July 30, 2007

WORKING PAPER

PART 2

A mathematical approach to develop a non-authoritative tree taxonomy

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SUMMARY

Identification of tree species has been carried out largely by experienced field assistants or taxonomic specialists in herbaria. The conversion of varying form and character states of a given species into objective algorithms ("taxonomic keys") that can be used independently from a human authority has been difficult, in particular in highly diverse tropical forests. We develop a new method with the following features, and test it with 9 species from the Los Tuxtlas Biological Research Station:

1) For a given geographic region, a matrix with (here) 898 character states with emphasis on non-fertile characters is scored.
2) The number of character states that serves to distinguish all species is minimized by binary integer optimization. The resulting character states are the strategically fastest ones for recognizing and distinguishing the tree species.
3) Characters can be chosen to apply to fertile herbarium specimens, to fertile trees in the field, or to non-fertile herbarium specimens and trees in the field.
4) If some character state cannot be oberserved, the optimization can be repeated for the group of undistinguishable species, providing other strategically fastest character states that let the members of a subgroup be distinguished.
5) The Jaccard similarity coefficient is used to indicate which species is closest to a given specimen. A 100% match of scores for identifying a specimen is not necessary.

The pitfalls of traditional taxonomic keys, such as getting lost or stuck with an unobservable character, or arriving at a species without knowing if its overall pattern of character states is closest to the to-be-identified specimen, are avoided with this method. To our knowledge it is also the first approach that employs mathematically rigourous optimization for taxa identification.

INTRODUCTION

Identifying a tree in a tropical forest can be a challenge. During a field trip it is commonplace that trees cannot be identified down to the species level, particularly when they are not producing fruits or flowers. The traditional and still most certain means of obtaining an identification is to send a herbarium specimen to a specialist in the tree's taxonomic group. While this practice should continue whenever possible, the process can be very slow and there are several circumstances under which it is not feasible, including the lack of specialists for a number of what are then called "orphan" groups. Moreover, on the sites of long-term efforts such as management of conservation areas or production forests, it is desirable as well as practical to achieve self-sufficiency in identification of a local tree flora. In the present paper we propose a method with which this can be achieved

This is the second working paper that was elaborated by Dr. Martin Ricker together with Dr. Douglas Daly during his sabbatical years at the Institute of Systematic Botany of the New York Botanical Garden from August 2006 to July 2007. In the first working paper we developed an illustrated and annotated list of 203 characters and 898 character states for the matrix we employ in this second paper. Here we also discuss a number of more conceptual issues in taxonomy, particularly tree species taxonomy.

The original idea was to focus on tree families worldwide, using as a starting point the character matrix published by Goldberg (2003). In turned out, however, that independently of the usefulness of the selected characters and character states by Goldberg, the matrix worked only when character states were consistent throughout all members of a given tree family. Furthermore, the number of character states required to distinguish the approximately 232 tree families, is much larger than the number of characters provided by Goldberg. In addition, there is considerable discussion of regrouping some families and about the character states that occur within circumscribed families. In practice, one would need to consult a taxonomic specialist for each family.

Consequently we decided it would be a greater contribution to develop an approach and a method for developing species-level identification tools that could be adapted to different sites. At the species level, the variation of character states is much more reduced, and it is possible to score character states from a single specimen, an approach that would make no sense at the family level.

Our test case consists of the tree species known from a geographical region, the slopes of the San Martín Tuxtla volcano in Veracruz, Mexico.

Traditional identification tools have been taxonomic keys, i.e., text that represents a usually dichotomous algorithm that proceeds stepwise through character states until reaching an identification. Such keys have been published by taxonomists generally for themselves and other taxonomists, to circumscribe and defend a species concept rather than make it identifiable in the field by a non-taxonomist. The character states they use are often not available in a given specimen, or require expert anatomical expert knowledge to be determined. Furthermore, they have always presented the problem that one can get "off track" irreversibly, either by determining one character state wrong or by discovering an individual slightly beyond the range of recorded variation. Our proposed method pretend to overcome those problems.

METHODS

Development of a species list:

We define the growth form "tree" here as those plants that stand self-sustained (thus excluding lianas) and reach a maximum height of at least 3 m anywhere in its distribution. We do not distinguish monopodial growth ("trees") and polypodial growth ("shrubs"), and also do not exclude monocotyledonous plants such as palms (Ricker et al., online first, p.4). Trees in our definition include a large portion of the over 200,000 species of flowering plants (i.e., angiosperms; see Cronquist 1981, Smith et al. 2004, Heywood et al. 2007), many species of conifers (i.e., temperate gymnosperms; see van Gelderen & van Hoey Smith 2005), trunked cycads (i.e., tropical gymnosperms, see Whitelock 2002), and tree ferns (see Large & Braggins 2004).

Field work for this project was carried out between September 2004 and August 2005 in the Biosphere Reserve Los Tuxtlas (Veracruz, Mexico). In several excursions around the Los Tuxtlas Biological Field Station and on the slopes of the San Martín volcano, principally the field assistant and local resident Eladio Velasco-Sinaca collected herbarium samples from as many tree species as possible. A collection of 250 specimens resulted and was transferred to the national herbarium MEXU at the Biology Institute in Mexico City. Duplicates were shipped from MEXU to the herbarium NY of the New York Botanical Garden, arriving there in October 2006. In addition, we

took advantage of a collection of 29 specimens collected in 1993 near the Biological Field Station in Los Tuxtlas that was already at the New York Botanical Garden.

Identifications of the specimens were made or verified and corrected whenever possible, first by the field assistants, and then by specialists in MEXU. In NY, the specimens were separated by Douglas C. Daly into those for which a specialist existed somewhere in the world (including at NY), and those called orphan groups. A total of 144 specimens were processed for shipping to various specialists. For the orphan-groups, those specimens were separated whose identification was still open or much in doubt. These were identified whenever possible by Douglas C. Daly and Martin Ricker via comparisons with specimens in the herbarium NY, supported in some cases by taxonomic literature (description and taxonomic keys).

Development of a character matrix:

A list of 203 characters and 898 character states was developed in the first part of the working paper (Daly & Ricker 2007). We employ the terms "character" and "character state" in the sense of Sneath & Sokal (1973: 71): "A character is a property or feature which varies from one kind of organism to another… The nature of the margins of the leaves becomes the character, while entire, serrated, undulating, or any other types of margins of the leaves become different states of the character." To test our method, 11 specimen in 9 species were selected for scoring. Three codes were used: 0 = character state absent, 1 = character state = present, 2 = character state unknown/not observable.

Comparison of the similarity of specimens:

Specimens were compared by calculating pairwise the Jaccard similarity coefficient, not taking into account those rows where the code was 2 (state unknown) for either specimen. The Jaccard similarity coefficient calculates the number of coincidences of present (= 1) character states in a pair of specimens as a proportion of the total number of present character states in either specimen (Sneath & Sokal 1973: 131-132). It is appropriate when negative matches are to be excluded.

Minimization of the number of character states:

The objective is to minimize the number of character states necessary to distinguish the 11 specimens. The method used was (binary) interger linear optimnization (see Wolsey 1998), and the

