	1.00E+04	1.00E-04	26	69	5	0.260000	0.690000	0.050000
I_AB	radiation	1	1.00E+08	1.00E-06	29	3	13	0.644444	0.066667	0.288889

I_AB	radiation	1	1.00E+08	1.00E-05	73	7	17	0.752577	0.072165	0.175258
I_AB	radiation	1	1.00E+08	1.00E-04	61	38	1	0.610000	0.380000	0.010000
I_AB	radiation	1	1.00E+09	1.00E-06	26	6	6	0.684211	0.157895	0.157895
I_AB	radiation	1	1.00E+09	1.00E-05	61	13	24	0.622449	0.132653	0.244898
I_AB	radiation	1	1.00E+09	1.00E-04	60	37	3	0.600000	0.370000	0.030000
I_AB	radiation	10	1.00E+03	0.00E+00	0	89	4	0.000000	0.956989	0.043011
I_AB	radiation	10	1.00E+03	1.00E-06	0	87	5	0.000000	0.945652	0.054348
I_AB	radiation	10	1.00E+03	1.00E-05	0	87	10	0.000000	0.896907	0.103093
I_AB	radiation	10	1.00E+03	1.00E-04	4	82	14	0.040000	0.820000	0.140000
I_AB	radiation	10	1.00E+04	0.00E+00	0	63	24	0.000000	0.724138	0.275862
I_AB	radiation	10	1.00E+04	1.00E-06	2	57	19	0.025641	0.730769	0.243590
I_AB	radiation	10	1.00E+04	1.00E-05	10	74	11	0.105263	0.778947	0.115789
I_AB	radiation	10	1.00E+04	1.00E-04	22	73	5	0.220000	0.730000	0.050000
I_AB	radiation	10	1.00E+08	1.00E-06	31	4	17	0.596154	0.076923	0.326923
I_AB	radiation	10	1.00E+08	1.00E-05	62	16	20	0.632653	0.163265	0.204082
I_AB	radiation	10	1.00E+08	1.00E-04	62	36	2	0.620000	0.360000	0.020000
I_AB	radiation	10	1.00E+09	1.00E-06	19	7	18	0.431818	0.159091	0.409091
I_AB	radiation	10	1.00E+09	1.00E-05	69	15	15	0.696970	0.151515	0.151515
I_AB	radiation	10	1.00E+09	1.00E-04	56	40	4	0.560000	0.400000	0.040000
I_AB	radiation	100	1.00E+03	0.00E+00	3	78	18	0.030303	0.787879	0.181818
I_AB	radiation	100	1.00E+03	1.00E-06	2	84	13	0.020202	0.848485	0.131313
I_AB	radiation	100	1.00E+03	1.00E-05	3	74	22	0.030303	0.747475	0.222222
I_AB	radiation	100	1.00E+03	1.00E-04	6	81	13	0.060000	0.810000	0.130000
I_AB	radiation	100	1.00E+04	0.00E+00	0	73	18	0.000000	0.802198	0.197802
I_AB	radiation	100	1.00E+04	1.00E-06	3	56	28	0.034483	0.643678	0.321839
I_AB	radiation	100	1.00E+04	1.00E-05	12	64	20	0.125000	0.666667	0.208333
I_AB	radiation	100	1.00E+04	1.00E-04	30	62	8	0.300000	0.620000	0.080000
I_AB	radiation	100	1.00E+08	1.00E-06	28	5	16	0.571429	0.102041	0.326531
I_AB	radiation	100	1.00E+08	1.00E-05	72	14	14	0.720000	0.140000	0.140000
I_AB	radiation	100	1.00E+08	1.00E-04	61	34	5	0.610000	0.340000	0.050000
I_AB	radiation	100	1.00E+09	1.00E-06	23	4	21	0.479167	0.083333	0.437500
I_AB	radiation	100	1.00E+09	1.00E-05	73	12	14	0.737374	0.121212	0.141414
I_AB	radiation	100	1.00E+09	1.00E-04	66	30	3	0.666667	0.303030	0.030303
I_AB	radiation	1000	1.00E+03	0.00E+00	19	64	17	0.190000	0.640000	0.170000
I_AB	radiation	1000	1.00E+03	1.00E-06	22	61	17	0.220000	0.610000	0.170000
I_AB	radiation	1000	1.00E+03	1.00E-05	18	66	16	0.180000	0.660000	0.160000
I_AB	radiation	1000	1.00E+03	1.00E-04	24	59	17	0.240000	0.590000	0.170000
I_AB	radiation	1000	1.00E+04	0.00E+00	3	49	39	0.032967	0.538462	0.428571
I_AB	radiation	1000	1.00E+04	1.00E-06	5	46	42	0.053763	0.494624	0.451613
I_AB	radiation	1000	1.00E+04	1.00E-05	6	58	34	0.061224	0.591837	0.346939
I_AB	radiation	1000	1.00E+04	1.00E-04	26	56	18	0.260000	0.560000	0.180000
I_AB	radiation	1000	1.00E+08	1.00E-06	27	1	18	0.586957	0.021739	0.391304
I_AB	radiation	1000	1.00E+08	1.00E-05	56	12	32	0.560000	0.120000	0.320000
I_AB	radiation	1000	1.00E+08	1.00E-04	46	34	20	0.460000	0.340000	0.200000
I_AB	radiation	1000	1.00E+09	1.00E-06	31	1	24	0.553571	0.017857	0.428571
I_AB	radiation	1000	1.00E+09	1.00E-05	63	5	32	0.630000	0.050000	0.320000
I_AB	radiation	1000	1.00E+09	1.00E-04	46	31	23	0.460000	0.310000	0.230000
I_AB	radiation	10000	1.00E+03	0.00E+00	31	44	25	0.310000	0.440000	0.250000
I_AB	radiation	10000	1.00E+03	1.00E-06	34	46	20	0.340000	0.460000	0.200000
I_AB	radiation	10000	1.00E+03	1.00E-05	35	35	30	0.350000	0.350000	0.300000
I_AB	radiation	10000	1.00E+03	1.00E-04	28	45	27	0.280000	0.450000	0.270000

I_AB	radiation	10000	1.00E+04	0.00E+00	13	41	46	0.130000	0.410000	0.460000
I_AB	radiation	10000	1.00E+04	1.00E-06	20	33	47	0.200000	0.330000	0.470000
I_AB	radiation	10000	1.00E+04	1.00E-05	17	40	43	0.170000	0.400000	0.430000
I_AB	radiation	10000	1.00E+04	1.00E-04	24	34	42	0.240000	0.340000	0.420000
I_AB	radiation	10000	1.00E+08	1.00E-06	27	1	11	0.692308	0.025641	0.282051
I_AB	radiation	10000	1.00E+08	1.00E-05	46	5	48	0.464646	0.050505	0.484848
I_AB	radiation	10000	1.00E+08	1.00E-04	43	17	40	0.430000	0.170000	0.400000
I_AB	radiation	10000	1.00E+09	1.00E-06	29	4	11	0.659091	0.090909	0.250000
I_AB	radiation	10000	1.00E+09	1.00E-05	54	7	39	0.540000	0.070000	0.390000
I_AB	radiation	10000	1.00E+09	1.00E-04	39	23	38	0.390000	0.230000	0.380000
I_AB	radiation	100000	1.00E+03	0.00E+00	31	36	33	0.310000	0.360000	0.330000
I_AB	radiation	100000	1.00E+03	1.00E-06	36	35	29	0.360000	0.350000	0.290000
I_AB	radiation	100000	1.00E+03	1.00E-05	34	42	24	0.340000	0.420000	0.240000
I_AB	radiation	100000	1.00E+03	1.00E-04	28	45	27	0.280000	0.450000	0.270000
I_AB	radiation	100000	1.00E+04	0.00E+00	33	23	44	0.330000	0.230000	0.440000
I_AB	radiation	100000	1.00E+04	1.00E-06	29	21	50	0.290000	0.210000	0.500000
I_AB	radiation	100000	1.00E+04	1.00E-05	30	20	50	0.300000	0.200000	0.500000
I_AB	radiation	100000	1.00E+04	1.00E-04	31	23	46	0.310000	0.230000	0.460000
I_AB	radiation	100000	1.00E+08	1.00E-06	20	4	26	0.400000	0.080000	0.520000
I_AB	radiation	100000	1.00E+08	1.00E-05	35	9	56	0.350000	0.090000	0.560000
I_AB	radiation	100000	1.00E+08	1.00E-04	33	20	47	0.330000	0.200000	0.470000
I_AB	radiation	100000	1.00E+09	1.00E-06	27	2	21	0.540000	0.040000	0.420000
I_AB	radiation	100000	1.00E+09	1.00E-05	36	14	50	0.360000	0.140000	0.500000
I_AB	radiation	100000	1.00E+09	1.00E-04	30	20	50	0.300000	0.200000	0.500000
I_AC	radiation	1	1.00E+03	0.00E+00	0	86	9	0.000000	0.905263	0.094737
I_AC	radiation	1	1.00E+03	1.00E-06	0	84	10	0.000000	0.893617	0.106383
I_AC	radiation	1	1.00E+03	1.00E-05	2	80	14	0.020833	0.833333	0.145833
I_AC	radiation	1	1.00E+03	1.00E-04	2	83	15	0.020000	0.830000	0.150000
I_AC	radiation	1	1.00E+04	0.00E+00	0	80	1	0.000000	0.987654	0.012346
I_AC	radiation	1	1.00E+04	1.00E-06	0	85	3	0.000000	0.965909	0.034091
I_AC	radiation	1	1.00E+04	1.00E-05	1	80	15	0.010417	0.833333	0.156250
I_AC	radiation	1	1.00E+04	1.00E-04	2	71	27	0.020000	0.710000	0.270000
I_AC	radiation	1	1.00E+08	1.00E-06	0	45	0	0.000000	1.000000	0.000000
I_AC	radiation	1	1.00E+08	1.00E-05	1	93	3	0.010309	0.958763	0.030928
I_AC	radiation	1	1.00E+08	1.00E-04	3	81	16	0.030000	0.810000	0.160000
I_AC	radiation	1	1.00E+09	1.00E-06	0	38	0	0.000000	1.000000	0.000000
I_AC	radiation	1	1.00E+09	1.00E-05	0	90	8	0.000000	0.918367	0.081633
I_AC	radiation	1	1.00E+09	1.00E-04	1	69	30	0.010000	0.690000	0.300000
I_AC	radiation	10	1.00E+03	0.00E+00	0	84	9	0.000000	0.903226	0.096774
I_AC	radiation	10	1.00E+03	1.00E-06	1	83	8	0.010870	0.902174	0.086957
I_AC	radiation	10	1.00E+03	1.00E-05	2	89	6	0.020619	0.917526	0.061856
I_AC	radiation	10	1.00E+03	1.00E-04	6	77	17	0.060000	0.770000	0.170000
I_AC	radiation	10	1.00E+04	0.00E+00	0	86	1	0.000000	0.988506	0.011494
I_AC	radiation	10	1.00E+04	1.00E-06	0	73	5	0.000000	0.935897	0.064103
I_AC	radiation	10	1.00E+04	1.00E-05	0	79	16	0.000000	0.831579	0.168421
I_AC	radiation	10	1.00E+04	1.00E-04	1	69	30	0.010000	0.690000	0.300000
I_AC	radiation	10	1.00E+08	1.00E-06	0	52	0	0.000000	1.000000	0.000000
I_AC	radiation	10	1.00E+08	1.00E-05	1	90	7	0.010204	0.918367	0.071429
I_AC	radiation	10	1.00E+08	1.00E-04	3	76	21	0.030000	0.760000	0.210000
I_AC	radiation	10	1.00E+09	1.00E-06	0	44	0	0.000000	1.000000	0.000000
I_AC	radiation	10	1.00E+09	1.00E-05	2	90	7	0.020202	0.909091	0.070707