software LINGO (see www.lindo.com). The mathematical formulation in the input file for LINGO was the following:

```
MIN =

          CS_001 +CS_002 +CS_003 +CS_004 +CS_005 +CS_006 +CS_007 +CS_008 +CS_009
 +CS_010 +CS_011 +CS_012 +CS_013 +CS_014 +CS_015 +CS_016 +CS_017 +CS_018 +CS_019

...

 +CS_880 +CS_881 +CS_882 +CS_883 +CS_884 +CS_885 +CS_886 +CS_887 +CS_888 +CS_889
 +CS_890 +CS_891 +CS_892 +CS_893 +CS_894 +CS_895 +CS_896 +CS_897;


@BIN(CS_001); @BIN(CS_002); @BIN(CS_003); @BIN(CS_004); @BIN(CS_005);

…

@BIN(CS_893); @BIN(CS_894); @BIN(CS_895);
@BIN(CS_896); @BIN(CS_897);

!Dussia_mexicana & Pouteria_sapota;
  CS_044 +CS_049 +CS_050 +CS_071 +CS_087 +CS_088 +CS_089 +CS_115 +CS_116 +CS_120
 +CS_122 +CS_137 +CS_139 +CS_152 +CS_153 +CS_166 +CS_167 +CS_171 +CS_173 +CS_174
 +CS_177 +CS_179 +CS_181 +CS_188 +CS_189 +CS_193 +CS_194 +CS_199 +CS_200 +CS_201
 +CS_203 +CS_255 +CS_256 +CS_262 +CS_263 +CS_264 +CS_265 +CS_278 +CS_279 +CS_294
 +CS_295 +CS_316 +CS_318 +CS_328 +CS_331 +CS_339 +CS_341 +CS_347 +CS_350 +CS_355
 +CS_356 +CS_357 +CS_371 +CS_372 +CS_381 +CS_382 +CS_410 +CS_411 +CS_413 +CS_422
 +CS_434 +CS_435 +CS_469 +CS_474 +CS_485 +CS_486 +CS_500 +CS_501 +CS_505 +CS_506
 +CS_517 +CS_518 +CS_533 +CS_534 +CS_559 +CS_565 +CS_571 +CS_572 +CS_587 +CS_595
 +CS_601 +CS_602 +CS_606 +CS_607 +CS_625 +CS_626 +CS_632 +CS_633 +CS_637 +CS_640
 +CS_642 +CS_644 +CS_651 +CS_655 +CS_658 +CS_660 +CS_662 +CS_664 +CS_665 +CS_666
 +CS_685 +CS_686 +CS_688 +CS_693 +CS_699 +CS_703 +CS_706 +CS_733 +CS_737 +CS_739
 +CS_740 +CS_748 +CS_755 +CS_756 +CS_759 +CS_796 +CS_798 +CS_805 +CS_806 +CS_819
 +CS_820 +CS_832 +CS_835 +CS_848 +CS_849 +CS_850 +CS_854 +CS_855 +CS_861 +CS_870
 +CS_874 +CS_878 +CS_891 +CS_892 +CS_893 >= 1;

!Dussia_mexicana & Bursera_simaruba;
  CS_041 +CS_044 +CS_050 +CS_070 +CS_082 +CS_083 +CS_115 +CS_116 +CS_120 +CS_122
 +CS_145 +CS_147 +CS_173 +CS_174 +CS_177 +CS_179 +CS_204 +CS_205 +CS_255 +CS_256
 +CS_267 +CS_270 +CS_278 +CS_279 +CS_296 +CS_297 +CS_315 +CS_316 +CS_320 +CS_321
 +CS_328 +CS_329 +CS_330 +CS_331 +CS_338 +CS_339 +CS_343 +CS_344 +CS_351 +CS_359
 +CS_360 +CS_361 +CS_371 +CS_372 +CS_379 +CS_380 +CS_381 +CS_382 +CS_410 +CS_411
 +CS_413 +CS_423 +CS_429 +CS_430 +CS_432 +CS_434 +CS_439 +CS_440 +CS_442 +CS_444
 +CS_466 +CS_468 +CS_469 +CS_476 +CS_486 +CS_489 +CS_492 +CS_497 +CS_500 +CS_501
 +CS_506 +CS_507 +CS_513 +CS_514 +CS_518 +CS_520 +CS_521 +CS_522 +CS_527 +CS_530
 +CS_532 +CS_533 +CS_534 +CS_544 +CS_545 +CS_590 +CS_595 +CS_622 +CS_623 +CS_632
 +CS_633 +CS_639 +CS_642 +CS_662 +CS_664 +CS_688 +CS_694 +CS_701 +CS_703 +CS_705
 +CS_707 +CS_719 +CS_720 +CS_725 +CS_727 +CS_733 +CS_735 +CS_748 +CS_755 +CS_757
 +CS_759 +CS_774 +CS_785 +CS_786 +CS_795 +CS_796 +CS_799 +CS_801 +CS_802 +CS_805
 +CS_806 +CS_817 +CS_818 +CS_819 +CS_820 +CS_841 +CS_842 +CS_846 +CS_848 +CS_849
 +CS_851 +CS_870 +CS_878 +CS_879 +CS_891 +CS_893 >= 1;
```

…

```
!Cordia_alliodora & Pseudolmedia_glabrata_MALE;
  CS_001 +CS_060 +CS_062 +CS_064 +CS_067 +CS_072 +CS_073 +CS_078 +CS_079 +CS_081
 +CS_083 +CS_092 +CS_093 +CS_114 +CS_115 +CS_116 +CS_120 +CS_121 +CS_123 +CS_130
 +CS_135 +CS_193 +CS_269 +CS_270 +CS_275 +CS_276 +CS_278 +CS_281 +CS_286 +CS_288
 +CS_296 +CS_297 +CS_309 +CS_310 +CS_313 +CS_314 +CS_318 +CS_325 +CS_326 +CS_327
 +CS_329 +CS_331 +CS_332 +CS_333 +CS_336 +CS_337 +CS_341 +CS_348 +CS_349 +CS_350
 +CS_351 +CS_353 +CS_386 +CS_387 +CS_429 +CS_430 +CS_439 +CS_440 +CS_490 +CS_492
 +CS_496 +CS_497 +CS_499 +CS_500 +CS_524 +CS_525 +CS_531 +CS_532 +CS_533 +CS_535
 +CS_548 +CS_552 +CS_553 +CS_554 +CS_557 +CS_573 +CS_574 +CS_581 +CS_582 +CS_592
 +CS_601 +CS_603 +CS_607 +CS_614 +CS_619 +CS_623 +CS_625 +CS_632 +CS_639 +CS_651
 +CS_656 +CS_666 +CS_667 +CS_668 +CS_679 +CS_720 +CS_727 +CS_729 +CS_736 +CS_739
 +CS_744 +CS_748 +CS_756 +CS_761 +CS_764 +CS_767 +CS_772 +CS_774 +CS_778 +CS_782
 +CS_785 +CS_793 +CS_794 +CS_799 +CS_821 +CS_824 +CS_829 +CS_838 +CS_839 +CS_846
 +CS_849 +CS_864 +CS_885 +CS_894 >= 1;

!Pseudolmedia_glabrata_FEMALE & Pseudolmedia_glabrata_MALE;
  CS_581 +CS_585 +CS_594 +CS_603 +CS_608 +CS_610 +CS_616 +CS_656 +CS_662 +CS_668
 +CS_674 +CS_683 +CS_685 +CS_688 +CS_729 +CS_733 +CS_739 +CS_744 +CS_751 +CS_753
 +CS_756 +CS_762 +CS_767 +CS_774 +CS_776 +CS_777 +CS_782 +CS_785 +CS_786 +CS_789
 +CS_798 +CS_819 +CS_824 +CS_827 +CS_835 +CS_842 +CS_848 +CS_850 +CS_855 +CS_863
 +CS_892 +CS_894 >= 1;

END
```

Binary integer programming means that each variable can only be either 0 or 1, and is indicated in LINGO by "@BIN(Variable)." The first line is the objective function ("Min = …"), and indicates that the sum of all character state values should be as small as possible. After the binary command, a sequence of constraints is given. Each constraint is a pairwise comparison between two specimens, and sums all character states that serve to distinguish the pair in question (i.e., in one specimen it is 1 and the other 0). At the end of each constraint, it is indicated that the sum shall be ">= 1", i.e., when minimizing the list, there should be at least on character state remain that makes it possible to distinguish the pair. We could also choose 2, 3 ,4 etc. character states, or even vary the number between pairs in question. The consequence would be to require a larger number of character states to be able to distinguish any two specimens with 2, 3, 4 etc. character states; at the some point, when the number becomes too large, the problem becomes infeasible to solve.

The number of constraints depends exclusively on the number of specimens that are to be compared. The formula for calculating the number of constraints is: $0.5 \cdot [(\text{Number of specimens})^2 - (\text{Number of specimens})]$. With 11 specimens here, there are 55 constraints, and with 1000 specimens there are 499,500 constraints. To develop the LINGO input file for such large numbers

of constraints, a *Delphi* program was written (by Martin Ricker) that converts the character state matrix (see Appendix 3) into the appropiate LINGO input file. The program, called *Taxonomy*, is given in Appendix 1.

There is one additional feature build into the program *Taxonomy*. The program checks if for a given character (into which character states are grouped) there is any character state that is present in both members of a pair in question. If this is true, then that character and all its character states are qualified as "useless" for distinguishing that particular pair of taxonomic units. An example: If one finds a tree in a pasture, according to our matrix in Appendix 3 it could be *Pouteria sapota* but not *Dussia mexicana*. So this helps to identify a tree that grows in pasture. The character is, however, not useful to distinguish the two species consistently in any habitat where they can be found: In lowland tropical forest a tree could be either *Pouteria sapota* or *Dussia mexicana*. Therefore, for some character states the character works to distinguish these two species, and for other character states it does not. To avoid this ambiguity, this character with all its character states will not be included as useful in an optimal solution to distinguish these two species.

RESULTS

Development of a species list:

A total of 279 specimens from the area of the Biological Research Station and the slopes of the San Martín volcano in Los Tuxtlas were processed in the herbarium of the New York Botanical Garden. The specimens and their final or preliminary identifications are presented in Appendix 2. At the current stage in the identification process, they represent approximately 215 species. Unfortunately the identification process via specialists in different institutions is very slow, taking months and possibly over a year. For the specimens of this work, we hope to have final results in 2008. Therefore, it is also pending to analyze which species have not yet been described for the region, and prepare a new annotated list of tree species from the slopes of the San Martín Tuxtla volcano (see Álvarez del Castillo 1977, Castillo-Campos et al. online., Ibarra-Manríquez & Sinaca-Colín 1995, 1996a, 1996b, and 1997).

Development of a character matrix:

The developed character matrix of 898 character states for 11 specimens is presented in Appendix 3. The scoring was carried out by Douglas C. Daly, and thus reflects consistently his perception. A refined definition of each character state, which will be more objetive and independent from the scoring person, is still in progress. Two specimens are repetitions of the species for the following reason: *Pseudolmedia glabrata* is dioecious, and we scored separately the male and female plant, as if these were distinct species. The other specimen is a second specimen of *Cordia alliodora* from Acre in Brazil; we wanted to see how similar two specimens of the same species from different countries would result in our scoring system.

Comparison of the similarity of specimens:

The following table shows the resultung Jaccard coefficients for all pairwise comparisons among the 11 specimens. The number of character states for calculating each Jaccard coefficient varied for each pairwise comparison: The lowest was 670 (POUSAP and CORALLAC), and the highest 890 (BURSIM and PSEGLAM).

	DUSMEX	POUSAP	BURSIM	GUAGRA	NECAMB
POUSAP	0.372				
BURSIM	0.340	0.316			
GUAGRA	0.428	0.367	0.408		
NECAMB	0.340	0.354	0.336	0.371	
NECLUN	0.354	0.376	0.351	0.349	0.596
ULMMEX	0.367	0.311	0.290	0.265	0.336
CORALL	0.333	0.387	0.364	0.336	0.388
PSEGLAF	0.309	0.339	0.350	0.332	0.481
PSEGLAM	0.296	0.298	0.333	0.311	0.411
CORALLAC	0.327	0.354	0.354	0.351	0.365

	NECLUN	ULMMEX	CORALL	PSEGLAF	PSEGLAM
ULMMEX	0.332				
CORALL	0.354	0.352			

PSEGLAF	0.417	0.346	0.333		
PSEGLAM	0.328	0.313	0.330	0.743	
CORALLAC	0.330	0.338	0.563	0.340	0.350

DUSMEX = *Dussia mexicana*; POUSAP = *Pouteria sapota*; BURSIM = *Bursera simaruba*; GUAGRA = *Guarea grandifolia*; NECAMB = *Nectandra ambigens*; NECLUN = *Nectandra lundellii*; ULMMEX = *Ulmus mexicana*; CORALL = *Cordia alliodora* from Los Tuxtlas; PSEGLAF = *Pseudolmedia glabrata* female; PSEGLAM = *Pseudolmedia glabrata* male; CORALLAC = *Cordia alliodora* from Acre, Brazil.

The average Jaccard coefficient is 0.364 (SE = 0.0104), in a range from 0.265 to 0.743. All specimens can be distingushed, as no pairwise comparison results in a Jaccard coefficient of 1. Indeed, the average Jaccard is low, indicating that there are many character states that help to distinguish specimens. The comparison of the male and female *Pseudolmedia glabrata* resulted in a Jaccard coefficient of 0.743, the maximum value of all comparisons, but still surprisingly far from 1. The comparison of *Cordia alliodora* from Los Tuxtlas and from Acre in Brasil resulted in 0.563, which is the second-highest value of all comparisons but also surprisingly low. This indicates that the method works for distinguishing the 11 specimens and is promising for many more specimens, but could also benefit from refinement of defining and recognizing the employed character states.

Minimization of the number of character states:

For the 11 taxonomic units in 9 species, a minimum of 4 character states out of the 898 is needed to be able to distinguish each possible pair of specimens by at least 1 character state. A minimum of 24 character states out of the 898 is needed to be able to distinguish each possible pair of specimens by at least 10 character states. There are alternative solutions in both cases. In the following table, the reader can verify for him or herself that any pair of specimens presents at least the required number of different character states (scored 1 and 0, or 0 and 1):

Optimal solution when there should be at least **1 character state** different between any pairwise comparison of species:

A)	B)	C)	D)	E)	F)	G)	H)	I)	J)	K)	L)	M)
CS_278	70	0	1	1	0	1	0	1	0	1	1	1
CS_379	93	1	1	0	1	1	0	0	0	0	0	1
CS_499	122	0	0	0	1	1	0	0	0	1	1	0
CS_790	183	1	1	1	1	1	1	0	0	1	0	0

CS_278: Leaf surface texture on bottom = smooth.

CS_379: Apex width of acuminate leaf or leaflet = broadly acuminate.

CS_499: Exterior tertiary course of leaf or leaflet = absent.

CS_790: Shape of trichomes on sepals or tepals = simple hairs.

Optimal solution when there should be at least **10 character states** different between any pairwise comparison of species:

A)	B)	C)	D)	E)	F)	G)	H)	I)	J)	K)	L)	M)
CS_278	70	0	1	1	0	1	0	1	0	1	1	1
CS_331	81	1	0	0	0	0	1	0	1	0	0	1
CS_379	93	1	1	0	1	1	0	0	0	0	0	1
CS_381	94	1	0	0	1	1	0	1	0	0	0	1
CS_439	108	1	1	0	0	0	0	1	0	1	1	1
CS_442	109	1	1	0	0	0	1	1	0	0	0	0
CS_485	119	0	1	0	0	1	0	0	1	0	0	0
CS_486	119	1	0	0	0	0	0	0	1	1	1	1
CS_499	122	0	0	0	1	1	0	0	0	1	1	0
CS_524	128	0	0	0	0	1	0	1	1	0	0	1
CS_532	130	1	1	0	1	1	0	0	0	1	1	1
CS_533	131	1	0	0	1	1	1	0	0	1	1	1
CS_590	140	0	0	1	1	1	1	0	0	0	0	1
CS_616	145	0	0	0	0	1	1	1	0	1	0	0

CS_622	146	0	0	1	1	0	0	0	0	0	0	1
CS_662	153	0	1	1	0	1	1	1	1	0	1	1
CS_733	170	1	0	0	0	1	1	1	0	1	0	2
CS_739	171	1	0	1	0	1	1	1	1	1	0	1
CS_756	174	0	1	0	0	1	1	1	1	1	0	1
CS_774	179	1	1	0	1	1	1	1	1	1	0	0
CS_778	180	0	0	0	0	0	0	1	0	1	0	1
CS_790	183	1	1	1	1	1	1	0	0	1	0	0
CS_799	184	0	1	0	1	0	1	0	0	1	0	0
CS_843	194	0	0	1	0	0	0	0	0	1	0	2

CS_278: Leaf surface texture on bottom = smooth.

CS_331: Leaf or leaflet trichomes on bottom of blade = dense.

CS_379: Apex width of acuminate leaf or leaflet = broadly acuminate.

CS_381: Apex length of acuminate leaf or leaflet = < 10 mm.

CS_439: Trend towards base of major secondary angle to midvein of leaf or leaflet = increasing toward base.

CS_442: Trend towards apex of major secondary angle to midvein of leaf or leaflet = uniform.

CS_485: Epimedial tertiary pattern of leaf or leaflet = opposite percurrent.

CS_486: Epimedial tertiary pattern of leaf or leaflet = alternate percurrent.

CS_499: Exterior tertiary course of leaf or leaflet = absent.

CS_524: Perimarginal veins = absent.

CS_532: Inflorescence timing = with mature leaves.

CS_533: Inflorescence position = axillary to present leaves.

CS_590: Shape of the corolla of the flower = salverform.

CS_616: Number of petals of the flower = absent.

CS_622: Fusion of petals = free.

CS_662: Filament connation of stamens = free.

CS_733: Number of chambers of the ovary = one.

CS_739: Flower pistillode = absent.

CS_756: Number of flower ovules = one per locule.

CS_774: Number of stigmas per style = one.

CS_778: Position of the stigmas relative to the style = decurrent.

CS_790: Shape of trichomes on sepals or tepals = simple hairs.

CS_799: Orientation of trichomes on sepals or tepals = appressed.

CS_843: Color of fruit exocarp = red.

A) Code of character state, when all character states in Ricker & Daly (2007) are consecutively numbered; B) Code number of character as defined in Ricker & Daly (2007); C) *Dussia mexicana*; D) *Pouteria sapota*; E) *Bursera simaruba*; F) *Guarea grandifolia*; G) *Nectandra ambigens*; H) *Nectandra lundellii*; I) *Ulmus mexicana*; J) *Cordia alliodora* from Los Tuxtlas; K) *Pseudolmedia glabrata* female; L) *Pseudolmedia glabrata* male; M) *Cordia alliodora* from Acre in Brazil.

DISCUSSION

Taxonomy is the study of individuals first, of groups of individuals second (including species), and of groups of groups third (Blackwelder 1967: 340). While its methods have evolved, the concepts for defining, describing, and naming species or other groupings of biological diversity goes back to Carolus Linnaeus (1707-1778). Ideally, taxonomic work should be an objective science, not only in describing character states of groups of individuals, but also in the way to circumscribe a group and give it a distinctive name. To work in this way would require straightforward definitions with rigorous criteria for taxa. The nature of variation in character states and recognition of form has made the development of such criteria difficult. The recognition of form and characters that vary slightly within a given species has been notoriously difficult to carry out by a machine. Just consider the often controversial and sometimes polemical discussion about what exactly is a species (for a good discussion on species concepts see Judd et al. 2002):

> *Blackwelder (1967: 162-163)*: "It is not possible to define what a species is, or what species are, in general. They are the taxa placed at the species level, but there is no real definition in this statement. Species in this conceptual sense cannot be classified either. Just as a chemist probably could not rigidly define just what is 'a chemical' and what is not, so the

taxonomist cannot define what is a species and what is not. The chemist, however, *can* define each one of the chemicals known to him and can distinguish them, and the taxonomist *can* define each species known to him."

Mayr (1969: 314): "Species are groups of interbreeding natural populations that are reproductively isolated from other such groups."

Wiley (1978: 17): "A species is a lineage of ancestral descendant populations which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate."

Mishler & Brandon (1987: 406): "A species is the least inclusive taxon recognized in a classification, into which organisms are grouped because of evidence of monophyly (usually, but not restricted to, the presence of synapomorphies), that is ranked as a species because it is the smallest "important" lineage deemed worthy of formal recognition, where "important" refers to the action of those processes that are dominant in producing and maintaining lineages in a particular case."

Cronquist (1988: 71): "Species are the smallest groups that are consistently and persistently distinct, and distinguishable by ordinary means."

Ricker & Daly (in this paper): For the purposes of this paper we add the *statistical species concept*: "A tree species is a statistical populations of tree specimen, ideally the living trees but otherwise at least represented by herbarium specimen."

As a result of the inherent difficulty to standardize definitions and criteria, taxonomy as a science has been (1) mainly descriptive, and (2) authoritative in that taxonomic experts define and recognize taxa. For example, the textbook of Blackwelder (1967: 162-163) states: "There is no objective way to tell whether a difference is merely a variation within a species or actually a distinction between two species. It is the basis of good taxonomy that the taxonomist develops the ability to recognize the value of most differences." During the last decade and with the advances of image taking and processing, excellent visual guides and descriptions to tree species of both temperate zones and the tropics have been published: Hora (1986), Rodríguez-Rojas & Sibille-Martina (1996), Pennington & Sarukhán (1998), Godet (1999), Coombes (2002), Phillips & Rix (2002), Barwick (2004), More & White (2005), and Russell et al. (2007).