I_AC	radiation	10	1.00E+09	1.00E-04	1	67	32	0.010000	0.670000	0.320000
I_AC	radiation	100	1.00E+03	0.00E+00	5	81	13	0.050505	0.818182	0.131313
I_AC	radiation	100	1.00E+03	1.00E-06	3	87	9	0.030303	0.878788	0.090909
I_AC	radiation	100	1.00E+03	1.00E-05	0	85	14	0.000000	0.858586	0.141414
I_AC	radiation	100	1.00E+03	1.00E-04	4	71	25	0.040000	0.710000	0.250000
I_AC	radiation	100	1.00E+04	0.00E+00	7	78	6	0.076923	0.857143	0.065934
I_AC	radiation	100	1.00E+04	1.00E-06	3	77	7	0.034483	0.885057	0.080460
I_AC	radiation	100	1.00E+04	1.00E-05	4	80	12	0.041667	0.833333	0.125000
I_AC	radiation	100	1.00E+04	1.00E-04	4	74	22	0.040000	0.740000	0.220000
I_AC	radiation	100	1.00E+08	1.00E-06	1	48	0	0.020408	0.979592	0.000000
I_AC	radiation	100	1.00E+08	1.00E-05	2	98	0	0.020000	0.980000	0.000000
I_AC	radiation	100	1.00E+08	1.00E-04	4	77	19	0.040000	0.770000	0.190000
I_AC	radiation	100	1.00E+09	1.00E-06	4	44	0	0.083333	0.916667	0.000000
I_AC	radiation	100	1.00E+09	1.00E-05	6	91	2	0.060606	0.919192	0.020202
I_AC	radiation	100	1.00E+09	1.00E-04	4	78	17	0.040404	0.787879	0.171717
I_AC	radiation	1000	1.00E+03	0.00E+00	19	62	19	0.190000	0.620000	0.190000
I_AC	radiation	1000	1.00E+03	1.00E-06	19	66	15	0.190000	0.660000	0.150000
I_AC	radiation	1000	1.00E+03	1.00E-05	21	60	19	0.210000	0.600000	0.190000
I_AC	radiation	1000	1.00E+03	1.00E-04	19	60	21	0.190000	0.600000	0.210000
I_AC	radiation	1000	1.00E+04	0.00E+00	20	69	2	0.219780	0.758242	0.021978
I_AC	radiation	1000	1.00E+04	1.00E-06	22	70	1	0.236559	0.752688	0.010753
I_AC	radiation	1000	1.00E+04	1.00E-05	29	65	4	0.295918	0.663265	0.040816
I_AC	radiation	1000	1.00E+04	1.00E-04	24	63	13	0.240000	0.630000	0.130000
I_AC	radiation	1000	1.00E+08	1.00E-06	13	33	0	0.282609	0.717391	0.000000
I_AC	radiation	1000	1.00E+08	1.00E-05	23	77	0	0.230000	0.770000	0.000000
I_AC	radiation	1000	1.00E+08	1.00E-04	16	75	9	0.160000	0.750000	0.090000
I_AC	radiation	1000	1.00E+09	1.00E-06	16	40	0	0.285714	0.714286	0.000000
I_AC	radiation	1000	1.00E+09	1.00E-05	28	72	0	0.280000	0.720000	0.000000
I_AC	radiation	1000	1.00E+09	1.00E-04	29	55	16	0.290000	0.550000	0.160000
I_AC	radiation	10000	1.00E+03	0.00E+00	39	42	19	0.390000	0.420000	0.190000
I_AC	radiation	10000	1.00E+03	1.00E-06	38	38	24	0.380000	0.380000	0.240000
I_AC	radiation	10000	1.00E+03	1.00E-05	40	40	20	0.400000	0.400000	0.200000
I_AC	radiation	10000	1.00E+03	1.00E-04	30	45	25	0.300000	0.450000	0.250000
I_AC	radiation	10000	1.00E+04	0.00E+00	52	48	0	0.520000	0.480000	0.000000
I_AC	radiation	10000	1.00E+04	1.00E-06	53	47	0	0.530000	0.470000	0.000000
I_AC	radiation	10000	1.00E+04	1.00E-05	45	55	0	0.450000	0.550000	0.000000
I_AC	radiation	10000	1.00E+04	1.00E-04	50	46	4	0.500000	0.460000	0.040000
I_AC	radiation	10000	1.00E+08	1.00E-06	21	18	0	0.538462	0.461538	0.000000
I_AC	radiation	10000	1.00E+08	1.00E-05	41	58	0	0.414141	0.585859	0.000000
I_AC	radiation	10000	1.00E+08	1.00E-04	39	58	3	0.390000	0.580000	0.030000
I_AC	radiation	10000	1.00E+09	1.00E-06	22	22	0	0.500000	0.500000	0.000000
I_AC	radiation	10000	1.00E+09	1.00E-05	52	48	0	0.520000	0.480000	0.000000
I_AC	radiation	10000	1.00E+09	1.00E-04	40	58	2	0.400000	0.580000	0.020000
I_AC	radiation	100000	1.00E+03	0.00E+00	35	33	32	0.350000	0.330000	0.320000
I_AC	radiation	100000	1.00E+03	1.00E-06	33	34	33	0.330000	0.340000	0.330000
I_AC	radiation	100000	1.00E+03	1.00E-05	33	34	33	0.330000	0.340000	0.330000
I_AC	radiation	100000	1.00E+03	1.00E-04	31	36	33	0.310000	0.360000	0.330000
I_AC	radiation	100000	1.00E+04	0.00E+00	42	57	1	0.420000	0.570000	0.010000
I_AC	radiation	100000	1.00E+04	1.00E-06	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1.00E+04	1.00E-05	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1.00E+04	1.00E-04	60	38	2	0.600000	0.380000	0.020000

I_AC	radiation	100000	1.00E+08	1.00E-06	24	26	0	0.480000	0.520000	0.000000
I_AC	radiation	100000	1.00E+08	1.00E-05	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1.00E+08	1.00E-04	40	59	1	0.400000	0.590000	0.010000
I_AC	radiation	100000	1.00E+09	1.00E-06	25	25	0	0.500000	0.500000	0.000000
I_AC	radiation	100000	1.00E+09	1.00E-05	63	37	0	0.630000	0.370000	0.000000
I_AC	radiation	100000	1.00E+09	1.00E-04	57	43	0	0.570000	0.430000	0.000000
I_BC	radiation	1	1.00E+03	0.00E+00	9	8	78	0.094737	0.084211	0.821053
I_BC	radiation	1	1.00E+03	1.00E-06	10	12	72	0.106383	0.127660	0.765957
I_BC	radiation	1	1.00E+03	1.00E-05	8	12	76	0.083333	0.125000	0.791667
I_BC	radiation	1	1.00E+03	1.00E-04	9	19	72	0.090000	0.190000	0.720000
I_BC	radiation	1	1.00E+04	0.00E+00	1	25	55	0.012346	0.308642	0.679012
I_BC	radiation	1	1.00E+04	1.00E-06	2	27	59	0.022727	0.306818	0.670455
I_BC	radiation	1	1.00E+04	1.00E-05	4	26	66	0.041667	0.270833	0.687500
I_BC	radiation	1	1.00E+04	1.00E-04	3	29	68	0.030000	0.290000	0.680000
I_BC	radiation	1	1.00E+08	1.00E-06	0	13	32	0.000000	0.288889	0.711111
I_BC	radiation	1	1.00E+08	1.00E-05	0	21	76	0.000000	0.216495	0.783505
I_BC	radiation	1	1.00E+08	1.00E-04	0	19	81	0.000000	0.190000	0.810000
I_BC	radiation	1	1.00E+09	1.00E-06	0	6	32	0.000000	0.157895	0.842105
I_BC	radiation	1	1.00E+09	1.00E-05	0	32	66	0.000000	0.326531	0.673469
I_BC	radiation	1	1.00E+09	1.00E-04	1	33	66	0.010000	0.330000	0.660000
I_BC	radiation	10	1.00E+03	0.00E+00	9	4	80	0.096774	0.043011	0.860215
I_BC	radiation	10	1.00E+03	1.00E-06	7	6	79	0.076087	0.065217	0.858696
I_BC	radiation	10	1.00E+03	1.00E-05	5	9	83	0.051546	0.092784	0.855670
I_BC	radiation	10	1.00E+03	1.00E-04	12	17	71	0.120000	0.170000	0.710000
I_BC	radiation	10	1.00E+04	0.00E+00	1	25	61	0.011494	0.287356	0.701149
I_BC	radiation	10	1.00E+04	1.00E-06	2	23	53	0.025641	0.294872	0.679487
I_BC	radiation	10	1.00E+04	1.00E-05	1	26	68	0.010526	0.273684	0.715789
I_BC	radiation	10	1.00E+04	1.00E-04	3	32	65	0.030000	0.320000	0.650000
I_BC	radiation	10	1.00E+08	1.00E-06	0	17	35	0.000000	0.326923	0.673077
I_BC	radiation	10	1.00E+08	1.00E-05	0	27	71	0.000000	0.275510	0.724490
I_BC	radiation	10	1.00E+08	1.00E-04	1	23	76	0.010000	0.230000	0.760000
I_BC	radiation	10	1.00E+09	1.00E-06	0	17	27	0.000000	0.386364	0.613636
I_BC	radiation	10	1.00E+09	1.00E-05	1	22	76	0.010101	0.222222	0.767677
I_BC	radiation	10	1.00E+09	1.00E-04	0	38	62	0.000000	0.380000	0.620000
I_BC	radiation	100	1.00E+03	0.00E+00	16	14	69	0.161616	0.141414	0.696970
I_BC	radiation	100	1.00E+03	1.00E-06	10	10	79	0.101010	0.101010	0.797980
I_BC	radiation	100	1.00E+03	1.00E-05	17	19	63	0.171717	0.191919	0.636364
I_BC	radiation	100	1.00E+03	1.00E-04	14	23	63	0.140000	0.230000	0.630000
I_BC	radiation	100	1.00E+04	0.00E+00	14	10	67	0.153846	0.109890	0.736264
I_BC	radiation	100	1.00E+04	1.00E-06	11	24	52	0.126437	0.275862	0.597701
I_BC	radiation	100	1.00E+04	1.00E-05	9	23	64	0.093750	0.239583	0.666667
I_BC	radiation	100	1.00E+04	1.00E-04	7	23	70	0.070000	0.230000	0.700000
I_BC	radiation	100	1.00E+08	1.00E-06	0	15	34	0.000000	0.306122	0.693878
I_BC	radiation	100	1.00E+08	1.00E-05	0	14	86	0.000000	0.140000	0.860000
I_BC	radiation	100	1.00E+08	1.00E-04	0	24	76	0.000000	0.240000	0.760000
I_BC	radiation	100	1.00E+09	1.00E-06	1	20	27	0.020833	0.416667	0.562500
I_BC	radiation	100	1.00E+09	1.00E-05	1	17	81	0.010101	0.171717	0.818182
I_BC	radiation	100	1.00E+09	1.00E-04	2	18	79	0.020202	0.181818	0.797980
I_BC	radiation	1000	1.00E+03	0.00E+00	26	12	62	0.260000	0.120000	0.620000
I_BC	radiation	1000	1.00E+03	1.00E-06	15	17	68	0.150000	0.170000	0.680000
I_BC	radiation	1000	1.00E+03	1.00E-05	16	20	64	0.160000	0.200000	0.640000

I_BC	radiation	1000	1.00E+03	1.00E-04	15	23	62	0.150000	0.230000	0.620000
I_BC	radiation	1000	1.00E+04	0.00E+00	36	6	49	0.395604	0.065934	0.538462
I_BC	radiation	1000	1.00E+04	1.00E-06	36	7	50	0.387097	0.075269	0.537634
I_BC	radiation	1000	1.00E+04	1.00E-05	27	10	61	0.275510	0.102041	0.622449
I_BC	radiation	1000	1.00E+04	1.00E-04	18	14	68	0.180000	0.140000	0.680000
I_BC	radiation	1000	1.00E+08	1.00E-06	1	20	25	0.021739	0.434783	0.543478
I_BC	radiation	1000	1.00E+08	1.00E-05	0	34	66	0.000000	0.340000	0.660000
I_BC	radiation	1000	1.00E+08	1.00E-04	6	23	71	0.060000	0.230000	0.710000
I_BC	radiation	1000	1.00E+09	1.00E-06	1	24	31	0.017857	0.428571	0.553571
I_BC	radiation	1000	1.00E+09	1.00E-05	3	30	67	0.030000	0.300000	0.670000
I_BC	radiation	1000	1.00E+09	1.00E-04	6	33	61	0.060000	0.330000	0.610000
I_BC	radiation	10000	1.00E+03	0.00E+00	18	26	56	0.180000	0.260000	0.560000
I_BC	radiation	10000	1.00E+03	1.00E-06	25	19	56	0.250000	0.190000	0.560000
I_BC	radiation	10000	1.00E+03	1.00E-05	26	24	50	0.260000	0.240000	0.500000
I_BC	radiation	10000	1.00E+03	1.00E-04	32	20	48	0.320000	0.200000	0.480000
I_BC	radiation	10000	1.00E+04	0.00E+00	35	12	53	0.350000	0.120000	0.530000
I_BC	radiation	10000	1.00E+04	1.00E-06	30	17	53	0.300000	0.170000	0.530000
I_BC	radiation	10000	1.00E+04	1.00E-05	28	16	56	0.280000	0.160000	0.560000
I_BC	radiation	10000	1.00E+04	1.00E-04	26	21	53	0.260000	0.210000	0.530000
I_BC	radiation	10000	1.00E+08	1.00E-06	1	16	22	0.025641	0.410256	0.564103
I_BC	radiation	10000	1.00E+08	1.00E-05	6	44	49	0.060606	0.444444	0.494949
I_BC	radiation	10000	1.00E+08	1.00E-04	12	32	56	0.120000	0.320000	0.560000
I_BC	radiation	10000	1.00E+09	1.00E-06	1	17	26	0.022727	0.386364	0.590909
I_BC	radiation	10000	1.00E+09	1.00E-05	7	34	59	0.070000	0.340000	0.590000
I_BC	radiation	10000	1.00E+09	1.00E-04	14	26	60	0.140000	0.260000	0.600000
I_BC	radiation	100000	1.00E+03	0.00E+00	42	23	35	0.420000	0.230000	0.350000
I_BC	radiation	100000	1.00E+03	1.00E-06	35	30	35	0.350000	0.300000	0.350000
I_BC	radiation	100000	1.00E+03	1.00E-05	35	26	39	0.350000	0.260000	0.390000
I_BC	radiation	100000	1.00E+03	1.00E-04	37	27	36	0.370000	0.270000	0.360000
I_BC	radiation	100000	1.00E+04	0.00E+00	25	20	55	0.250000	0.200000	0.550000
I_BC	radiation	100000	1.00E+04	1.00E-06	27	24	49	0.270000	0.240000	0.490000
I_BC	radiation	100000	1.00E+04	1.00E-05	25	27	48	0.250000	0.270000	0.480000
I_BC	radiation	100000	1.00E+04	1.00E-04	19	29	52	0.190000	0.290000	0.520000
I_BC	radiation	100000	1.00E+08	1.00E-06	3	30	17	0.060000	0.600000	0.340000
I_BC	radiation	100000	1.00E+08	1.00E-05	10	47	43	0.100000	0.470000	0.430000
I_BC	radiation	100000	1.00E+08	1.00E-04	15	36	49	0.150000	0.360000	0.490000
I_BC	radiation	100000	1.00E+09	1.00E-06	0	26	24	0.000000	0.520000	0.480000
I_BC	radiation	100000	1.00E+09	1.00E-05	6	45	49	0.060000	0.450000	0.490000
I_BC	radiation	100000	1.00E+09	1.00E-04	20	30	50	0.200000	0.300000	0.500000
I_AB	stepping-stone	1	1.00E+03	0.00E+00	0	78	19	0.000000	0.804124	0.195876
I_AB	stepping-stone	1	1.00E+03	1.00E-06	1	82	12	0.010526	0.863158	0.126316
I_AB	stepping-stone	1	1.00E+03	1.00E-05	1	87	11	0.010101	0.878788	0.111111
I_AB	stepping-stone	1	1.00E+03	1.00E-04	2	92	6	0.020000	0.920000	0.060000
I_AB	stepping-stone	1	1.00E+04	0.00E+00	0	37	59	0.000000	0.385417	0.614583
I_AB	stepping-stone	1	1.00E+04	1.00E-06	2	26	57	0.023529	0.305882	0.670588
I_AB	stepping-stone	1	1.00E+04	1.00E-05	17	55	22	0.180851	0.585106	0.234043
I_AB	stepping-stone	1	1.00E+04	1.00E-04	17	80	2	0.171717	0.808081	0.020202
I_AB	stepping-stone	1	1.00E+08	1.00E-06	34	6	6	0.739130	0.130435	0.130435
I_AB	stepping-stone	1	1.00E+08	1.00E-05	72	16	9	0.742268	0.164948	0.092784
I_AB	stepping-stone	1	1.00E+08	1.00E-04	62	33	5	0.620000	0.330000	0.050000
I_AB	stepping-stone	1	1.00E+09	1.00E-06	29	5	1	0.828571	0.142857	0.028571