Taxonomy could exclusively be the science of naming unambiguously groups of organisms that share common character states. Over the last decades it has however been an additional, if not the major goal, to develop classification systems that reflect evolution over time. Phylogenetic classification results in grouping genetically similar individuals together. Since genetic similarity results in the best correlations of phenotypic character states in all ways (physiology, chemistry, behaviour), such a system takes best into account of all characters, whether these are examined or not. For example, biologists would not group all yellow-flowering plants together in one taxa, even when this would be practical for identification purposes. The field of systematics has been much more conceptual than the field of traditional taxonomy, and taxonomic naming and identification has become a type of "service by-product" of phylogenetic research. Here we turn back to the original problem of how to identify species and taxa, once they have been described by a scientific authority. Our proposed methods will respond to the following restrictions. First, it shall respect the the accepted names of species and other ranks that have been defined over time and that may still be corrected and modified by systematisists to reflect evolutionay relationships. Second, it shall work like a published key, which once published by the specialist ideally does not require to send a specimen for identification to the specialist. And third, the method shall serve the many non-taxonomist end-users of taxonomic identifications of tree species, such as ecologists, foresters, gardeners, conservationists, natural products chemists, and landscape architects. Our proposed method as applied here to 11 specimens as a test case, has the following features:

1) Matrix development: For a given geographic region, a matrix with (here) 898 character states with emphasis on non-fertile characters is scored.
2) Minimization of the necessary character states: The number of character states that serves to distinguish all species is minimized by binary integer optimization. The resulting character states are the strategically fastest ones for recognizing and distinguishing the tree species.
3) Choice of types of characters: Characters can be chosen to apply to fertile herbarium specimens, to fertile trees in the field, or to non-fertile herbarium specimens and trees in the field.
4) Repetition of optimization when the recommended characters can not be scored: If some character state cannot be oberserved, the optimization can be repeated for the group of undistinguishable species, providing other strategically fastest character states that let the members of a subgroup be distinguished.

5) Association of a specimen with a species via a similarity coefficient: The Jaccard similarity coefficient is used to indicate which species is closest to a given specimen. A 100% match of scores for identifying a specimen is not necessary.

The pitfalls of traditional taxonomic keys, such as getting lost or stuck with an unobservable character, or arriving at a species without knowing if its overall pattern of character states is closest to the to-be-identified specimen, are avoided with this method. To our knowledge it is also the first approach that employs mathematically rigourous optimization for taxa identification. In these ways our approach forms part of the current research trend to advance semi-automatized plant identification, be it on the phenotypic (Agarwal et al. 2006) or the molecular level (Cowan et al. 2006).

The devlopment of independent software to carry out our suggested method is currently in progress. The expansion of the matrix to include more species and the refinement of the character states is also in progress.

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APPENDIX 1: THE PROGRAM *TAXONOMY* (IN *DELPHI* PROGRAMMING LANGUAGE)

```
                                                                    {May 20, 2007}
{Dr. Martin Ricker
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unit Character_Min;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtDlgs, OleServer, ExcelXP, Menus, ActnList,
  Grids, DirOutln, ColorGrd, IdBaseComponent, IdComponent, IdMessageCoder,
  ExtCtrls, TeeProcs, TeEngine, Chart, AppEvnts;

type
  TForm1 = class(TForm)
    Button3: TButton;
    Button1: TButton;
    OpenTextFileDialog1: TOpenTextFileDialog;

    procedure Button3Click(Sender: TObject);
    procedure Button1Click(Sender: TObject);
  end;



var
  Form1: TForm1;
  FileName: string;
  InFile, OutFile: text;

  Number_Of_Character_States: word;
  Number_Of_Taxonomic_Units: word;


implementation

{$R *.dfm}


{-------------------------------------------------------------------------------}


{INPUT FILE SELECTION}
```

```
procedure TForm1.Button3Click(Sender: TObject);

begin
  FileName := 'Character_Matrix.txt';

  if OpenTextFileDialog1.Execute then
    FileName := OpenTextFileDialog1.FileName;

  Canvas.FillRect(Rect(10, Screen.Height, Screen.Width, Screen.Height-105));
  Canvas.Font.Size := 14;
  Canvas.Font.Color := clMaroon;
  Canvas.TextOut (10, Screen.Height-105, 'INPUT FILE:  ' + FileName);
  Canvas.Font.Color := clBlack;

  Button1.Enabled := true;
end;


{-------------------------------------------------------------------------}


{WRITE FILE FOR LINGO}
procedure TForm1.Button1Click(Sender: TObject);

type
  WordNumber_Array = array[1..1000] of word;  {for up to 1000 species}
  TaxUnitName_Array = array[1..1000] of string;

var
  CharacterStateValue: WordNumber_Array;
  Char_Nr: word;
  FirstEntry: boolean;
  I, J, K, N: word;
  StringName: string[6];
  TaxUnitName: TaxUnitName_Array;
  Unit1, Unit2: word;
  Useful: boolean;
  Useless_Character: WordNumber_Array;

begin
  for I := 1 to 1000 do
    begin
      CharacterStateValue[I] := 3;
      Useless_Character[I] := 0;
    end;

  AssignFile (InFile, FileName);
  AssignFile (OutFile, 'Minimize_Characters.lg4');

  reset (InFile);
  rewrite (OutFile);

  readln (InFile, Number_Of_Character_States, Number_Of_Taxonomic_Units);
  readln (InFile); {Name}
  readln (InFile); {Name}
  for I := 1 to (Number_Of_Taxonomic_Units) do
    readln (InFile, StringName);
```

```
writeln (OutFile, ' MIN = ');
I := 1;
repeat
  writeln (OutFile);
  repeat
    readln (InFile, StringName);
    if (I = 1) then
      write (OutFile, '          ', StringName)
    else
      write (OutFile, ' +', StringName);
    I := I + 1
  until
    (I /10 = round(I /10)) or
    (I >= Number_Of_Character_States + 1);
until
  (I >= Number_Of_Character_States + 1);
write (OutFile, ';');
writeln (OutFile);
writeln (OutFile);
writeln (OutFile);

CloseFile (InFile);
reset (InFile);
readln (InFile, Number_Of_Character_States, Number_Of_Taxonomic_Units);
readln (InFile); {Name}
readln (InFile); {Name}
for I := 1 to (Number_Of_Taxonomic_Units) do
  readln (InFile);  {NAMES}

I := 1;
repeat
  repeat
    readln (InFile, StringName);
    write (OutFile, '@BIN(', StringName, '); ');
    I := I + 1
  until
    (I /8 = round(I /8)) or
    (I >= Number_Of_Character_States + 1);

  writeln (OutFile);
until
  I >= Number_Of_Character_States + 1;

writeln (OutFile);
CloseFile (InFile);



for Unit1 := 1 to (Number_Of_Taxonomic_Units - 1) do
  for Unit2 := (Unit1 + 1) to Number_Of_Taxonomic_Units do
    begin
      {DETERMINE WHICH CHARACTERS DON'T HAVE OVERLAPS BETWEEN THE PAIR}
      reset (InFile);
      readln (InFile, Number_Of_Character_States, Number_Of_Taxonomic_Units);
      readln (InFile); {character state column name}
      readln (InFile); {character column name}
```

```
for J := 1 to Number_Of_Taxonomic_Units do
  readln (InFile, TaxUnitName[J]);

for I := 1 to (Number_Of_Character_States) do
  begin
    read (InFile, StringName);
    read (InFile, Char_Nr);
    for J := 1 to (Number_Of_Taxonomic_Units - 1) do
      read (InFile, CharacterStateValue[J]);
    readln (InFile, CharacterStateValue[Number_Of_Taxonomic_Units]);

    if (CharacterStateValue[Unit1] = 1) and
       (CharacterStateValue[Unit2] = 1) then {The character is useless}
        begin
      Useless_Character[I] := Char_Nr;
      Str(Char_nr, StringName);
      Canvas.TextOut (400, 200, StringName);
        end
    else
      Useless_Character[I] := 0;
  end;
CloseFile (InFile);

{DETERMINE WHICH CHARACTER STATES TO INCLUDE}
reset (InFile);
readln (InFile, Number_Of_Character_States, Number_Of_Taxonomic_Units);
readln (InFile); {character state column name}
readln (InFile); {character column name}
for J := 1 to Number_Of_Taxonomic_Units do
  readln (InFile, TaxUnitName[J]);
writeln (OutFile, '!', TaxUnitName[Unit1], ' & ',
                      TaxUnitName[Unit2], ';');

K := 0;
FirstEntry := true;
for I := 1 to (Number_Of_Character_States) do
  begin
    read (InFile, StringName);
    read (InFile, Char_Nr);
    for J := 1 to (Number_Of_Taxonomic_Units - 1) do
      read (InFile, CharacterStateValue[J]);
    readln (InFile, CharacterStateValue[Number_Of_Taxonomic_Units]);

    if (CharacterStateValue[Unit1] +
        CharacterStateValue[Unit2] = 1) then
      begin
        {Check if useless character}
        Useful := true;
        for N := 1 to Number_Of_Character_States do
          if (Char_Nr = Useless_Character[N]) then
            Useful := false;

        if (Useful = true) then
          begin
            K := K + 1;
            if (FirstEntry = true) then
              begin
```

```
                        write (OutFile, '  ', StringName);
                        FirstEntry := false;
                      end
                    else
                      write (OutFile, ' +', StringName);

                    if (K /10 = round(K /10)) or
                       (K >= Number_Of_Character_States) then
                      begin
                        writeln (OutFile);
                        K := 0;
                      end;
                  end;
              end;
          end;
{**}        write (OutFile, ' >= 1;');
        writeln (OutFile);
        writeln (OutFile);
        CloseFile (InFile);
      end;

  writeln (OutFile, 'END');
  CloseFile (OutFile);

  Canvas.FillRect(Rect(400, 0, Screen.Width, Screen.Height-105));
  Canvas.Font.Size := 20;
  Canvas.Font.Color := clRed;
  Canvas.TextOut(round(300 + (Screen.Width-400)/2), 350, 'DONE!');
end;


{-------------------------------------------------------------------------------}


end.




program Taxonomy;

uses
  Forms,
  Character_Min in 'Character_Min.pas' {Form1};

{$R *.res}

begin
  Application.Initialize;

  Application.CreateForm(TForm1, Form1);
  Application.Run;
end.
```