I_AB	stepping-stone	1	1.00E+09	1.00E-05	71	13	12	0.739583	0.135417	0.125000
I_AB	stepping-stone	1	1.00E+09	1.00E-04	63	35	2	0.630000	0.350000	0.020000
I_AB	stepping-stone	10	1.00E+03	0.00E+00	0	87	10	0.000000	0.896907	0.103093
I_AB	stepping-stone	10	1.00E+03	1.00E-06	0	79	15	0.000000	0.840426	0.159574
I_AB	stepping-stone	10	1.00E+03	1.00E-05	2	88	10	0.020000	0.880000	0.100000
I_AB	stepping-stone	10	1.00E+03	1.00E-04	3	85	12	0.030000	0.850000	0.120000
I_AB	stepping-stone	10	1.00E+04	0.00E+00	1	27	57	0.011765	0.317647	0.670588
I_AB	stepping-stone	10	1.00E+04	1.00E-06	3	33	49	0.035294	0.388235	0.576471
I_AB	stepping-stone	10	1.00E+04	1.00E-05	15	59	20	0.159574	0.627660	0.212766
I_AB	stepping-stone	10	1.00E+04	1.00E-04	12	85	3	0.120000	0.850000	0.030000
I_AB	stepping-stone	10	1.00E+08	1.00E-06	34	2	3	0.871795	0.051282	0.076923
I_AB	stepping-stone	10	1.00E+08	1.00E-05	74	8	13	0.778947	0.084211	0.136842
I_AB	stepping-stone	10	1.00E+08	1.00E-04	70	29	1	0.700000	0.290000	0.010000
I_AB	stepping-stone	10	1.00E+09	1.00E-06	44	3	4	0.862745	0.058824	0.078431
I_AB	stepping-stone	10	1.00E+09	1.00E-05	71	15	11	0.731959	0.154639	0.113402
I_AB	stepping-stone	10	1.00E+09	1.00E-04	68	31	1	0.680000	0.310000	0.010000
I_AB	stepping-stone	100	1.00E+03	0.00E+00	5	70	21	0.052083	0.729167	0.218750
I_AB	stepping-stone	100	1.00E+03	1.00E-06	2	74	22	0.020408	0.755102	0.224490
I_AB	stepping-stone	100	1.00E+03	1.00E-05	7	77	16	0.070000	0.770000	0.160000
I_AB	stepping-stone	100	1.00E+03	1.00E-04	3	78	19	0.030000	0.780000	0.190000
I_AB	stepping-stone	100	1.00E+04	0.00E+00	1	23	64	0.011364	0.261364	0.727273
I_AB	stepping-stone	100	1.00E+04	1.00E-06	5	30	53	0.056818	0.340909	0.602273
I_AB	stepping-stone	100	1.00E+04	1.00E-05	10	60	26	0.104167	0.625000	0.270833
I_AB	stepping-stone	100	1.00E+04	1.00E-04	23	74	3	0.230000	0.740000	0.030000
I_AB	stepping-stone	100	1.00E+08	1.00E-06	30	5	13	0.625000	0.104167	0.270833
I_AB	stepping-stone	100	1.00E+08	1.00E-05	74	9	17	0.740000	0.090000	0.170000
I_AB	stepping-stone	100	1.00E+08	1.00E-04	62	35	3	0.620000	0.350000	0.030000
I_AB	stepping-stone	100	1.00E+09	1.00E-06	35	1	6	0.833333	0.023810	0.142857
I_AB	stepping-stone	100	1.00E+09	1.00E-05	70	9	18	0.721649	0.092784	0.185567
I_AB	stepping-stone	100	1.00E+09	1.00E-04	59	32	9	0.590000	0.320000	0.090000
I_AB	stepping-stone	1000	1.00E+03	0.00E+00	19	52	29	0.190000	0.520000	0.290000
I_AB	stepping-stone	1000	1.00E+03	1.00E-06	23	58	19	0.230000	0.580000	0.190000
I_AB	stepping-stone	1000	1.00E+03	1.00E-05	27	54	19	0.270000	0.540000	0.190000
I_AB	stepping-stone	1000	1.00E+03	1.00E-04	17	52	31	0.170000	0.520000	0.310000
I_AB	stepping-stone	1000	1.00E+04	0.00E+00	4	35	54	0.043011	0.376344	0.580645
I_AB	stepping-stone	1000	1.00E+04	1.00E-06	8	37	51	0.083333	0.385417	0.531250
I_AB	stepping-stone	1000	1.00E+04	1.00E-05	15	47	37	0.151515	0.474747	0.373737
I_AB	stepping-stone	1000	1.00E+04	1.00E-04	27	58	15	0.270000	0.580000	0.150000
I_AB	stepping-stone	1000	1.00E+08	1.00E-06	27	4	11	0.642857	0.095238	0.261905
I_AB	stepping-stone	1000	1.00E+08	1.00E-05	59	13	28	0.590000	0.130000	0.280000
I_AB	stepping-stone	1000	1.00E+08	1.00E-04	54	28	18	0.540000	0.280000	0.180000
I_AB	stepping-stone	1000	1.00E+09	1.00E-06	24	8	11	0.558140	0.186047	0.255814
I_AB	stepping-stone	1000	1.00E+09	1.00E-05	60	9	31	0.600000	0.090000	0.310000
I_AB	stepping-stone	1000	1.00E+09	1.00E-04	48	37	15	0.480000	0.370000	0.150000
I_AB	stepping-stone	10000	1.00E+03	0.00E+00	38	41	21	0.380000	0.410000	0.210000
I_AB	stepping-stone	10000	1.00E+03	1.00E-06	32	42	26	0.320000	0.420000	0.260000
I_AB	stepping-stone	10000	1.00E+03	1.00E-05	34	40	26	0.340000	0.400000	0.260000
I_AB	stepping-stone	10000	1.00E+03	1.00E-04	27	46	27	0.270000	0.460000	0.270000
I_AB	stepping-stone	10000	1.00E+04	0.00E+00	4	34	62	0.040000	0.340000	0.620000
I_AB	stepping-stone	10000	1.00E+04	1.00E-06	21	41	38	0.210000	0.410000	0.380000
I_AB	stepping-stone	10000	1.00E+04	1.00E-05	21	39	40	0.210000	0.390000	0.400000

I_AB	stepping-stone	10000	1.00E+04	1.00E-04	28	43	29	0.280000	0.430000	0.290000
I_AB	stepping-stone	10000	1.00E+08	1.00E-06	28	6	20	0.518519	0.111111	0.370370
I_AB	stepping-stone	10000	1.00E+08	1.00E-05	51	8	41	0.510000	0.080000	0.410000
I_AB	stepping-stone	10000	1.00E+08	1.00E-04	41	31	28	0.410000	0.310000	0.280000
I_AB	stepping-stone	10000	1.00E+09	1.00E-06	30	1	19	0.600000	0.020000	0.380000
I_AB	stepping-stone	10000	1.00E+09	1.00E-05	51	12	37	0.510000	0.120000	0.370000
I_AB	stepping-stone	10000	1.00E+09	1.00E-04	34	37	29	0.340000	0.370000	0.290000
I_AB	stepping-stone	100000	1.00E+03	0.00E+00	31	37	32	0.310000	0.370000	0.320000
I_AB	stepping-stone	100000	1.00E+03	1.00E-06	33	30	37	0.330000	0.300000	0.370000
I_AB	stepping-stone	100000	1.00E+03	1.00E-05	28	37	35	0.280000	0.370000	0.350000
I_AB	stepping-stone	100000	1.00E+03	1.00E-04	28	38	34	0.280000	0.380000	0.340000
I_AB	stepping-stone	100000	1.00E+04	0.00E+00	31	23	46	0.310000	0.230000	0.460000
I_AB	stepping-stone	100000	1.00E+04	1.00E-06	23	25	52	0.230000	0.250000	0.520000
I_AB	stepping-stone	100000	1.00E+04	1.00E-05	36	27	37	0.360000	0.270000	0.370000
I_AB	stepping-stone	100000	1.00E+04	1.00E-04	36	27	37	0.360000	0.270000	0.370000
I_AB	stepping-stone	100000	1.00E+08	1.00E-06	30	8	18	0.535714	0.142857	0.321429
I_AB	stepping-stone	100000	1.00E+08	1.00E-05	45	14	41	0.450000	0.140000	0.410000
I_AB	stepping-stone	100000	1.00E+08	1.00E-04	34	22	44	0.340000	0.220000	0.440000
I_AB	stepping-stone	100000	1.00E+09	1.00E-06	32	6	15	0.603774	0.113208	0.283019
I_AB	stepping-stone	100000	1.00E+09	1.00E-05	54	8	38	0.540000	0.080000	0.380000
I_AB	stepping-stone	100000	1.00E+09	1.00E-04	37	30	33	0.370000	0.300000	0.330000
I_AC	stepping-stone	1	1.00E+03	0.00E+00	0	77	20	0.000000	0.793814	0.206186
I_AC	stepping-stone	1	1.00E+03	1.00E-06	0	83	12	0.000000	0.873684	0.126316
I_AC	stepping-stone	1	1.00E+03	1.00E-05	0	71	28	0.000000	0.717172	0.282828
I_AC	stepping-stone	1	1.00E+03	1.00E-04	1	38	61	0.010000	0.380000	0.610000
I_AC	stepping-stone	1	1.00E+04	0.00E+00	0	83	13	0.000000	0.864583	0.135417
I_AC	stepping-stone	1	1.00E+04	1.00E-06	0	69	16	0.000000	0.811765	0.188235
I_AC	stepping-stone	1	1.00E+04	1.00E-05	1	25	68	0.010638	0.265957	0.723404
I_AC	stepping-stone	1	1.00E+04	1.00E-04	0	20	79	0.000000	0.202020	0.797980
I_AC	stepping-stone	1	1.00E+08	1.00E-06	0	6	40	0.000000	0.130435	0.869565
I_AC	stepping-stone	1	1.00E+08	1.00E-05	0	23	74	0.000000	0.237113	0.762887
I_AC	stepping-stone	1	1.00E+08	1.00E-04	3	46	51	0.030000	0.460000	0.510000
I_AC	stepping-stone	1	1.00E+09	1.00E-06	0	0	35	0.000000	0.000000	1.000000
I_AC	stepping-stone	1	1.00E+09	1.00E-05	0	22	74	0.000000	0.229167	0.770833
I_AC	stepping-stone	1	1.00E+09	1.00E-04	2	47	51	0.020000	0.470000	0.510000
I_AC	stepping-stone	10	1.00E+03	0.00E+00	0	90	7	0.000000	0.927835	0.072165
I_AC	stepping-stone	10	1.00E+03	1.00E-06	0	84	10	0.000000	0.893617	0.106383
I_AC	stepping-stone	10	1.00E+03	1.00E-05	0	79	21	0.000000	0.790000	0.210000
I_AC	stepping-stone	10	1.00E+03	1.00E-04	0	55	45	0.000000	0.550000	0.450000
I_AC	stepping-stone	10	1.00E+04	0.00E+00	0	76	9	0.000000	0.894118	0.105882
I_AC	stepping-stone	10	1.00E+04	1.00E-06	0	64	21	0.000000	0.752941	0.247059
I_AC	stepping-stone	10	1.00E+04	1.00E-05	0	28	66	0.000000	0.297872	0.702128
I_AC	stepping-stone	10	1.00E+04	1.00E-04	0	18	82	0.000000	0.180000	0.820000
I_AC	stepping-stone	10	1.00E+08	1.00E-06	0	3	36	0.000000	0.076923	0.923077
I_AC	stepping-stone	10	1.00E+08	1.00E-05	1	25	69	0.010526	0.263158	0.726316
I_AC	stepping-stone	10	1.00E+08	1.00E-04	1	39	60	0.010000	0.390000	0.600000
I_AC	stepping-stone	10	1.00E+09	1.00E-06	0	5	46	0.000000	0.098039	0.901961
I_AC	stepping-stone	10	1.00E+09	1.00E-05	0	20	77	0.000000	0.206186	0.793814
I_AC	stepping-stone	10	1.00E+09	1.00E-04	0	43	57	0.000000	0.430000	0.570000
I_AC	stepping-stone	100	1.00E+03	0.00E+00	1	81	14	0.010417	0.843750	0.145833
I_AC	stepping-stone	100	1.00E+03	1.00E-06	6	76	16	0.061224	0.775510	0.163265

I_AC	stepping-stone	100	1.00E+03	1.00E-05	3	75	22	0.030000	0.750000	0.220000
I_AC	stepping-stone	100	1.00E+03	1.00E-04	4	63	33	0.040000	0.630000	0.330000
I_AC	stepping-stone	100	1.00E+04	0.00E+00	0	75	13	0.000000	0.852273	0.147727
I_AC	stepping-stone	100	1.00E+04	1.00E-06	0	64	24	0.000000	0.727273	0.272727
I_AC	stepping-stone	100	1.00E+04	1.00E-05	0	36	60	0.000000	0.375000	0.625000
I_AC	stepping-stone	100	1.00E+04	1.00E-04	2	12	86	0.020000	0.120000	0.860000
I_AC	stepping-stone	100	1.00E+08	1.00E-06	2	10	36	0.041667	0.208333	0.750000
I_AC	stepping-stone	100	1.00E+08	1.00E-05	4	20	76	0.040000	0.200000	0.760000
I_AC	stepping-stone	100	1.00E+08	1.00E-04	5	25	70	0.050000	0.250000	0.700000
I_AC	stepping-stone	100	1.00E+09	1.00E-06	1	4	37	0.023810	0.095238	0.880952
I_AC	stepping-stone	100	1.00E+09	1.00E-05	3	27	67	0.030928	0.278351	0.690722
I_AC	stepping-stone	100	1.00E+09	1.00E-04	3	47	50	0.030000	0.470000	0.500000
I_AC	stepping-stone	1000	1.00E+03	0.00E+00	18	69	13	0.180000	0.690000	0.130000
I_AC	stepping-stone	1000	1.00E+03	1.00E-06	22	57	21	0.220000	0.570000	0.210000
I_AC	stepping-stone	1000	1.00E+03	1.00E-05	17	54	29	0.170000	0.540000	0.290000
I_AC	stepping-stone	1000	1.00E+03	1.00E-04	18	61	21	0.180000	0.610000	0.210000
I_AC	stepping-stone	1000	1.00E+04	0.00E+00	1	59	33	0.010753	0.634409	0.354839
I_AC	stepping-stone	1000	1.00E+04	1.00E-06	4	52	40	0.041667	0.541667	0.416667
I_AC	stepping-stone	1000	1.00E+04	1.00E-05	2	38	59	0.020202	0.383838	0.595960
I_AC	stepping-stone	1000	1.00E+04	1.00E-04	2	19	79	0.020000	0.190000	0.790000
I_AC	stepping-stone	1000	1.00E+08	1.00E-06	6	5	31	0.142857	0.119048	0.738095
I_AC	stepping-stone	1000	1.00E+08	1.00E-05	17	11	72	0.170000	0.110000	0.720000
I_AC	stepping-stone	1000	1.00E+08	1.00E-04	12	23	65	0.120000	0.230000	0.650000
I_AC	stepping-stone	1000	1.00E+09	1.00E-06	9	3	31	0.209302	0.069767	0.720930
I_AC	stepping-stone	1000	1.00E+09	1.00E-05	18	13	69	0.180000	0.130000	0.690000
I_AC	stepping-stone	1000	1.00E+09	1.00E-04	6	17	77	0.060000	0.170000	0.770000
I_AC	stepping-stone	10000	1.00E+03	0.00E+00	25	49	26	0.250000	0.490000	0.260000
I_AC	stepping-stone	10000	1.00E+03	1.00E-06	33	45	22	0.330000	0.450000	0.220000
I_AC	stepping-stone	10000	1.00E+03	1.00E-05	34	45	21	0.340000	0.450000	0.210000
I_AC	stepping-stone	10000	1.00E+03	1.00E-04	28	40	32	0.280000	0.400000	0.320000
I_AC	stepping-stone	10000	1.00E+04	0.00E+00	16	48	36	0.160000	0.480000	0.360000
I_AC	stepping-stone	10000	1.00E+04	1.00E-06	9	31	60	0.090000	0.310000	0.600000
I_AC	stepping-stone	10000	1.00E+04	1.00E-05	12	29	59	0.120000	0.290000	0.590000
I_AC	stepping-stone	10000	1.00E+04	1.00E-04	21	12	67	0.210000	0.120000	0.670000
I_AC	stepping-stone	10000	1.00E+08	1.00E-06	17	4	33	0.314815	0.074074	0.611111
I_AC	stepping-stone	10000	1.00E+08	1.00E-05	34	7	59	0.340000	0.070000	0.590000
I_AC	stepping-stone	10000	1.00E+08	1.00E-04	15	18	67	0.150000	0.180000	0.670000
I_AC	stepping-stone	10000	1.00E+09	1.00E-06	15	4	31	0.300000	0.080000	0.620000
I_AC	stepping-stone	10000	1.00E+09	1.00E-05	29	8	63	0.290000	0.080000	0.630000
I_AC	stepping-stone	10000	1.00E+09	1.00E-04	19	14	67	0.190000	0.140000	0.670000
I_AC	stepping-stone	100000	1.00E+03	0.00E+00	22	49	29	0.220000	0.490000	0.290000
I_AC	stepping-stone	100000	1.00E+03	1.00E-06	32	35	33	0.320000	0.350000	0.330000
I_AC	stepping-stone	100000	1.00E+03	1.00E-05	30	34	36	0.300000	0.340000	0.360000
I_AC	stepping-stone	100000	1.00E+03	1.00E-04	41	24	35	0.410000	0.240000	0.350000
I_AC	stepping-stone	100000	1.00E+04	0.00E+00	20	29	51	0.200000	0.290000	0.510000
I_AC	stepping-stone	100000	1.00E+04	1.00E-06	35	21	44	0.350000	0.210000	0.440000
I_AC	stepping-stone	100000	1.00E+04	1.00E-05	22	16	62	0.220000	0.160000	0.620000
I_AC	stepping-stone	100000	1.00E+04	1.00E-04	28	14	58	0.280000	0.140000	0.580000
I_AC	stepping-stone	100000	1.00E+08	1.00E-06	17	2	37	0.303571	0.035714	0.660714
I_AC	stepping-stone	100000	1.00E+08	1.00E-05	35	6	59	0.350000	0.060000	0.590000
I_AC	stepping-stone	100000	1.00E+08	1.00E-04	30	16	54	0.300000	0.160000	0.540000

I_AC	stepping-stone	100000	1.00E+09	1.00E-06	16	3	34	0.301887	0.056604	0.641509
I_AC	stepping-stone	100000	1.00E+09	1.00E-05	32	6	62	0.320000	0.060000	0.620000
I_AC	stepping-stone	100000	1.00E+09	1.00E-04	26	10	64	0.260000	0.100000	0.640000
I_BC	stepping-stone	1	1.00E+03	0.00E+00	21	20	56	0.216495	0.206186	0.577320
I_BC	stepping-stone	1	1.00E+03	1.00E-06	11	14	70	0.115789	0.147368	0.736842
I_BC	stepping-stone	1	1.00E+03	1.00E-05	15	27	57	0.151515	0.272727	0.575758
I_BC	stepping-stone	1	1.00E+03	1.00E-04	7	59	34	0.070000	0.590000	0.340000
I_BC	stepping-stone	1	1.00E+04	0.00E+00	11	63	22	0.114583	0.656250	0.229167
I_BC	stepping-stone	1	1.00E+04	1.00E-06	8	67	10	0.094118	0.788235	0.117647
I_BC	stepping-stone	1	1.00E+04	1.00E-05	8	79	7	0.085106	0.840426	0.074468
I_BC	stepping-stone	1	1.00E+04	1.00E-04	2	80	17	0.020202	0.808081	0.171717
I_BC	stepping-stone	1	1.00E+08	1.00E-06	0	46	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	1	1.00E+08	1.00E-05	1	82	14	0.010309	0.845361	0.144330
I_BC	stepping-stone	1	1.00E+08	1.00E-04	3	54	43	0.030000	0.540000	0.430000
I_BC	stepping-stone	1	1.00E+09	1.00E-06	0	35	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	1	1.00E+09	1.00E-05	0	86	10	0.000000	0.895833	0.104167
I_BC	stepping-stone	1	1.00E+09	1.00E-04	2	53	45	0.020000	0.530000	0.450000
I_BC	stepping-stone	10	1.00E+03	0.00E+00	8	10	79	0.082474	0.103093	0.814433
I_BC	stepping-stone	10	1.00E+03	1.00E-06	8	17	69	0.085106	0.180851	0.734043
I_BC	stepping-stone	10	1.00E+03	1.00E-05	15	16	69	0.150000	0.160000	0.690000
I_BC	stepping-stone	10	1.00E+03	1.00E-04	19	38	43	0.190000	0.380000	0.430000
I_BC	stepping-stone	10	1.00E+04	0.00E+00	4	66	15	0.047059	0.776471	0.176471
I_BC	stepping-stone	10	1.00E+04	1.00E-06	13	61	11	0.152941	0.717647	0.129412
I_BC	stepping-stone	10	1.00E+04	1.00E-05	7	79	8	0.074468	0.840426	0.085106
I_BC	stepping-stone	10	1.00E+04	1.00E-04	0	85	15	0.000000	0.850000	0.150000
I_BC	stepping-stone	10	1.00E+08	1.00E-06	1	38	0	0.025641	0.974359	0.000000
I_BC	stepping-stone	10	1.00E+08	1.00E-05	0	83	12	0.000000	0.873684	0.126316
I_BC	stepping-stone	10	1.00E+08	1.00E-04	5	56	39	0.050000	0.560000	0.390000
I_BC	stepping-stone	10	1.00E+09	1.00E-06	1	49	1	0.019608	0.960784	0.019608
I_BC	stepping-stone	10	1.00E+09	1.00E-05	0	88	9	0.000000	0.907216	0.092784
I_BC	stepping-stone	10	1.00E+09	1.00E-04	4	56	40	0.040000	0.560000	0.400000
I_BC	stepping-stone	100	1.00E+03	0.00E+00	20	15	61	0.208333	0.156250	0.635417
I_BC	stepping-stone	100	1.00E+03	1.00E-06	23	15	60	0.234694	0.153061	0.612245
I_BC	stepping-stone	100	1.00E+03	1.00E-05	20	15	65	0.200000	0.150000	0.650000
I_BC	stepping-stone	100	1.00E+03	1.00E-04	30	20	50	0.300000	0.200000	0.500000
I_BC	stepping-stone	100	1.00E+04	0.00E+00	10	71	7	0.113636	0.806818	0.079545
I_BC	stepping-stone	100	1.00E+04	1.00E-06	10	67	11	0.113636	0.761364	0.125000
I_BC	stepping-stone	100	1.00E+04	1.00E-05	8	79	9	0.083333	0.822917	0.093750
I_BC	stepping-stone	100	1.00E+04	1.00E-04	4	86	10	0.040000	0.860000	0.100000
I_BC	stepping-stone	100	1.00E+08	1.00E-06	0	48	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	100	1.00E+08	1.00E-05	3	90	7	0.030000	0.900000	0.070000
I_BC	stepping-stone	100	1.00E+08	1.00E-04	2	71	27	0.020000	0.710000	0.270000
I_BC	stepping-stone	100	1.00E+09	1.00E-06	1	41	0	0.023810	0.976190	0.000000
I_BC	stepping-stone	100	1.00E+09	1.00E-05	0	86	11	0.000000	0.886598	0.113402
I_BC	stepping-stone	100	1.00E+09	1.00E-04	1	59	40	0.010000	0.590000	0.400000
I_BC	stepping-stone	1000	1.00E+03	0.00E+00	24	18	58	0.240000	0.180000	0.580000
I_BC	stepping-stone	1000	1.00E+03	1.00E-06	23	18	59	0.230000	0.180000	0.590000
I_BC	stepping-stone	1000	1.00E+03	1.00E-05	21	27	52	0.210000	0.270000	0.520000
I_BC	stepping-stone	1000	1.00E+03	1.00E-04	21	31	48	0.210000	0.310000	0.480000
I_BC	stepping-stone	1000	1.00E+04	0.00E+00	33	58	2	0.354839	0.623656	0.021505
I_BC	stepping-stone	1000	1.00E+04	1.00E-06	35	58	3	0.364583	0.604167	0.031250

I_BC	stepping-stone	1000	1.00E+04	1.00E-05	32	63	4	0.323232	0.636364	0.040404
I_BC	stepping-stone	1000	1.00E+04	1.00E-04	23	72	5	0.230000	0.720000	0.050000
I_BC	stepping-stone	1000	1.00E+08	1.00E-06	9	33	0	0.214286	0.785714	0.000000
I_BC	stepping-stone	1000	1.00E+08	1.00E-05	19	81	0	0.190000	0.810000	0.000000
I_BC	stepping-stone	1000	1.00E+08	1.00E-04	24	59	17	0.240000	0.590000	0.170000
I_BC	stepping-stone	1000	1.00E+09	1.00E-06	14	29	0	0.325581	0.674419	0.000000
I_BC	stepping-stone	1000	1.00E+09	1.00E-05	16	84	0	0.160000	0.840000	0.000000
I_BC	stepping-stone	1000	1.00E+09	1.00E-04	19	73	8	0.190000	0.730000	0.080000
I_BC	stepping-stone	10000	1.00E+03	0.00E+00	23	24	53	0.230000	0.240000	0.530000
I_BC	stepping-stone	10000	1.00E+03	1.00E-06	25	23	52	0.250000	0.230000	0.520000
I_BC	stepping-stone	10000	1.00E+03	1.00E-05	20	28	52	0.200000	0.280000	0.520000
I_BC	stepping-stone	10000	1.00E+03	1.00E-04	24	37	39	0.240000	0.370000	0.390000
I_BC	stepping-stone	10000	1.00E+04	0.00E+00	42	57	1	0.420000	0.570000	0.010000
I_BC	stepping-stone	10000	1.00E+04	1.00E-06	44	56	0	0.440000	0.560000	0.000000
I_BC	stepping-stone	10000	1.00E+04	1.00E-05	47	53	0	0.470000	0.530000	0.000000
I_BC	stepping-stone	10000	1.00E+04	1.00E-04	36	61	3	0.360000	0.610000	0.030000
I_BC	stepping-stone	10000	1.00E+08	1.00E-06	26	28	0	0.481481	0.518519	0.000000
I_BC	stepping-stone	10000	1.00E+08	1.00E-05	35	65	0	0.350000	0.650000	0.000000
I_BC	stepping-stone	10000	1.00E+08	1.00E-04	49	48	3	0.490000	0.480000	0.030000
I_BC	stepping-stone	10000	1.00E+09	1.00E-06	22	28	0	0.440000	0.560000	0.000000
I_BC	stepping-stone	10000	1.00E+09	1.00E-05	42	58	0	0.420000	0.580000	0.000000
I_BC	stepping-stone	10000	1.00E+09	1.00E-04	44	54	2	0.440000	0.540000	0.020000
I_BC	stepping-stone	100000	1.00E+03	0.00E+00	31	34	35	0.310000	0.340000	0.350000
I_BC	stepping-stone	100000	1.00E+03	1.00E-06	30	40	30	0.300000	0.400000	0.300000
I_BC	stepping-stone	100000	1.00E+03	1.00E-05	41	37	22	0.410000	0.370000	0.220000
I_BC	stepping-stone	100000	1.00E+03	1.00E-04	39	31	30	0.390000	0.310000	0.300000
I_BC	stepping-stone	100000	1.00E+04	0.00E+00	51	49	0	0.510000	0.490000	0.000000
I_BC	stepping-stone	100000	1.00E+04	1.00E-06	44	54	2	0.440000	0.540000	0.020000
I_BC	stepping-stone	100000	1.00E+04	1.00E-05	50	49	1	0.500000	0.490000	0.010000
I_BC	stepping-stone	100000	1.00E+04	1.00E-04	54	43	3	0.540000	0.430000	0.030000
I_BC	stepping-stone	100000	1.00E+08	1.00E-06	34	22	0	0.607143	0.392857	0.000000
I_BC	stepping-stone	100000	1.00E+08	1.00E-05	51	49	0	0.510000	0.490000	0.000000
I_BC	stepping-stone	100000	1.00E+08	1.00E-04	41	59	0	0.410000	0.590000	0.000000
I_BC	stepping-stone	100000	1.00E+09	1.00E-06	29	24	0	0.547170	0.452830	0.000000
I_BC	stepping-stone	100000	1.00E+09	1.00E-05	42	58	0	0.420000	0.580000	0.000000
I_BC	stepping-stone	100000	1.00E+09	1.00E-04	48	50	2	0.480000	0.500000	0.020000