APPENDIX 2: LIST OF SPECIMENS FROM LOS TUXTLAS PROCESSED IN THE HERBARIUM OF THE NEW YORK BOTANICAL GARDEN

1) SPECIMENS IN THE HERBARIUM NY OF THE NEW YORK BOTANICAL GARDEN: Ordered alphabetically by family, for each specimen the collection code (BGC = Braulio Gómez-Chagala; EVS = Eladio Velasco-Sinaca; MR = Martin Ricker), the species, and in parenthesis the person who made the identification is provided.

Actinidiaceae:
BGC 124: *Saurauia yassicae* Loes (Braulio Gómez-Chagala).

Anacardiaceae:
EVS 642: *Spondias radlkoferi* Donn. Sm. (Eladio Velasco-Sinaca).
BGC 93: *Tapirira mexicana* Marchand (Braulio Gómez-Chagala).

Annonaceae:
EVS 682: *Desmopsis schippii* Standl. (Douglas C. Daly and Martin Ricker).
EVS 562: *Malvea depressa* (Baill.) R.E. Fr. (Eladio Velasco-Sinaca).
MR 121: *Rollinia mucosa* (Jacq.) Baill. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).
EVS 619: *Rollinia mucosa* (Jacq.) Baill. (Eladio Velasco-Sinaca).
EVS 658: *Tridimeris hahniana* Baill. (Eladio Velasco-Sinaca).

Apocynaceae:
EVS 112: *Stemmadenia donnell-smithii* (Rose) Woodson (Eladio Velasco-Sinaca).
EVS 640: *Stemmadenia galeottiana* (A. Rich.) Miers (Eladio Velasco-Sinaca).
EVS 108: *Tabernaemontana alba* Mill. (Eladio Velasco-Sinaca).
EVS 536: *Tabernaemontana alba* Mill. (Eladio Velasco-Sinaca).

Araliaceae:
MR 102: *Dendropanax arboreus* (L.) Decne. & Planch. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Betulaceae:

EVS 659: *Carpinus caroliniana* Walter (Eladio Velasco-Sinaca).

Bombacaceae:

MR 104: *Quararibea funebris* (La Llave) Vischer (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 109: *Quararibea yunckerii* Standl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Boraginaceae:

BGC 104: *Cordia alliodora* (Ruíz & Pav.) Oken (Braulio Gómez-Chagala, confirmed by Jacquelyn Kallunki).

MR 148: *Cordia stellifera* I.M. Johnst. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 696: *Cordia stellifera* I.M. Johnst. (Eladio Velasco-Sinaca, confirmed by Jacquelyn Kallunki).

Burseraceae:

MR 133: *Bursera simaruba* (L.) Sarg. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Caesalpiniaceae:

EVS 605: *Cynometra retusa* Britton & Rose (Eladio Velasco-Sinaca and Mario Sousa).

MR 134: *Senna multijuga* (Rich.) H.S. Irwin & Barneby (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 565: *Senna papillosa* (Britton & Rose) Irwin & Barneby (Eladio Velasco-Sinaca and Gabriel Flores).

Capparaceae:

MR 119: *Crataeva tapia* L. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Cecropiaceae:

EVS 609: *Coussapoa purpusii* Standl. (Braulio Gómez-Chagala).

Celastraceae:

BGC 108: *Crossopetalum parviflorum* (Hemsl.) Lundell (Álvaro Campos).

EVS 582: *Maytenus purpusii* Lundell (Douglas C. Daly and Martin Ricker).

EVS 612: *Maytenus purpusii* Standl. (Douglas C. Daly and Martin Ricker).

EVS 765: *Perrottetia longistylis* Rose (Mike Nee [genus] and Douglas C. Daly [species]).

EVS 668: *Wimmeria bartlettii* Lundell (Eladio Velasco-Sinaca).

EVS 700: *Wimmeria bartlettii* Lundell (Eladio Velasco-Sinaca).

EVS 625: *Zinowiewia* sp. nov?!, close to *Z. costaricensis* (Julio Lombardi [genus] and Douglas C. Daly [species]).

Chloranthaceae:

EVS 688: *Hedyosmum mexicanum* Cordem. ex Baill. (Santiago Sinaca-Colín).

Clethraceae:

EVS 698: *Clethra pringlei* S. Watson (Santiago Sinaca-Colín [genus] and Douglas C. Daly [species]).

Ericaceae:

EVS 660: *Gaultheria acuminata* Schlecht. & Cham. (James L. Luteyn).

Erythroxylaceae:

EVS 644: Erythroxylum macrophyllum Cav. (sensu lato; Douglas C. Daly and Martin Ricker).

EVS 631: *Erythroxylum panamense* Turcz. (Santiago Sinaca-Colín, confirmed by Douglas C. Daly).

Euphorbiaceae:

EVS 560: *Adelia barbinervis* Schltdl. & Cham. (Eladio Velasco-Sinaca).

MR 122: *Croton schiedeanus* Schltdl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 136: *Omphalea oleifera* Hemsl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 573: *Tetrorchidium rotundatum* Standl. (Eladio Velasco-Sinaca).

Flacourtiaceae:

MR 110: *Pleuranthodendron lindenii* (Turcz.) Sleumer (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Juglandaceae:

EVS 749: *Alfaroa costaricensis* Standl. (Eladio Velasco-Sinaca).

EVS 705: *Juglans olanchana* Standl. & L.O. Williams (Eladio Velasco-Sinaca).

Lauraceae:

EVS 706: *Beilschmiedia costaricensis* (Mez & Pittier) C.K. Allen (Douglas C. Daly and Martin Ricker).

MR 147: *Licaria velutina* van der Werff (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 129: *Nectandra ambigens* (S.F. Blake) C.K. Allen (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 140: *Nectandra lundellii* C.K. Allen (Douglas C. Daly and Martin Ricker).

Magnoliaceae:

EVS 669: *Talauma mexicana* (DC.) Don (Eladio Velasco-Sinaca).

EVS 699: *Talauma mexicana* (DC.) Don (Eladio Velasco-Sinaca).

Meliaceae:

MR 146: *Guarea grandifolia* DC. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 112: *Trichilia breviflora* Blake & Standl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Mimosaceae:

EVS 671: *Abarema idiopoda* (S.F. Blake) Barneby & J.W. Grimes (Eladio Velasco-Sinaca and Mario Sousa).

EVS 747: *Abarema idiopoda* (S.F. Blake) Barneby & J.W. Grimes (Mario Sousa).

BGC 128: *Inga acrocephala* Steud. (Mario Sousa).

EVS 733: *Inga acrocephala* Steud. (Eladio Velasco-Sinaca and Mario Sousa).

MR 123: *Inga brevialata* Ducke (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 538: *Inga nobilis* Willd. (Mario Sousa).

BGC 113: *Inga paterno* Harms (Mario Sousa).

EVS 104: *Inga pavoniana* Don (Eladio Velasco-Sinaca and Mario Sousa).

EVS 621: *Inga sinacae* M. Sousa & Ibarra-Manríquez (Eladio Velasco-Sinaca and Mario Sousa).

EVS 735: *Inga tuerckheimii* Pittier (Mario Sousa).

MR 151: *Pithecellobium hymenaeifolium* (Bonpl. ex Humb. & Willd.) Benth. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 720: *Zygia unifoliolata* (Benth.) Pittier (Mario Sousa).

Monimiaceae:

EVS 731: *Mollinedia butleriana* Standl. (Santiago Sinaca-Colín).

EVS 629: *Mollinedia viridiflora* Tul. (Santiago Sinaca-Colín).

Moraceae:

MR 143: *Clarisa biflora* Ruiz & Pav. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 708: *Clarisa biflora* Ruiz & Pav. (Eladio Velasco-Sinaca).

EVS 580: *Ficus colubrinae* Standl. (Eladio Velasco-Sinaca).

EVS 616: *Ficus eugeniaefolia* (Liebm.) Hemsl. (Eladio Velasco-Sinaca).

BGC 107: *Ficus obtusifolia* H.B.K. (Álvaro Campos).

EVS 535: *Ficus pertusa* L.f. (Eladio Velasco-Sinaca).

BGC 102: *Ficus yoponensis* Desv. (Álvaro Campos).

EVS 712: *Poulsenia armata* (Miq.) Standl. (Eladio Velasco-Sinaca).

EVS 604: *Pseudolmedia glabrata* (Liebm.) C.C. Berg (Eladio Velasco-Sinaca).

EVS 655: *Pseudolmedia glabrata* (Liebm.) C.C. Berg (Eladio Velasco-Sinaca).

EVS 540: *Trophis mexicana* (Liebm.) Bureau (Eladio Velasco-Sinaca).

Myrtaceae:

MR 118: *Eugenia inirebensis* P.E. Sánchez (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Nyctaginaceae:

EVS 683: *Guapira linearibracteata* (Heinerl) Standl. [= *G. costaricana* (Standl.) Woodson] (Douglas C. Daly and Martin Ricker).

MR 127: *Neea psychotrioides* Donn. Sm. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 603: *Neea psychotrioides* Donn. Sm. (Eladio Velasco-Sinaca).

Papilionaceae:

EVS 772: *Dalbergia glomerata* Hemsl. (Mario Sousa).

EVS 530: *Dalbergia stevensonii* Standl. (Mario Sousa).

BGC 111: *Diphysa americana* (Miller) M. Sousa (Mario Sousa).

MR 132: *Dussia mexicana* (Standl.) Harms (Miguel A. Sinaca-Colín & Guillermo Ibarra-Manríquez).

EVS 695: *Dussia mexicana* (Standl.) Harms (Eladio Velasco-Sinaca and Mario Sousa).

EVS 584: *Erythrina folkersii* Krukoff & Moldenke (Eladio Velasco-Sinaca and Mario Sousa).

EVS 613: *Gliricidia sepium* (Jacq.) Steud. (Eladio Velasco-Sinaca and Mario Sousa).

MR 150: *Lonchocarpus cruentus* Lundell (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

EVS 679A: *Lonchocarpus guatemalensis* Benth. (Mario Sousa).

EVS 571: *Lonchocarpus santarosanus* Donn. Sm. (Mario Sousa).

EVS 652: *Lonchocarpus unifoliolatus* Benth. (Eladio Velasco-Sinaca and Mario Sousa).

EVS 614: *Platymiscium dimorphandrum* Donn. Sm. (Eladio Velasco-Sinaca and Mario Sousa).

EVS 581: *Swartzia guatemalensis* (Donn. Sm.) Pittier (Eladio Velasco-Sinaca and Mario Sousa).

EVS 716: *Swartzia, guatemalensis* (Donn. Sm.) Pittier (Mario Sousa).

Polygonaceae:

EVS 121: *Coccoloba hondurensis* Lundell (Eladio Velasco-Sinaca).

EVS 718: *Coccoloba hondurensis* Lundell (Eladio Velasco-Sinaca).

EVS 657: *Coccoloba lindaviana* Howard (Douglas C. Daly and Martin Ricker).

Rhamnaceae:

EVS 662: *Rhamnus capriifolia* Schltdl. var. *capriifolia* (Mike Nee [genus] and Douglas C. Daly [species]).

Rosaceae:

EVS 685: *Prunus tetradenia* Koehne (Jorge A. Pérez-Zabala).

EVS 766: *Prunus tetradenia* Koehne (Mike Nee [genus] and Jorge A. Pérez-Zabala [species]).

Rubiaceae:

MR 152: *Faramea occidentalis* (L.) A. Rich. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 103: *Hamelia longipes* Standl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 107: *Psychotria chiapensis* Standl. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Sabiaceae:

EVS 638: *Meliosma alba* (Schltdl.) Walp (Douglas C. Daly and Martin Ricker).

EVS 729: *Meliosma dentata* Liebm. (Santiago Sinaca-Colín).

EVS 665: *Meliosma idiopoda* S.F. Blake (Clara H. Ramos).

Sapotaceae:

MR 131: *Pouteria sapota* (Jacq.) H.E. Moore & Stearn (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Solanaceae:

EVS 667: *Cestrum glanduliferum* Francey (Mike Nee).

EVS 566: *Cestrum racemosum* Ruíz & Pav. (Eladio Velasco-Sinaca, confirmed by Mike Nee).

EVS 694: *Cestrum racemosum* Ruíz & Pav. (Eladio Velasco-Sinaca, confirmed by Mike Nee).

EVS 576: *Solanum circinatum* Bohs (Mike Nee).

Staphyleaceae:

EVS 600: *Turpinia occidentalis* (Sw.) G. Don (Eladio Velasco-Sinaca).

EVS 732: *Turpinia, occidentalis* (Sw.) G. Don (Eladio Velasco-Sinaca).

Tiliaceae:

MR 141: *Mortoniodendron guatemalense* Standl. & Steyerm. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

MR 137: *Trichospermum galeottii* (Turcz.) Kosterm. (Miguel A. Sinaca-Colín and Guillermo Ibarra-Manríquez).

Ulmaceae:

EVS 599: *Ampelocera hottlei* (Standl.) Standl. (Eladio Velasco-Sinaca).

EVS 90: *Trema micrantha* (L.) Blume (Eladio Velasco-Sinaca).

EVS 651: *Ulmus mexicana* (Liebm.) Planch. (Eladio Velasco-Sinaca).

Urticaceae:

EVS 103: *Myriocarpa longipes* Liebm. (Eladio Velasco-Sinaca).

EVS 100: *Urera caracasana* (Jacq.) Griseb. (Eladio Velasco-Sinaca).

EVS 606: *Urera elata* (Sw.) Griseb. (Eladio Velasco-Sinaca).

Vochysiaceae:

EVS 719: *Vochysia guatemalensis* Donn. Sm. (Eladio Velasco-Sinaca).

Melastomataceae sent to F. Michelangeli (NY):

BGC 92: *Conostegia xalapensis* (Kunth) G. Don ex DC. (Braulio Gómez-Chagala,

EVS 623: *Miconia* sp. (Eladio Velasco-Sinaca).

EVS 763: *Miconia*?? (Eladio Velasco-Sinaca).

Simaroubaceae sent to W. Thomas (NY):

EVS 643: *Picramnia anditdesma*?? (Santiago Sinaca-Colín).

EVS 715: *Picramnia hirsuta* W.W. Thomas (Santiago Sinaca-Colín).

2) SPECIMENS SENT TO SPECIALISTS IN OTHER HERBARIA:

Ordered alphabetically by family, the name of the specialist and the acronym of the herbarium where he or she works is given, followed for each specimen by the collection code (BGC = Braulio Gómez-Chagala; EVS = Eladio Velasco-Sinaca), the preliminary identification of the species, and in parenthesis the person who made the preliminary identification.

Aquifoliaceae sent to P.A. Loizeau (G):

BGC 118: *Ilex valeri* Standl. (Álvaro Campos).

EVS 641: *Ilex valeri* Standl. (Eladio Velasco-Sinaca).

EVS 730: *Ilex quercetorum* I.M. Johnst. ?! (Eladio Velasco-Sinaca).

EVS 741: *Ilex quercetorum* I.M. Johnst. ?! (Eladio Velasco-Sinaca).

EVS 670A: *Ilex quercetorum* I.M. Johnst. ?? (Eladio Velasco-Sinaca).

Araliaceae sent to D. Frodin (K):

BGC 97: *Dendropanax arboreus* (L.) Decne. & Planch. (Braulio Gómez-Chagala).

EVS 645: *Dendropanax* sp.(Eladio Velasco-Sinaca).

Bignoniaceae sent to L. Lohmann (SPF):

EVS 586: *Amphitecna tuxtlensis* A.H. Gentry (Eladio Velasco-Sinaca).

EVS 615: *Tabebuia guayacan* (Seem.) Hemsl. (Eladio Velasco-Sinaca).

EVS 646: *Tabebuia guayacan* (Seem.) Hemsl. (Eladio Velasco-Sinaca).

Bombacaceae (*Quararibea*) sent to B. Alverson (WIS):

EVS 98: *Quararibea yunckerii* Standl. (Eladio Velasco-Sinaca).

EVS 127: *Quararibea funebris* (La Llave) Vischer (Eladio Velasco-Sinaca).

Bombacaceae (*Ceiba*) sent to P. Gibbs (STA):

EVS 575: *Ceiba pentandra* (L.) Gaertn. (Eladio Velasco-Sinaca).

Capparaceae sent to H.H. Iltis (WIS):

EVS 543: *Capparis baducca* L. or *tuxtlensis*?? (Eladio Velasco-Sinaca).

EVS 544: *Capparis baducca* L. or *tuxtlensis*?? (Eladio Velasco-Sinaca).

EVS 551: *Capparis baducca* L. or *tuxtlensis*?? (Eladio Velasco-Sinaca).

EVS 618: *Crataeva tapia* L. (Eladio Velasco-Sinaca).

EVS 656: *Capparis mollicella* Standl. (Eladio Velasco-Sinaca).

EVS 714: *Capparis baducca* L. or *tuxtlensis*? (Eladio Velasco-Sinaca).

EVS 721: *Capparis mollicella* Standl. (Eladio Velasco-Sinaca).

Clusiaceae sent to B. Hammel (MO):

EVS 123: *Calophyllum brasiliense* Cambess. (Eladio Velasco-Sinaca).

EVS 637: *Garcinia intermedia* (Pittier) Hammel (Eladio Velasco-Sinaca).

Ebenaceae sent to B. Wallnöfer (W):

EVS 681: *Diospyros conzattii* Standl. (Esteban Martínez).

Elaeocarpaceae sent toTerry Pennington (K):

EVS 636: *Sloanea medusula* Schum. et Pittier (Eladio Velasco-Sinaca).

EVS 684A: *Sloanea medusula* Schum. et Pittier (Eladio Velasco-Sinaca).

Euphorbiaceae (*Croton*) sent to P. Berry (MICH):

EVS 116: *Croton schiedeanus* Schltdl. (Eladio Velasco-Sinaca).

EVS 675: *Croton draco* Schltdl. (Santiago Sinaca-Colín).

Fagaceae (*Quercus*) sent to K. Nixon (BH):

EVS 690: *Quercus* sp. (Eladio Velasco-Sinaca).