TABLE 4

Path	splitting_model	N_f	T1	mean	$I_{ij} > 0$	$I_{ij} < 0$	$I_{ij} = 0$	**Mean_ij**	**Mean_ji**	**Mean_0**
I_AB	radiation	1	1e3	-0.9158	0	87	8	0.000000	0.915789	0.084211
I_AB	radiation	1	1e3	-0.8723	0	82	12	0.000000	0.872340	0.127660
I_AB	radiation	1	1e3	-0.9375	0	90	6	0.000000	0.937500	0.062500
I_AB	radiation	1	1e3	-0.8200	1	83	16	0.010000	0.830000	0.160000
I_AB	radiation	1	1e4	-0.7037	0	57	24	0.000000	0.703704	0.296296
I_AB	radiation	1	1e4	-0.6477	3	60	25	0.034091	0.681818	0.284091
I_AB	radiation	1	1e4	-0.8021	2	79	15	0.020833	0.822917	0.156250
I_AB	radiation	1	1e4	-0.4300	26	69	5	0.260000	0.690000	0.050000
I_AB	radiation	1	1e8	0.5778	29	3	13	0.644444	0.066667	0.288889
I_AB	radiation	1	1e8	0.6804	73	7	17	0.752577	0.072165	0.175258
I_AB	radiation	1	1e8	0.2300	61	38	1	0.610000	0.380000	0.010000

I_AB	radiation	1	1e9	0.5263	26	6	6	0.684211	0.157895	0.157895
I_AB	radiation	1	1e9	0.4898	61	13	24	0.622449	0.132653	0.244898
I_AB	radiation	1	1e9	0.2300	60	37	3	0.600000	0.370000	0.030000
I_AB	radiation	10	1e3	-0.9570	0	89	4	0.000000	0.956989	0.043011
I_AB	radiation	10	1e3	-0.9457	0	87	5	0.000000	0.945652	0.054348
I_AB	radiation	10	1e3	-0.8969	0	87	10	0.000000	0.896907	0.103093
I_AB	radiation	10	1e3	-0.7800	4	82	14	0.040000	0.820000	0.140000
I_AB	radiation	10	1e4	-0.7241	0	63	24	0.000000	0.724138	0.275862
I_AB	radiation	10	1e4	-0.7051	2	57	19	0.025641	0.730769	0.243590
I_AB	radiation	10	1e4	-0.6737	10	74	11	0.105263	0.778947	0.115789
I_AB	radiation	10	1e4	-0.5100	22	73	5	0.220000	0.730000	0.050000
I_AB	radiation	10	1e8	0.5192	31	4	17	0.596154	0.076923	0.326923
I_AB	radiation	10	1e8	0.4694	62	16	20	0.632653	0.163265	0.204082
I_AB	radiation	10	1e8	0.2600	62	36	2	0.620000	0.360000	0.020000
I_AB	radiation	10	1e9	0.2727	19	7	18	0.431818	0.159091	0.409091
I_AB	radiation	10	1e9	0.5455	69	15	15	0.696970	0.151515	0.151515
I_AB	radiation	10	1e9	0.1600	56	40	4	0.560000	0.400000	0.040000
I_AB	radiation	100	1e3	-0.7576	3	78	18	0.030303	0.787879	0.181818
I_AB	radiation	100	1e3	-0.8283	2	84	13	0.020202	0.848485	0.131313
I_AB	radiation	100	1e3	-0.7172	3	74	22	0.030303	0.747475	0.222222
I_AB	radiation	100	1e3	-0.7500	6	81	13	0.060000	0.810000	0.130000
I_AB	radiation	100	1e4	-0.8022	0	73	18	0.000000	0.802198	0.197802
I_AB	radiation	100	1e4	-0.6092	3	56	28	0.034483	0.643678	0.321839
I_AB	radiation	100	1e4	-0.5417	12	64	20	0.125000	0.666667	0.208333
I_AB	radiation	100	1e4	-0.3200	30	62	8	0.300000	0.620000	0.080000
I_AB	radiation	100	1e8	0.4694	28	5	16	0.571429	0.102041	0.326531
I_AB	radiation	100	1e8	0.5800	72	14	14	0.720000	0.140000	0.140000
I_AB	radiation	100	1e8	0.2700	61	34	5	0.610000	0.340000	0.050000
I_AB	radiation	100	1e9	0.3958	23	4	21	0.479167	0.083333	0.437500
I_AB	radiation	100	1e9	0.6162	73	12	14	0.737374	0.121212	0.141414
I_AB	radiation	100	1e9	0.3636	66	30	3	0.666667	0.303030	0.030303
I_AB	radiation	1000	1e3	-0.4500	19	64	17	0.190000	0.640000	0.170000
I_AB	radiation	1000	1e3	-0.3900	22	61	17	0.220000	0.610000	0.170000
I_AB	radiation	1000	1e3	-0.4800	18	66	16	0.180000	0.660000	0.160000
I_AB	radiation	1000	1e3	-0.3500	24	59	17	0.240000	0.590000	0.170000
I_AB	radiation	1000	1e4	-0.5055	3	49	39	0.032967	0.538462	0.428571
I_AB	radiation	1000	1e4	-0.4409	5	46	42	0.053763	0.494624	0.451613
I_AB	radiation	1000	1e4	-0.5306	6	58	34	0.061224	0.591837	0.346939
I_AB	radiation	1000	1e4	-0.3000	26	56	18	0.260000	0.560000	0.180000
I_AB	radiation	1000	1e8	0.5652	27	1	18	0.586957	0.021739	0.391304
I_AB	radiation	1000	1e8	0.4400	56	12	32	0.560000	0.120000	0.320000
I_AB	radiation	1000	1e8	0.1200	46	34	20	0.460000	0.340000	0.200000
I_AB	radiation	1000	1e9	0.5357	31	1	24	0.553571	0.017857	0.428571
I_AB	radiation	1000	1e9	0.5800	63	5	32	0.630000	0.050000	0.320000
I_AB	radiation	1000	1e9	0.1500	46	31	23	0.460000	0.310000	0.230000
I_AB	radiation	10000	1e3	-0.1300	31	44	25	0.310000	0.440000	0.250000
I_AB	radiation	10000	1e3	-0.1200	34	46	20	0.340000	0.460000	0.200000
I_AB	radiation	10000	1e3	0.0000	35	35	30	0.350000	0.350000	0.300000
I_AB	radiation	10000	1e3	-0.1700	28	45	27	0.280000	0.450000	0.270000
I_AB	radiation	10000	1e4	-0.2800	13	41	46	0.130000	0.410000	0.460000
I_AB	radiation	10000	1e4	-0.1300	20	33	47	0.200000	0.330000	0.470000

I_AB	radiation	10000	1e4	-0.2300	17	40	43	0.170000	0.400000	0.430000
I_AB	radiation	10000	1e4	-0.1000	24	34	42	0.240000	0.340000	0.420000
I_AB	radiation	10000	1e8	0.6667	27	1	11	0.692308	0.025641	0.282051
I_AB	radiation	10000	1e8	0.4141	46	5	48	0.464646	0.050505	0.484848
I_AB	radiation	10000	1e8	0.2600	43	17	40	0.430000	0.170000	0.400000
I_AB	radiation	10000	1e9	0.5682	29	4	11	0.659091	0.090909	0.250000
I_AB	radiation	10000	1e9	0.4700	54	7	39	0.540000	0.070000	0.390000
I_AB	radiation	10000	1e9	0.1600	39	23	38	0.390000	0.230000	0.380000
I_AB	radiation	100000	1e3	-0.0500	31	36	33	0.310000	0.360000	0.330000
I_AB	radiation	100000	1e3	0.0100	36	35	29	0.360000	0.350000	0.290000
I_AB	radiation	100000	1e3	-0.0800	34	42	24	0.340000	0.420000	0.240000
I_AB	radiation	100000	1e3	-0.1700	28	45	27	0.280000	0.450000	0.270000
I_AB	radiation	100000	1e4	0.1000	33	23	44	0.330000	0.230000	0.440000
I_AB	radiation	100000	1e4	0.0800	29	21	50	0.290000	0.210000	0.500000
I_AB	radiation	100000	1e4	0.1000	30	20	50	0.300000	0.200000	0.500000
I_AB	radiation	100000	1e4	0.0800	31	23	46	0.310000	0.230000	0.460000
I_AB	radiation	100000	1e8	0.3200	20	4	26	0.400000	0.080000	0.520000
I_AB	radiation	100000	1e8	0.2600	35	9	56	0.350000	0.090000	0.560000
I_AB	radiation	100000	1e8	0.1300	33	20	47	0.330000	0.200000	0.470000
I_AB	radiation	100000	1e9	0.5000	27	2	21	0.540000	0.040000	0.420000
I_AB	radiation	100000	1e9	0.2200	36	14	50	0.360000	0.140000	0.500000
I_AB	radiation	100000	1e9	0.1000	30	20	50	0.300000	0.200000	0.500000
I_BC	radiation	1	1e3	0.0105	9	8	78	0.094737	0.084211	0.821053
I_BC	radiation	1	1e3	-0.0213	10	12	72	0.106383	0.127660	0.765957
I_BC	radiation	1	1e3	-0.0417	8	12	76	0.083333	0.125000	0.791667
I_BC	radiation	1	1e3	-0.1000	9	19	72	0.090000	0.190000	0.720000
I_BC	radiation	1	1e4	-0.2963	1	25	55	0.012346	0.308642	0.679012
I_BC	radiation	1	1e4	-0.2841	2	27	59	0.022727	0.306818	0.670455
I_BC	radiation	1	1e4	-0.2292	4	26	66	0.041667	0.270833	0.687500
I_BC	radiation	1	1e4	-0.2600	3	29	68	0.030000	0.290000	0.680000
I_BC	radiation	1	1e8	-0.2889	0	13	32	0.000000	0.288889	0.711111
I_BC	radiation	1	1e8	-0.2165	0	21	76	0.000000	0.216495	0.783505
I_BC	radiation	1	1e8	-0.1900	0	19	81	0.000000	0.190000	0.810000
I_BC	radiation	1	1e9	-0.1579	0	6	32	0.000000	0.157895	0.842105
I_BC	radiation	1	1e9	-0.3265	0	32	66	0.000000	0.326531	0.673469
I_BC	radiation	1	1e9	-0.3200	1	33	66	0.010000	0.330000	0.660000
I_BC	radiation	10	1e3	0.0538	9	4	80	0.096774	0.043011	0.860215
I_BC	radiation	10	1e3	0.0109	7	6	79	0.076087	0.065217	0.858696
I_BC	radiation	10	1e3	-0.0412	5	9	83	0.051546	0.092784	0.855670
I_BC	radiation	10	1e3	-0.0500	12	17	71	0.120000	0.170000	0.710000
I_BC	radiation	10	1e4	-0.2759	1	25	61	0.011494	0.287356	0.701149
I_BC	radiation	10	1e4	-0.2692	2	23	53	0.025641	0.294872	0.679487
I_BC	radiation	10	1e4	-0.2632	1	26	68	0.010526	0.273684	0.715789
I_BC	radiation	10	1e4	-0.2900	3	32	65	0.030000	0.320000	0.650000
I_BC	radiation	10	1e8	-0.3269	0	17	35	0.000000	0.326923	0.673077
I_BC	radiation	10	1e8	-0.2755	0	27	71	0.000000	0.275510	0.724490
I_BC	radiation	10	1e8	-0.2200	1	23	76	0.010000	0.230000	0.760000
I_BC	radiation	10	1e9	-0.3864	0	17	27	0.000000	0.386364	0.613636
I_BC	radiation	10	1e9	-0.2121	1	22	76	0.010101	0.222222	0.767677
I_BC	radiation	10	1e9	-0.3800	0	38	62	0.000000	0.380000	0.620000
I_BC	radiation	100	1e3	0.0202	16	14	69	0.161616	0.141414	0.696970