EVS 693: *Quercus skinneri* Benth.?? (Eladio Velasco-Sinaca).

Flacourtiaceae sent to M. Alford (USMS):

EVS 102: *Pleuranthodendron lindenii* (Turcz.) Sleumer (Eladio Velasco-Sinaca).

BGC 110: *Casearia* sp. (Álvaro Campos).

EVS 542: *Lunania mexicana* Brandegee (Eladio Velasco-Sinaca).

EVS 564: *Casearia sylvestris* Sw. (Eladio Velasco-Sinaca).

EVS 597: Unidentified Flacourtiaceae (Douglas C. Daly).

EVS 634: *Casearia*?? (Eladio Velasco-Sinaca).

EVS 664: *Casearia tacanensis* Lundell (Santiago Sinaca-Colín).

EVS 677: *Pleuranthodendron lindenii* (Turcz.) Sleumer (Eladio Velasco-Sinaca).

Icacinaceae sent to R. Duno de Stefano (CICY):

EVS 583: *Mappia racemosa* Jacq. (Eladio Velasco-Sinaca).

EVS 628: *Mappia racemosa* Jacq. (Eladio Velasco-Sinaca).

EVS 672: *Calatola costaricensis* Standl. (Eladio Velasco-Sinaca).

EVS 680: *Calatola costaricensis* Standl. (Eladio Velasco-Sinaca).

EVS 627A: *Calatola laevigata* Standl. (Eladio Velasco-Sinaca).

Lauraceae sent to H. van der Werff (MO):

BGC 101: *Nectandra salicifolia* (Kunth) Nees (Álvaro Campos).

BGC 105: *Ocotea dendrodaphne* Mez (Armando Ponce-Vargas).

BGC 117: *Nectandra lundellii* C.K. Allen (Álvaro Campos).

BGC 119: *Nectandra ambigens* (S.F.) C.K. Allen (Braulio Gómez-Chagala).

EVS 570: *Ocotea uxpanapana* T. Wendt & van der Werff (Eladio Velasco-Sinaca).

EVS 578: *Persea schiedeana* Nees (Eladio Velasco-Sinaca).

EVS 579: *Persea americana* Miller (Armando Ponce-Vargas).

EVS 594: *Ocotea verticellata* Rohwer (Eladio Velasco-Sinaca).

EVS 622: *Ocotea dendrodaphne* Mez (Santiago Sinaca-Colín).

EVS 624: *Nectandra salicifolia* (Kunth) Mez (Santiago Sinaca-Colín).

EVS 639: *Ocotea* sp. (Armando Ponce-Vargas).

EVS 647: *Ocotea rubiflora* Mez?? (Santiago Sinaca-Colín).

EVS 650: *Phoebe* sp. (Santiago Sinaca-Colín).

EVS 653: *Nectandra ambigens* (S.F. Blake) C.K. Allen (Eladio Velasco-Sinaca).

EVS 654: *Ocotea verticellata* Rohwer (Eladio Velasco-Sinaca).

EVS 686: *Licaria* or *Ocotea*?? (Armando Ponce-Vargas).

EVS 701: *Nectandra* or *Ocotea*?? (Armando Ponce-Vargas).

EVS 707: *Ocotea* sp. (Armando Ponce-Vargas).

EVS 709: *Licaria capitata* (Cham. & Schltdl.) Kosterm. (Armando Ponce-Vargas).

EVS 711: *Nectandra lundellii* C.K. Allen (Eladio Velasco-Sinaca).

EVS 726: *Ocotea rubiflora* Mez?? (Eladio Velasco-Sinaca).

EVS 736: *Ocotea cernua* (Nees) Mez (Armando Ponce-Vargas).

EVS 743: *Ocotea* sp. (Armando Ponce-Vargas).

EVS 745: *Nectandra salicifolia* (Kunth) Mez (Armando Ponce-Vargas).

EVS 752: *Phoebe* or *Ocotea* (Armando Ponce-Vargas).

EVS 702A: *Ocotea dendrodaphne* Mez (Armando Ponce-Vargas).

Malpighiaceae sent to W.R. Anderson (MICH):

EVS 593: *Bunchosia lindeniana* A. Juss (Santiago Sinaca-Colín).

EVS 661: *Bunchosia lindeniana* A. Juss (Santiago Sinaca-Colín).

Malvaceae sent to P. Fryxell (RSA):

BGC 91: *Hampea nutricia* Fryxell (Braulio Gómez-Chagala).

EVS 598: *Robinsonella mirandae* Gómez-Pompa (Eladio Velasco-Sinaca).

Meliaceae sent to T.D. Pennington (K):

EVS 99: *Trichilia martiana* C. DC. (Eladio Velasco-Sinaca).

BGC 114: *Guarea glabra* Vahl?? (Eladio Velasco-Sinaca).

EVS 125: *Guarea glabra* Vahl (Eladio Velasco-Sinaca).

EVS 555: *Trichilia havanensis* Jacq. (Eladio Velasco-Sinaca).

EVS 556: *Trichilia breviflora* S.F. Blake ex Standl. (Eladio Velasco-Sinaca).

EVS 585: *Guarea glabra* Vahl (Eladio Velasco-Sinaca).

EVS 674: *Trichilia breviflora* S.F. Blake ex Standl. (Eladio Velasco-Sinaca).

EVS 704: *Guarea grandifolia* DC. (Eladio Velasco-Sinaca).

EVS 713: *Trichilia martiana* C. DC. (Eladio Velasco-Sinaca).

EVS 742: *Guarea glabra* Vahl (Eladio Velasco-Sinaca).

EVS 744: *Trichilia hirta* L. (Eladio Velasco-Sinaca).

Monimiaceae sent to S. Renner (M):

EVS 611: *Siparuna andina* (Tul.) A.DC. (Eladio Velasco-Sinaca).

Myristicaceae sent to J. Janovec (BRIT):

EVS 635: *Virola guatemalensis* (Hemsl.) Warb. (Eladio Velasco-Sinaca).

EVS 678: *Virola guatemalensis* (Hemsl.) Warb. (Eladio Velasco-Sinaca).

Myrsinaceae sent to Ricketson (MO):

EVS 608: *Parathesis lenticellata* Lundell (Eladio Velasco-Sinaca).

EVS 632: *Icacorea compressa* (Kunth) Standl. (Eladio Velasco-Sinaca).

EVS 649: *Rapanea* sp. (Santiago Sinaca-Colín).

EVS 666: *Parathesis*?? (Eladio Velasco-Sinaca).

EVS 689: *Parathesis psychotrioides* Lundell (Eladio Velasco-Sinaca).

EVS 734: *Parathesis conzattii* (S.F. Blake) Lundell (Eladio Velasco-Sinaca).

EVS 770: *Parathesis* sp. (Eladio Velasco-Sinaca).

Myrtaceae sent to L. Kawasaki (F):

BGC 96: *Pimenta dioica* (L.) Merr. (Braulio Gómez-Chagala, confirmed by Lucia Kawasaki).

EVS 531: *Pimienta dioica* (L.) Merr. (Eladio Velasco-Sinaca, confirmed by Lucia Kawasaki).

EVS 541: *Eugenia capuli* (Schltdl. & Cham.) Hook. & Arn. (Lucia Kawasaki).

EVS 557: *Eugenia* sp. (Eladio Velasco-Sinaca [genus], confirmed by Lucia Kawasaki).

EVS 558: *Eugenia acapulcensis* Steud. (Lucia Kawasaki).

EVS 703: *Eugenia karwinskyana* O. Berg (Eladio Velasco-Sinaca [genus] and F. Barrie c/o Lucia Kawasaki [species]).

EVS 710: *Eugenia acapulcensis* Steud. (Eladio Velasco-Sinaca [genus] and Lucia Kawasaki [species]).

EVS 724: *Eugenia macrocarpa* Schltdl. & Cham. (Eladio Velasco-Sinaca [genus] and Lucia Kawasaki [species]).

EVS 725: *Myrcia splendens* (Sw.) DC. (L. Kawasaki).

EVS 727: *Calyptranthes* sp. (Santiago Sinaca-Colín [genus], confirmed by Lucia Kawasaki).

EVS 728: *Calyptranthes* sp. (Lucia Kawasaki).

EVS 768: *Eugenia colipensis* O. Berg (Eladio Velasco-Sinaca [genus] and Lucia Kawasaki [species]).

Ochnaceae sent to C. Sastre (P):

BGC 112: *Ouratea tuerckheimii* Donn. Sm. ?? (Álvaro Campos).

Oleaceae sent to P.S. Green (K):

EVS 691: *Linociera dominguensis* (Lam.) Krug & Urb. (Eladio Velasco-Sinaca).

Piperaceae sent to R. Callejas (HUA):

EVS 534: *Piper amalago* L. (Eladio Velasco-Sinaca).

Proteaceae sent to G. Prance (K):

EVS 723: *Roupala montana* Aubl. (Eladio Velasco-Sinaca).

Rubiaceae sent to C. Taylor (MO):

EVS 113: *Psychotria chiapensis* Standl. (Eladio Velasco-Sinaca and Attila Borhidi).

EVS 118: *Faramea occidentalis* (L.) A. Rich. (Eladio Velasco-Sinaca and Attila Borhidi).

EVS 537: *Arachnothryx buddleioides* (Benth.) Planch. (Attila Borhidi).

EVS 572: *Posoqueria latifolia* (Rudge) Ruíz & Pav. (Eladio Velasco-Sinaca and Attila Borhidi).

EVS 617: *Posoqueria latifolia* (Rudge) Ruíz & Pav. (Eladio Velasco-Sinaca and Attila Borhidi).