I_BC	radiation	100	1e3	0.0000	10	10	79	0.101010	0.101010	0.797980
I_BC	radiation	100	1e3	-0.0202	17	19	63	0.171717	0.191919	0.636364
I_BC	radiation	100	1e3	-0.0900	14	23	63	0.140000	0.230000	0.630000
I_BC	radiation	100	1e4	0.0440	14	10	67	0.153846	0.109890	0.736264
I_BC	radiation	100	1e4	-0.1494	11	24	52	0.126437	0.275862	0.597701
I_BC	radiation	100	1e4	-0.1458	9	23	64	0.093750	0.239583	0.666667
I_BC	radiation	100	1e4	-0.1600	7	23	70	0.070000	0.230000	0.700000
I_BC	radiation	100	1e8	-0.3061	0	15	34	0.000000	0.306122	0.693878
I_BC	radiation	100	1e8	-0.1400	0	14	86	0.000000	0.140000	0.860000
I_BC	radiation	100	1e8	-0.2400	0	24	76	0.000000	0.240000	0.760000
I_BC	radiation	100	1e9	-0.3958	1	20	27	0.020833	0.416667	0.562500
I_BC	radiation	100	1e9	-0.1616	1	17	81	0.010101	0.171717	0.818182
I_BC	radiation	100	1e9	-0.1616	2	18	79	0.020202	0.181818	0.797980
I_BC	radiation	1000	1e3	0.1400	26	12	62	0.260000	0.120000	0.620000
I_BC	radiation	1000	1e3	-0.0200	15	17	68	0.150000	0.170000	0.680000
I_BC	radiation	1000	1e3	-0.0400	16	20	64	0.160000	0.200000	0.640000
I_BC	radiation	1000	1e3	-0.0800	15	23	62	0.150000	0.230000	0.620000
I_BC	radiation	1000	1e4	0.3297	36	6	49	0.395604	0.065934	0.538462
I_BC	radiation	1000	1e4	0.3118	36	7	50	0.387097	0.075269	0.537634
I_BC	radiation	1000	1e4	0.1735	27	10	61	0.275510	0.102041	0.622449
I_BC	radiation	1000	1e4	0.0400	18	14	68	0.180000	0.140000	0.680000
I_BC	radiation	1000	1e8	-0.4130	1	20	25	0.021739	0.434783	0.543478
I_BC	radiation	1000	1e8	-0.3400	0	34	66	0.000000	0.340000	0.660000
I_BC	radiation	1000	1e8	-0.1700	6	23	71	0.060000	0.230000	0.710000
I_BC	radiation	1000	1e9	-0.4107	1	24	31	0.017857	0.428571	0.553571
I_BC	radiation	1000	1e9	-0.2700	3	30	67	0.030000	0.300000	0.670000
I_BC	radiation	1000	1e9	-0.2700	6	33	61	0.060000	0.330000	0.610000
I_BC	radiation	10000	1e3	-0.0800	18	26	56	0.180000	0.260000	0.560000
I_BC	radiation	10000	1e3	0.0600	25	19	56	0.250000	0.190000	0.560000
I_BC	radiation	10000	1e3	0.0200	26	24	50	0.260000	0.240000	0.500000
I_BC	radiation	10000	1e3	0.1200	32	20	48	0.320000	0.200000	0.480000
I_BC	radiation	10000	1e4	0.2300	35	12	53	0.350000	0.120000	0.530000
I_BC	radiation	10000	1e4	0.1300	30	17	53	0.300000	0.170000	0.530000
I_BC	radiation	10000	1e4	0.1200	28	16	56	0.280000	0.160000	0.560000
I_BC	radiation	10000	1e4	0.0500	26	21	53	0.260000	0.210000	0.530000
I_BC	radiation	10000	1e8	-0.3846	1	16	22	0.025641	0.410256	0.564103
I_BC	radiation	10000	1e8	-0.3838	6	44	49	0.060606	0.444444	0.494949
I_BC	radiation	10000	1e8	-0.2000	12	32	56	0.120000	0.320000	0.560000
I_BC	radiation	10000	1e9	-0.3636	1	17	26	0.022727	0.386364	0.590909
I_BC	radiation	10000	1e9	-0.2700	7	34	59	0.070000	0.340000	0.590000
I_BC	radiation	10000	1e9	-0.1200	14	26	60	0.140000	0.260000	0.600000
I_BC	radiation	100000	1e3	0.1900	42	23	35	0.420000	0.230000	0.350000
I_BC	radiation	100000	1e3	0.0500	35	30	35	0.350000	0.300000	0.350000
I_BC	radiation	100000	1e3	0.0900	35	26	39	0.350000	0.260000	0.390000
I_BC	radiation	100000	1e3	0.1000	37	27	36	0.370000	0.270000	0.360000
I_BC	radiation	100000	1e4	0.0500	25	20	55	0.250000	0.200000	0.550000
I_BC	radiation	100000	1e4	0.0300	27	24	49	0.270000	0.240000	0.490000
I_BC	radiation	100000	1e4	-0.0200	25	27	48	0.250000	0.270000	0.480000
I_BC	radiation	100000	1e4	-0.1000	19	29	52	0.190000	0.290000	0.520000
I_BC	radiation	100000	1e8	-0.5400	3	30	17	0.060000	0.600000	0.340000
I_BC	radiation	100000	1e8	-0.3700	10	47	43	0.100000	0.470000	0.430000

I_BC	radiation	100000	1e8	-0.2100	15	36	49	0.150000	0.360000	0.490000
I_BC	radiation	100000	1e9	-0.5200	0	26	24	0.000000	0.520000	0.480000
I_BC	radiation	100000	1e9	-0.3900	6	45	49	0.060000	0.450000	0.490000
I_BC	radiation	100000	1e9	-0.1000	20	30	50	0.200000	0.300000	0.500000
I_AC	radiation	1	1e3	-0.9053	0	86	9	0.000000	0.905263	0.094737
I_AC	radiation	1	1e3	-0.8936	0	84	10	0.000000	0.893617	0.106383
I_AC	radiation	1	1e3	-0.8125	2	80	14	0.020833	0.833333	0.145833
I_AC	radiation	1	1e3	-0.8100	2	83	15	0.020000	0.830000	0.150000
I_AC	radiation	1	1e4	-0.9877	0	80	1	0.000000	0.987654	0.012346
I_AC	radiation	1	1e4	-0.9659	0	85	3	0.000000	0.965909	0.034091
I_AC	radiation	1	1e4	-0.8229	1	80	15	0.010417	0.833333	0.156250
I_AC	radiation	1	1e4	-0.6900	2	71	27	0.020000	0.710000	0.270000
I_AC	radiation	1	1e8	-1.0000	0	45	0	0.000000	1.000000	0.000000
I_AC	radiation	1	1e8	-0.9485	1	93	3	0.010309	0.958763	0.030928
I_AC	radiation	1	1e8	-0.7800	3	81	16	0.030000	0.810000	0.160000
I_AC	radiation	1	1e9	-1.0000	0	38	0	0.000000	1.000000	0.000000
I_AC	radiation	1	1e9	-0.9184	0	90	8	0.000000	0.918367	0.081633
I_AC	radiation	1	1e9	-0.6800	1	69	30	0.010000	0.690000	0.300000
I_AC	radiation	10	1e3	-0.9032	0	84	9	0.000000	0.903226	0.096774
I_AC	radiation	10	1e3	-0.8913	1	83	8	0.010870	0.902174	0.086957
I_AC	radiation	10	1e3	-0.8969	2	89	6	0.020619	0.917526	0.061856
I_AC	radiation	10	1e3	-0.7100	6	77	17	0.060000	0.770000	0.170000
I_AC	radiation	10	1e4	-0.9885	0	86	1	0.000000	0.988506	0.011494
I_AC	radiation	10	1e4	-0.9359	0	73	5	0.000000	0.935897	0.064103
I_AC	radiation	10	1e4	-0.8316	0	79	16	0.000000	0.831579	0.168421
I_AC	radiation	10	1e4	-0.6800	1	69	30	0.010000	0.690000	0.300000
I_AC	radiation	10	1e8	-1.0000	0	52	0	0.000000	1.000000	0.000000
I_AC	radiation	10	1e8	-0.9082	1	90	7	0.010204	0.918367	0.071429
I_AC	radiation	10	1e8	-0.7300	3	76	21	0.030000	0.760000	0.210000
I_AC	radiation	10	1e9	-1.0000	0	44	0	0.000000	1.000000	0.000000
I_AC	radiation	10	1e9	-0.8889	2	90	7	0.020202	0.909091	0.070707
I_AC	radiation	10	1e9	-0.6600	1	67	32	0.010000	0.670000	0.320000
I_AC	radiation	100	1e3	-0.7677	5	81	13	0.050505	0.818182	0.131313
I_AC	radiation	100	1e3	-0.8485	3	87	9	0.030303	0.878788	0.090909
I_AC	radiation	100	1e3	-0.8586	0	85	14	0.000000	0.858586	0.141414
I_AC	radiation	100	1e3	-0.6700	4	71	25	0.040000	0.710000	0.250000
I_AC	radiation	100	1e4	-0.7802	7	78	6	0.076923	0.857143	0.065934
I_AC	radiation	100	1e4	-0.8506	3	77	7	0.034483	0.885057	0.080460
I_AC	radiation	100	1e4	-0.7917	4	80	12	0.041667	0.833333	0.125000
I_AC	radiation	100	1e4	-0.7000	4	74	22	0.040000	0.740000	0.220000
I_AC	radiation	100	1e8	-0.9592	1	48	0	0.020408	0.979592	0.000000
I_AC	radiation	100	1e8	-0.9600	2	98	0	0.020000	0.980000	0.000000
I_AC	radiation	100	1e8	-0.7300	4	77	19	0.040000	0.770000	0.190000
I_AC	radiation	100	1e9	-0.8333	4	44	0	0.083333	0.916667	0.000000
I_AC	radiation	100	1e9	-0.8586	6	91	2	0.060606	0.919192	0.020202
I_AC	radiation	100	1e9	-0.7475	4	78	17	0.040404	0.787879	0.171717
I_AC	radiation	1000	1e3	-0.4300	19	62	19	0.190000	0.620000	0.190000
I_AC	radiation	1000	1e3	-0.4700	19	66	15	0.190000	0.660000	0.150000
I_AC	radiation	1000	1e3	-0.3900	21	60	19	0.210000	0.600000	0.190000
I_AC	radiation	1000	1e3	-0.4100	19	60	21	0.190000	0.600000	0.210000
I_AC	radiation	1000	1e4	-0.5385	20	69	2	0.219780	0.758242	0.021978

I_AC	radiation	1000	1e4	-0.5161	22	70	1	0.236559	0.752688	0.010753
I_AC	radiation	1000	1e4	-0.3673	29	65	4	0.295918	0.663265	0.040816
I_AC	radiation	1000	1e4	-0.3900	24	63	13	0.240000	0.630000	0.130000
I_AC	radiation	1000	1e8	-0.4348	13	33	0	0.282609	0.717391	0.000000
I_AC	radiation	1000	1e8	-0.5400	23	77	0	0.230000	0.770000	0.000000
I_AC	radiation	1000	1e8	-0.5900	16	75	9	0.160000	0.750000	0.090000
I_AC	radiation	1000	1e9	-0.4286	16	40	0	0.285714	0.714286	0.000000
I_AC	radiation	1000	1e9	-0.4400	28	72	0	0.280000	0.720000	0.000000
I_AC	radiation	1000	1e9	-0.2600	29	55	16	0.290000	0.550000	0.160000
I_AC	radiation	10000	1e3	-0.0300	39	42	19	0.390000	0.420000	0.190000
I_AC	radiation	10000	1e3	0.0000	38	38	24	0.380000	0.380000	0.240000
I_AC	radiation	10000	1e3	0.0000	40	40	20	0.400000	0.400000	0.200000
I_AC	radiation	10000	1e3	-0.1500	30	45	25	0.300000	0.450000	0.250000
I_AC	radiation	10000	1e4	0.0400	52	48	0	0.520000	0.480000	0.000000
I_AC	radiation	10000	1e4	0.0600	53	47	0	0.530000	0.470000	0.000000
I_AC	radiation	10000	1e4	-0.1000	45	55	0	0.450000	0.550000	0.000000
I_AC	radiation	10000	1e4	0.0400	50	46	4	0.500000	0.460000	0.040000
I_AC	radiation	10000	1e8	0.0769	21	18	0	0.538462	0.461538	0.000000
I_AC	radiation	10000	1e8	-0.1717	41	58	0	0.414141	0.585859	0.000000
I_AC	radiation	10000	1e8	-0.1900	39	58	3	0.390000	0.580000	0.030000
I_AC	radiation	10000	1e9	0.0000	22	22	0	0.500000	0.500000	0.000000
I_AC	radiation	10000	1e9	0.0400	52	48	0	0.520000	0.480000	0.000000
I_AC	radiation	10000	1e9	-0.1800	40	58	2	0.400000	0.580000	0.020000
I_AC	radiation	100000	1e3	0.0200	35	33	32	0.350000	0.330000	0.320000
I_AC	radiation	100000	1e3	-0.0100	33	34	33	0.330000	0.340000	0.330000
I_AC	radiation	100000	1e3	-0.0100	33	34	33	0.330000	0.340000	0.330000
I_AC	radiation	100000	1e3	-0.0500	31	36	33	0.310000	0.360000	0.330000
I_AC	radiation	100000	1e4	-0.1500	42	57	1	0.420000	0.570000	0.010000
I_AC	radiation	100000	1e4	-0.0800	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1e4	-0.0800	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1e4	0.2200	60	38	2	0.600000	0.380000	0.020000
I_AC	radiation	100000	1e8	-0.0400	24	26	0	0.480000	0.520000	0.000000
I_AC	radiation	100000	1e8	-0.0800	46	54	0	0.460000	0.540000	0.000000
I_AC	radiation	100000	1e8	-0.1900	40	59	1	0.400000	0.590000	0.010000
I_AC	radiation	100000	1e9	0.0000	25	25	0	0.500000	0.500000	0.000000
I_AC	radiation	100000	1e9	0.2600	63	37	0	0.630000	0.370000	0.000000
I_AC	radiation	100000	1e9	0.1400	57	43	0	0.570000	0.430000	0.000000
I_AB	stepping-stone	1	1e3	-0.8041	0	78	19	0.000000	0.804124	0.195876
I_AB	stepping-stone	1	1e3	-0.8526	1	82	12	0.010526	0.863158	0.126316
I_AB	stepping-stone	1	1e3	-0.8687	1	87	11	0.010101	0.878788	0.111111
I_AB	stepping-stone	1	1e3	-0.9000	2	92	6	0.020000	0.920000	0.060000
I_AB	stepping-stone	1	1e4	-0.3854	0	37	59	0.000000	0.385417	0.614583
I_AB	stepping-stone	1	1e4	-0.2824	2	26	57	0.023529	0.305882	0.670588
I_AB	stepping-stone	1	1e4	-0.4043	17	55	22	0.180851	0.585106	0.234043
I_AB	stepping-stone	1	1e4	-0.6364	17	80	2	0.171717	0.808081	0.020202
I_AB	stepping-stone	1	1e8	0.6087	34	6	6	0.739130	0.130435	0.130435
I_AB	stepping-stone	1	1e8	0.5773	72	16	9	0.742268	0.164948	0.092784
I_AB	stepping-stone	1	1e8	0.2900	62	33	5	0.620000	0.330000	0.050000
I_AB	stepping-stone	1	1e9	0.6857	29	5	1	0.828571	0.142857	0.028571
I_AB	stepping-stone	1	1e9	0.6042	71	13	12	0.739583	0.135417	0.125000
I_AB	stepping-stone	1	1e9	0.2800	63	35	2	0.630000	0.350000	0.020000

I_AB	stepping-stone	10	1e3	-0.8969	0	87	10	0.000000	0.896907	0.103093
I_AB	stepping-stone	10	1e3	-0.8404	0	79	15	0.000000	0.840426	0.159574
I_AB	stepping-stone	10	1e3	-0.8600	2	88	10	0.020000	0.880000	0.100000
I_AB	stepping-stone	10	1e3	-0.8200	3	85	12	0.030000	0.850000	0.120000
I_AB	stepping-stone	10	1e4	-0.3059	1	27	57	0.011765	0.317647	0.670588
I_AB	stepping-stone	10	1e4	-0.3529	3	33	49	0.035294	0.388235	0.576471
I_AB	stepping-stone	10	1e4	-0.4681	15	59	20	0.159574	0.627660	0.212766
I_AB	stepping-stone	10	1e4	-0.7300	12	85	3	0.120000	0.850000	0.030000
I_AB	stepping-stone	10	1e8	0.8205	34	2	3	0.871795	0.051282	0.076923
I_AB	stepping-stone	10	1e8	0.6947	74	8	13	0.778947	0.084211	0.136842
I_AB	stepping-stone	10	1e8	0.4100	70	29	1	0.700000	0.290000	0.010000
I_AB	stepping-stone	10	1e9	0.8039	44	3	4	0.862745	0.058824	0.078431
I_AB	stepping-stone	10	1e9	0.5773	71	15	11	0.731959	0.154639	0.113402
I_AB	stepping-stone	10	1e9	0.3700	68	31	1	0.680000	0.310000	0.010000
I_AB	stepping-stone	100	1e3	-0.6771	5	70	21	0.052083	0.729167	0.218750
I_AB	stepping-stone	100	1e3	-0.7347	2	74	22	0.020408	0.755102	0.224490
I_AB	stepping-stone	100	1e3	-0.7000	7	77	16	0.070000	0.770000	0.160000
I_AB	stepping-stone	100	1e3	-0.7500	3	78	19	0.030000	0.780000	0.190000
I_AB	stepping-stone	100	1e4	-0.2500	1	23	64	0.011364	0.261364	0.727273
I_AB	stepping-stone	100	1e4	-0.2841	5	30	53	0.056818	0.340909	0.602273
I_AB	stepping-stone	100	1e4	-0.5208	10	60	26	0.104167	0.625000	0.270833
I_AB	stepping-stone	100	1e4	-0.5100	23	74	3	0.230000	0.740000	0.030000
I_AB	stepping-stone	100	1e8	0.5208	30	5	13	0.625000	0.104167	0.270833
I_AB	stepping-stone	100	1e8	0.6500	74	9	17	0.740000	0.090000	0.170000
I_AB	stepping-stone	100	1e8	0.2700	62	35	3	0.620000	0.350000	0.030000
I_AB	stepping-stone	100	1e9	0.8095	35	1	6	0.833333	0.023810	0.142857
I_AB	stepping-stone	100	1e9	0.6289	70	9	18	0.721649	0.092784	0.185567
I_AB	stepping-stone	100	1e9	0.2700	59	32	9	0.590000	0.320000	0.090000
I_AB	stepping-stone	1000	1e3	-0.3300	19	52	29	0.190000	0.520000	0.290000
I_AB	stepping-stone	1000	1e3	-0.3500	23	58	19	0.230000	0.580000	0.190000
I_AB	stepping-stone	1000	1e3	-0.2700	27	54	19	0.270000	0.540000	0.190000
I_AB	stepping-stone	1000	1e3	-0.3500	17	52	31	0.170000	0.520000	0.310000
I_AB	stepping-stone	1000	1e4	-0.3333	4	35	54	0.043011	0.376344	0.580645
I_AB	stepping-stone	1000	1e4	-0.3021	8	37	51	0.083333	0.385417	0.531250
I_AB	stepping-stone	1000	1e4	-0.3232	15	47	37	0.151515	0.474747	0.373737
I_AB	stepping-stone	1000	1e4	-0.3100	27	58	15	0.270000	0.580000	0.150000
I_AB	stepping-stone	1000	1e8	0.5476	27	4	11	0.642857	0.095238	0.261905
I_AB	stepping-stone	1000	1e8	0.4600	59	13	28	0.590000	0.130000	0.280000
I_AB	stepping-stone	1000	1e8	0.2600	54	28	18	0.540000	0.280000	0.180000
I_AB	stepping-stone	1000	1e9	0.3721	24	8	11	0.558140	0.186047	0.255814
I_AB	stepping-stone	1000	1e9	0.5100	60	9	31	0.600000	0.090000	0.310000
I_AB	stepping-stone	1000	1e9	0.1100	48	37	15	0.480000	0.370000	0.150000
I_AB	stepping-stone	10000	1e3	-0.0300	38	41	21	0.380000	0.410000	0.210000
I_AB	stepping-stone	10000	1e3	-0.1000	32	42	26	0.320000	0.420000	0.260000
I_AB	stepping-stone	10000	1e3	-0.0600	34	40	26	0.340000	0.400000	0.260000
I_AB	stepping-stone	10000	1e3	-0.1900	27	46	27	0.270000	0.460000	0.270000
I_AB	stepping-stone	10000	1e4	-0.3000	4	34	62	0.040000	0.340000	0.620000
I_AB	stepping-stone	10000	1e4	-0.2000	21	41	38	0.210000	0.410000	0.380000
I_AB	stepping-stone	10000	1e4	-0.1800	21	39	40	0.210000	0.390000	0.400000
I_AB	stepping-stone	10000	1e4	-0.1500	28	43	29	0.280000	0.430000	0.290000
I_AB	stepping-stone	10000	1e8	0.4074	28	6	20	0.518519	0.111111	0.370370

I_AB	stepping-stone	10000	1e8	0.4300	51	8	41	0.510000	0.080000	0.410000
I_AB	stepping-stone	10000	1e8	0.1000	41	31	28	0.410000	0.310000	0.280000
I_AB	stepping-stone	10000	1e9	0.5800	30	1	19	0.600000	0.020000	0.380000
I_AB	stepping-stone	10000	1e9	0.3900	51	12	37	0.510000	0.120000	0.370000
I_AB	stepping-stone	10000	1e9	-0.0300	34	37	29	0.340000	0.370000	0.290000
I_AB	stepping-stone	100000	1e3	-0.0600	31	37	32	0.310000	0.370000	0.320000
I_AB	stepping-stone	100000	1e3	0.0300	33	30	37	0.330000	0.300000	0.370000
I_AB	stepping-stone	100000	1e3	-0.0900	28	37	35	0.280000	0.370000	0.350000
I_AB	stepping-stone	100000	1e3	-0.1000	28	38	34	0.280000	0.380000	0.340000
I_AB	stepping-stone	100000	1e4	0.0800	31	23	46	0.310000	0.230000	0.460000
I_AB	stepping-stone	100000	1e4	-0.0200	23	25	52	0.230000	0.250000	0.520000
I_AB	stepping-stone	100000	1e4	0.0900	36	27	37	0.360000	0.270000	0.370000
I_AB	stepping-stone	100000	1e4	0.0900	36	27	37	0.360000	0.270000	0.370000
I_AB	stepping-stone	100000	1e8	0.3929	30	8	18	0.535714	0.142857	0.321429
I_AB	stepping-stone	100000	1e8	0.3100	45	14	41	0.450000	0.140000	0.410000
I_AB	stepping-stone	100000	1e8	0.1200	34	22	44	0.340000	0.220000	0.440000
I_AB	stepping-stone	100000	1e9	0.4906	32	6	15	0.603774	0.113208	0.283019
I_AB	stepping-stone	100000	1e9	0.4600	54	8	38	0.540000	0.080000	0.380000
I_AB	stepping-stone	100000	1e9	0.0700	37	30	33	0.370000	0.300000	0.330000
I_BC	stepping-stone	1	1e3	0.0103	21	20	56	0.216495	0.206186	0.577320
I_BC	stepping-stone	1	1e3	-0.0316	11	14	70	0.115789	0.147368	0.736842
I_BC	stepping-stone	1	1e3	-0.1212	15	27	57	0.151515	0.272727	0.575758
I_BC	stepping-stone	1	1e3	-0.5200	7	59	34	0.070000	0.590000	0.340000
I_BC	stepping-stone	1	1e4	-0.5417	11	63	22	0.114583	0.656250	0.229167
I_BC	stepping-stone	1	1e4	-0.6941	8	67	10	0.094118	0.788235	0.117647
I_BC	stepping-stone	1	1e4	-0.7553	8	79	7	0.085106	0.840426	0.074468
I_BC	stepping-stone	1	1e4	-0.7879	2	80	17	0.020202	0.808081	0.171717
I_BC	stepping-stone	1	1e8	-1.0000	0	46	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	1	1e8	-0.8351	1	82	14	0.010309	0.845361	0.144330
I_BC	stepping-stone	1	1e8	-0.5100	3	54	43	0.030000	0.540000	0.430000
I_BC	stepping-stone	1	1e9	-1.0000	0	35	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	1	1e9	-0.8958	0	86	10	0.000000	0.895833	0.104167
I_BC	stepping-stone	1	1e9	-0.5100	2	53	45	0.020000	0.530000	0.450000
I_BC	stepping-stone	10	1e3	-0.0206	8	10	79	0.082474	0.103093	0.814433
I_BC	stepping-stone	10	1e3	-0.0957	8	17	69	0.085106	0.180851	0.734043
I_BC	stepping-stone	10	1e3	-0.0100	15	16	69	0.150000	0.160000	0.690000
I_BC	stepping-stone	10	1e3	-0.1900	19	38	43	0.190000	0.380000	0.430000
I_BC	stepping-stone	10	1e4	-0.7294	4	66	15	0.047059	0.776471	0.176471
I_BC	stepping-stone	10	1e4	-0.5647	13	61	11	0.152941	0.717647	0.129412
I_BC	stepping-stone	10	1e4	-0.7660	7	79	8	0.074468	0.840426	0.085106
I_BC	stepping-stone	10	1e4	-0.8500	0	85	15	0.000000	0.850000	0.150000
I_BC	stepping-stone	10	1e8	-0.9487	1	38	0	0.025641	0.974359	0.000000
I_BC	stepping-stone	10	1e8	-0.8737	0	83	12	0.000000	0.873684	0.126316
I_BC	stepping-stone	10	1e8	-0.5100	5	56	39	0.050000	0.560000	0.390000
I_BC	stepping-stone	10	1e9	-0.9412	1	49	1	0.019608	0.960784	0.019608
I_BC	stepping-stone	10	1e9	-0.9072	0	88	9	0.000000	0.907216	0.092784
I_BC	stepping-stone	10	1e9	-0.5200	4	56	40	0.040000	0.560000	0.400000
I_BC	stepping-stone	100	1e3	0.0521	20	15	61	0.208333	0.156250	0.635417
I_BC	stepping-stone	100	1e3	0.0816	23	15	60	0.234694	0.153061	0.612245
I_BC	stepping-stone	100	1e3	0.0500	20	15	65	0.200000	0.150000	0.650000
I_BC	stepping-stone	100	1e3	0.1000	30	20	50	0.300000	0.200000	0.500000

I_BC	stepping-stone	100	1e4	-0.6932	10	71	7	0.113636	0.806818	0.079545
I_BC	stepping-stone	100	1e4	-0.6477	10	67	11	0.113636	0.761364	0.125000
I_BC	stepping-stone	100	1e4	-0.7396	8	79	9	0.083333	0.822917	0.093750
I_BC	stepping-stone	100	1e4	-0.8200	4	86	10	0.040000	0.860000	0.100000
I_BC	stepping-stone	100	1e8	-1.0000	0	48	0	0.000000	1.000000	0.000000
I_BC	stepping-stone	100	1e8	-0.8700	3	90	7	0.030000	0.900000	0.070000
I_BC	stepping-stone	100	1e8	-0.6900	2	71	27	0.020000	0.710000	0.270000
I_BC	stepping-stone	100	1e9	-0.9524	1	41	0	0.023810	0.976190	0.000000
I_BC	stepping-stone	100	1e9	-0.8866	0	86	11	0.000000	0.886598	0.113402
I_BC	stepping-stone	100	1e9	-0.5800	1	59	40	0.010000	0.590000	0.400000
I_BC	stepping-stone	1000	1e3	0.0600	24	18	58	0.240000	0.180000	0.580000
I_BC	stepping-stone	1000	1e3	0.0500	23	18	59	0.230000	0.180000	0.590000
I_BC	stepping-stone	1000	1e3	-0.0600	21	27	52	0.210000	0.270000	0.520000
I_BC	stepping-stone	1000	1e3	-0.1000	21	31	48	0.210000	0.310000	0.480000
I_BC	stepping-stone	1000	1e4	-0.2688	33	58	2	0.354839	0.623656	0.021505
I_BC	stepping-stone	1000	1e4	-0.2396	35	58	3	0.364583	0.604167	0.031250
I_BC	stepping-stone	1000	1e4	-0.3131	32	63	4	0.323232	0.636364	0.040404
I_BC	stepping-stone	1000	1e4	-0.4900	23	72	5	0.230000	0.720000	0.050000
I_BC	stepping-stone	1000	1e8	-0.5714	9	33	0	0.214286	0.785714	0.000000
I_BC	stepping-stone	1000	1e8	-0.6200	19	81	0	0.190000	0.810000	0.000000
I_BC	stepping-stone	1000	1e8	-0.3500	24	59	17	0.240000	0.590000	0.170000
I_BC	stepping-stone	1000	1e9	-0.3488	14	29	0	0.325581	0.674419	0.000000
I_BC	stepping-stone	1000	1e9	-0.6800	16	84	0	0.160000	0.840000	0.000000
I_BC	stepping-stone	1000	1e9	-0.5400	19	73	8	0.190000	0.730000	0.080000
I_BC	stepping-stone	10000	1e3	-0.0100	23	24	53	0.230000	0.240000	0.530000
I_BC	stepping-stone	10000	1e3	0.0200	25	23	52	0.250000	0.230000	0.520000
I_BC	stepping-stone	10000	1e3	-0.0800	20	28	52	0.200000	0.280000	0.520000
I_BC	stepping-stone	10000	1e3	-0.1300	24	37	39	0.240000	0.370000	0.390000
I_BC	stepping-stone	10000	1e4	-0.1500	42	57	1	0.420000	0.570000	0.010000
I_BC	stepping-stone	10000	1e4	-0.1200	44	56	0	0.440000	0.560000	0.000000
I_BC	stepping-stone	10000	1e4	-0.0600	47	53	0	0.470000	0.530000	0.000000
I_BC	stepping-stone	10000	1e4	-0.2500	36	61	3	0.360000	0.610000	0.030000
I_BC	stepping-stone	10000	1e8	-0.0370	26	28	0	0.481481	0.518519	0.000000
I_BC	stepping-stone	10000	1e8	-0.3000	35	65	0	0.350000	0.650000	0.000000
I_BC	stepping-stone	10000	1e8	0.0100	49	48	3	0.490000	0.480000	0.030000
I_BC	stepping-stone	10000	1e9	-0.1200	22	28	0	0.440000	0.560000	0.000000
I_BC	stepping-stone	10000	1e9	-0.1600	42	58	0	0.420000	0.580000	0.000000
I_BC	stepping-stone	10000	1e9	-0.1000	44	54	2	0.440000	0.540000	0.020000
I_BC	stepping-stone	100000	1e3	-0.0300	31	34	35	0.310000	0.340000	0.350000
I_BC	stepping-stone	100000	1e3	-0.1000	30	40	30	0.300000	0.400000	0.300000
I_BC	stepping-stone	100000	1e3	0.0400	41	37	22	0.410000	0.370000	0.220000
I_BC	stepping-stone	100000	1e3	0.0800	39	31	30	0.390000	0.310000	0.300000
I_BC	stepping-stone	100000	1e4	0.0200	51	49	0	0.510000	0.490000	0.000000
I_BC	stepping-stone	100000	1e4	-0.1000	44	54	2	0.440000	0.540000	0.020000
I_BC	stepping-stone	100000	1e4	0.0100	50	49	1	0.500000	0.490000	0.010000
I_BC	stepping-stone	100000	1e4	0.1100	54	43	3	0.540000	0.430000	0.030000
I_BC	stepping-stone	100000	1e8	0.2143	34	22	0	0.607143	0.392857	0.000000
I_BC	stepping-stone	100000	1e8	0.0200	51	49	0	0.510000	0.490000	0.000000
I_BC	stepping-stone	100000	1e8	-0.1800	41	59	0	0.410000	0.590000	0.000000
I_BC	stepping-stone	100000	1e9	0.0943	29	24	0	0.547170	0.452830	0.000000
I_BC	stepping-stone	100000	1e9	-0.1600	42	58	0	0.420000	0.580000	0.000000

I_BC	stepping-stone	100000	1e9	-0.0200	48	50	2	0.480000	0.500000	0.020000
I_AC	stepping-stone	1	1e3	-0.7938	0	77	20	0.000000	0.793814	0.206186
I_AC	stepping-stone	1	1e3	-0.8737	0	83	12	0.000000	0.873684	0.126316
I_AC	stepping-stone	1	1e3	-0.7172	0	71	28	0.000000	0.717172	0.282828
I_AC	stepping-stone	1	1e3	-0.3700	1	38	61	0.010000	0.380000	0.610000
I_AC	stepping-stone	1	1e4	-0.8646	0	83	13	0.000000	0.864583	0.135417
I_AC	stepping-stone	1	1e4	-0.8118	0	69	16	0.000000	0.811765	0.188235
I_AC	stepping-stone	1	1e4	-0.2553	1	25	68	0.010638	0.265957	0.723404
I_AC	stepping-stone	1	1e4	-0.2020	0	20	79	0.000000	0.202020	0.797980
I_AC	stepping-stone	1	1e8	-0.1304	0	6	40	0.000000	0.130435	0.869565
I_AC	stepping-stone	1	1e8	-0.2371	0	23	74	0.000000	0.237113	0.762887
I_AC	stepping-stone	1	1e8	-0.4300	3	46	51	0.030000	0.460000	0.510000
I_AC	stepping-stone	1	1e9	0.0000	0	0	35	0.000000	0.000000	1.000000
I_AC	stepping-stone	1	1e9	-0.2292	0	22	74	0.000000	0.229167	0.770833
I_AC	stepping-stone	1	1e9	-0.4500	2	47	51	0.020000	0.470000	0.510000
I_AC	stepping-stone	10	1e3	-0.9278	0	90	7	0.000000	0.927835	0.072165
I_AC	stepping-stone	10	1e3	-0.8936	0	84	10	0.000000	0.893617	0.106383
I_AC	stepping-stone	10	1e3	-0.7900	0	79	21	0.000000	0.790000	0.210000
I_AC	stepping-stone	10	1e3	-0.5500	0	55	45	0.000000	0.550000	0.450000
I_AC	stepping-stone	10	1e4	-0.8941	0	76	9	0.000000	0.894118	0.105882
I_AC	stepping-stone	10	1e4	-0.7529	0	64	21	0.000000	0.752941	0.247059
I_AC	stepping-stone	10	1e4	-0.2979	0	28	66	0.000000	0.297872	0.702128
I_AC	stepping-stone	10	1e4	-0.1800	0	18	82	0.000000	0.180000	0.820000
I_AC	stepping-stone	10	1e8	-0.0769	0	3	36	0.000000	0.076923	0.923077
I_AC	stepping-stone	10	1e8	-0.2526	1	25	69	0.010526	0.263158	0.726316
I_AC	stepping-stone	10	1e8	-0.3800	1	39	60	0.010000	0.390000	0.600000
I_AC	stepping-stone	10	1e9	-0.0980	0	5	46	0.000000	0.098039	0.901961
I_AC	stepping-stone	10	1e9	-0.2062	0	20	77	0.000000	0.206186	0.793814
I_AC	stepping-stone	10	1e9	-0.4300	0	43	57	0.000000	0.430000	0.570000
I_AC	stepping-stone	100	1e3	-0.8333	1	81	14	0.010417	0.843750	0.145833
I_AC	stepping-stone	100	1e3	-0.7143	6	76	16	0.061224	0.775510	0.163265
I_AC	stepping-stone	100	1e3	-0.7200	3	75	22	0.030000	0.750000	0.220000
I_AC	stepping-stone	100	1e3	-0.5900	4	63	33	0.040000	0.630000	0.330000
I_AC	stepping-stone	100	1e4	-0.8523	0	75	13	0.000000	0.852273	0.147727
I_AC	stepping-stone	100	1e4	-0.7273	0	64	24	0.000000	0.727273	0.272727
I_AC	stepping-stone	100	1e4	-0.3750	0	36	60	0.000000	0.375000	0.625000
I_AC	stepping-stone	100	1e4	-0.1000	2	12	86	0.020000	0.120000	0.860000
I_AC	stepping-stone	100	1e8	-0.1667	2	10	36	0.041667	0.208333	0.750000
I_AC	stepping-stone	100	1e8	-0.1600	4	20	76	0.040000	0.200000	0.760000
I_AC	stepping-stone	100	1e8	-0.2000	5	25	70	0.050000	0.250000	0.700000
I_AC	stepping-stone	100	1e9	-0.0714	1	4	37	0.023810	0.095238	0.880952
I_AC	stepping-stone	100	1e9	-0.2474	3	27	67	0.030928	0.278351	0.690722
I_AC	stepping-stone	100	1e9	-0.4400	3	47	50	0.030000	0.470000	0.500000
I_AC	stepping-stone	1000	1e3	-0.5100	18	69	13	0.180000	0.690000	0.130000
I_AC	stepping-stone	1000	1e3	-0.3500	22	57	21	0.220000	0.570000	0.210000
I_AC	stepping-stone	1000	1e3	-0.3700	17	54	29	0.170000	0.540000	0.290000
I_AC	stepping-stone	1000	1e3	-0.4300	18	61	21	0.180000	0.610000	0.210000
I_AC	stepping-stone	1000	1e4	-0.6237	1	59	33	0.010753	0.634409	0.354839
I_AC	stepping-stone	1000	1e4	-0.5000	4	52	40	0.041667	0.541667	0.416667
I_AC	stepping-stone	1000	1e4	-0.3636	2	38	59	0.020202	0.383838	0.595960
I_AC	stepping-stone	1000	1e4	-0.1700	2	19	79	0.020000	0.190000	0.790000

I_AC	stepping-stone	1000	1e8	0.0238	6	5	31	0.142857	0.119048	0.738095
I_AC	stepping-stone	1000	1e8	0.0600	17	11	72	0.170000	0.110000	0.720000
I_AC	stepping-stone	1000	1e8	-0.1100	12	23	65	0.120000	0.230000	0.650000
I_AC	stepping-stone	1000	1e9	0.1395	9	3	31	0.209302	0.069767	0.720930
I_AC	stepping-stone	1000	1e9	0.0500	18	13	69	0.180000	0.130000	0.690000
I_AC	stepping-stone	1000	1e9	-0.1100	6	17	77	0.060000	0.170000	0.770000
I_AC	stepping-stone	10000	1e3	-0.2400	25	49	26	0.250000	0.490000	0.260000
I_AC	stepping-stone	10000	1e3	-0.1200	33	45	22	0.330000	0.450000	0.220000
I_AC	stepping-stone	10000	1e3	-0.1100	34	45	21	0.340000	0.450000	0.210000
I_AC	stepping-stone	10000	1e3	-0.1200	28	40	32	0.280000	0.400000	0.320000
I_AC	stepping-stone	10000	1e4	-0.3200	16	48	36	0.160000	0.480000	0.360000
I_AC	stepping-stone	10000	1e4	-0.2200	9	31	60	0.090000	0.310000	0.600000
I_AC	stepping-stone	10000	1e4	-0.1700	12	29	59	0.120000	0.290000	0.590000
I_AC	stepping-stone	10000	1e4	0.0900	21	12	67	0.210000	0.120000	0.670000
I_AC	stepping-stone	10000	1e8	0.2407	17	4	33	0.314815	0.074074	0.611111
I_AC	stepping-stone	10000	1e8	0.2700	34	7	59	0.340000	0.070000	0.590000
I_AC	stepping-stone	10000	1e8	-0.0300	15	18	67	0.150000	0.180000	0.670000
I_AC	stepping-stone	10000	1e9	0.2200	15	4	31	0.300000	0.080000	0.620000
I_AC	stepping-stone	10000	1e9	0.2100	29	8	63	0.290000	0.080000	0.630000
I_AC	stepping-stone	10000	1e9	0.0500	19	14	67	0.190000	0.140000	0.670000
I_AC	stepping-stone	100000	1e3	-0.2700	22	49	29	0.220000	0.490000	0.290000
I_AC	stepping-stone	100000	1e3	-0.0300	32	35	33	0.320000	0.350000	0.330000
I_AC	stepping-stone	100000	1e3	-0.0400	30	34	36	0.300000	0.340000	0.360000
I_AC	stepping-stone	100000	1e3	0.1700	41	24	35	0.410000	0.240000	0.350000
I_AC	stepping-stone	100000	1e4	-0.0900	20	29	51	0.200000	0.290000	0.510000
I_AC	stepping-stone	100000	1e4	0.1400	35	21	44	0.350000	0.210000	0.440000
I_AC	stepping-stone	100000	1e4	0.0600	22	16	62	0.220000	0.160000	0.620000
I_AC	stepping-stone	100000	1e4	0.1400	28	14	58	0.280000	0.140000	0.580000
I_AC	stepping-stone	100000	1e8	0.2679	17	2	37	0.303571	0.035714	0.660714
I_AC	stepping-stone	100000	1e8	0.2900	35	6	59	0.350000	0.060000	0.590000
I_AC	stepping-stone	100000	1e8	0.1400	30	16	54	0.300000	0.160000	0.540000
I_AC	stepping-stone	100000	1e9	0.2453	16	3	34	0.301887	0.056604	0.641509
I_AC	stepping-stone	100000	1e9	0.2600	32	6	62	0.320000	0.060000	0.620000
I_AC	stepping-stone	100000	1e9	0.1600	26	10	64	0.260000	0.100000	0.640000

TABLE 5