EVS 626: *Renistipula galeottii* (Standl.) Borhidi (Attila Borhidi).

EVS 648: *Psychotria limonensis* K. Krause (Attila Borhidi).

EVS 663: *Palicourea padifolia* (Willd. ex Roem. et Schult.) C.M. Taylor et Lorence (Attila Borhidi).

EVS 750: *Randia pterocarpa* Lorence & Dwyer (Santiago Sinaca-Colín and Attila Borhidi).

Sapindaceae sent to P. Acevedo-Rodríguez (US):

Rosamond Coates 50: *Cupania belizensis* Standl. (Braulio Gómez-Chagala).

BGC 94: *Allophylus campostachys* S.F. Blake (Braulio Gómez-Chagala).

EVS 673: *Sapindus saponaria* L. (Eladio Velasco-Sinaca).

EVS 769: *Cupania glabra* Sw. (Eladio Velasco-Sinaca).

EVS 771: *Cupania glabra* Sw. (Eladio Velasco-Sinaca).

Sapotaceae sent to T.D. Pennington (K):

BGC 106: *Chrysophyllum mexicanum* (Esteban Martínez).

BGC 120: *Pouteria* sp. (Esteban Martínez).

EVS 568: *Sideroxylon portoricense* Urb. (Eladio Velasco-Sinaca).

EVS 692: *Sideroxylon* sp. (Esteban Martínez).

EVS 722: *Sideroxylon* sp. (Esteban Martínez).

Theaceae sent to A. Weitzman (US):

EVS 737: *Ternstroemia tepezapote* Cham. & Schltdl.?? (Esteban Martínez).

Theophrastaceae sent to B. Stahl (GU):

EVS 630: *Deherainia smaragdina* (Planch. ex Linden) Decne. (Eladio Velasco-Sinaca).

Tiliaceae sent to L. Dorr (US):

BGC 103: *Trichospermum galeotii* (Turcz.) Kosterm. (Álvaro Campos).

BGC 116: *Mortoniodendron guatemalense* Standl. & Steyerm. (Álvaro Campos).

EVS 563: *Heliocarpus donnell-smithii* Rose (Eladio Velasco-Sinaca).

EVS 602: *Mortoniodendron guatemalense* Standl. & Steyerm. (Eladio Velasco-Sinaca).

EVS 717: *Trichospermum galeottii* (Turcz.) Kosterm. (Eladio Velasco-Sinaca).

Verbenaceae sent out to S. Atkins (K):

EVS 532: *Cornutia grandifolia* (Schltdl. & Cham.) Schauer (Eladio Velasco-Sinaca).

EVS 567: *Lippia myriocephala* Schltdl. & Cham. (Eladio Velasco-Sinaca).

EVS 596: *Aegiphila costaricensis* Moldenke (Eladio Velasco-Sinaca).

EVS 620: *Citharexylum affine* G. Don (Eladio Velasco-Sinaca).

EVS 687: *Citharexylum hexangulare* Greenm. (Eladio Velasco-Sinaca).

EVS 697: *Aegiphila costaricensis* Moldenke (Eladio Velasco-Sinaca).

Violaceae sent to H.E. Ballard (OSU):

EVS 110: *Rinorea hummelii* Sprague (Eladio Velasco-Sinaca).

EVS 561: *Rinorea guatemalensis* (S. Watson) Bartlett (Eladio Velasco-Sinaca).

EVS 587: *Orthion oblanceolatum* Lundell (Eladio Velasco-Sinaca).

APPENDIX 3: CHARACTER MATRIX FOR 11 SPECIMENS

The file is prepared as a text input file for the program *Taxonomy* of Appendix 1. The first column contains a code of each character state, when all character states in Ricker & Daly (2007) are consecutively numbered. The second column provides the code number of each character as defined in Ricker & Daly (2007).

898 11
CHARACTER_STATE
CHAR_NR
Dussia_mexicana
Pouteria_sapota
Bursera_simaruba
Guarea_grandifolia
Nectandra_ambigens
Nectandra_lundellii
Ulmus_mexicana
Cordia_alliodora_Tux
Pseudolmedia_glabrata_FEMALE
Pseudolmedia_glabrata_MALE
Cordia_alliodora_Acre

CS_001	1	1	1	1	1	1	1	1	1	1	1	1
CS_002	1	1	1	1	0	0	0	1	0	0	0	0
CS_003	1	0	0	0	0	0	0	1	0	0	0	0
CS_004	2	0	0	0	0	0	0	0	0	0	0	0
CS_005	2	0	0	0	2	0	0	0	0	0	0	0
CS_006	2	0	0	0	0	0	0	0	0	0	0	0
CS_007	2	0	0	0	0	0	0	0	0	0	0	0
CS_008	2	0	0	0	0	0	0	0	0	0	0	0
CS_009	2	0	1	1	0	0	0	0	1	0	0	0
CS_010	2	0	0	0	0	0	0	0	0	0	0	0
CS_011	2	1	1	1	1	1	1	1	1	1	1	1
CS_012	2	1	1	1	0	0	0	1	0	0	0	0
CS_013	2	0	0	0	0	0	0	1	0	0	0	0
CS_014	2	0	0	0	0	0	0	0	0	0	0	0
CS_015	2	0	0	2	0	0	0	0	0	0	0	0
CS_016	2	0	0	1	0	0	0	0	0	0	0	0
CS_017	2	0	0	0	0	0	0	0	0	0	0	0
CS_018	2	0	0	0	0	0	0	1	0	0	0	0
CS_019	3	1	1	1	1	1	1	1	1	1	1	0
CS_020	3	0	1	1	0	0	0	0	1	0	0	1

CS_021	4	1	1	1	1	1	1	1	1	1	1	0
CS_022	4	0	1	1	0	0	0	0	1	0	0	1
CS_023	5	1	1	1	1	1	1	1	1	1	1	2
CS_024	5	2	0	2	2	2	2	0	2	2	2	2
CS_025	5	2	0	2	2	2	2	0	2	1	1	2
CS_026	6	0	0	0	0	0	0	0	0	0	0	2
CS_027	6	1	1	1	1	1	1	1	1	1	1	2
CS_028	6	1	0	0	2	0	0	1	0	0	0	2
CS_029	7	1	1	1	1	1	1	1	1	1	1	1
CS_030	7	0	0	0	0	0	0	0	0	0	0	0
CS_031	7	0	0	0	0	0	0	0	0	0	0	0
CS_032	7	0	0	0	0	0	0	0	0	0	0	0
CS_033	7	0	0	0	0	0	0	0	0	0	0	0
CS_034	7	0	0	0	0	0	0	0	0	0	0	0
CS_035	7	0	0	0	0	0	0	0	0	0	0	0
CS_036	8	1	1	1	1	1	1	1	1	1	1	1
CS_037	8	0	0	0	0	0	0	0	0	0	0	0
CS_038	9	1	1	1	1	1	0	1	1	1	1	1
CS_039	9	0	0	0	0	0	0	0	0	0	0	0
CS_040	9	0	0	0	0	0	0	0	0	0	0	0
CS_041	10	1	1	0	1	1	1	1	2	1	1	2
CS_042	10	2	0	1	0	0	0	0	2	0	0	2
CS_043	10	2	0	0	0	0	0	2	2	0	0	2
CS_044	11	0	1	1	2	1	1	1	1	1	1	2
CS_045	11	2	0	0	2	0	2	0	0	0	0	2
CS_046	11	2	0	0	2	0	2	0	0	0	0	2
CS_047	11	2	0	0	2	0	2	0	0	0	0	2
CS_048	11	0	0	0	2	0	2	0	0	0	0	2
CS_049	11	0	1	0	2	1	2	2	2	2	2	2
CS_050	11	1	0	0	2	0	2	2	0	0	0	2
CS_051	11	0	0	0	2	0	2	0	0	0	0	2
CS_052	11	0	0	0	2	0	2	0	0	0	0	2
CS_053	12	0	0	0	2	0	2	0	0	0	0	1
CS_054	12	1	1	0	2	1	2	0	1	1	1	0
CS_055	12	0	0	0	2	0	2	0	0	0	0	0
CS_056	12	0	0	0	2	0	2	0	0	0	0	0
CS_057	12	0	0	1	2	0	2	0	0	1	1	0
CS_058	12	1	1	1	2	1	2	1	1	1	1	0
CS_059	12	0	0	0	2	0	2	0	0	0	0	0
CS_060	13	0	0	1	2	0	2	0	0	1	1	2
CS_061	13	1	0	0	2	0	2	0	0	0	0	2
CS_062	13	1	1	1	2	0	2	1	1	0	0	2
CS_063	13	0	0	1	2	0	2	0	0	0	0	2
CS_064	13	0	0	0	2	1	2	0	0	1	1	2
CS_065	13	0	0	0	0	0	0	0	0	0	0	2
CS_066	14	0	0	0	2	0	2	0	0	0	0	2
CS_067	14	2	0	0	2	1	2	0	1	0	0	2
CS_068	14	2	1	0	2	0	2	0	0	0	0	2
CS_069	14	2	1	0	2	0	2	1	0	0	0	2
CS_070	14	0	0	1	2	0	2	0	0	0	0	2
CS_071	14	0	1	0	2	0	2	0	0	0	0	2
CS_072	14	2	0	0	2	0	2	0	0	1	1	2
CS_073	15	2	1	0	2	0	2	0	1	0	0	2
CS_074	15	2	0	0	2	0	2	1	0	0	0	2
CS_075	15	2	0	0	2	0	2	0	0	0	0	2
CS_076	15	2	0	0	2	0	2	0	0	0	0	2

CS_077	16	2	0	0	0	0	2	1	0	0	0	2
CS_078	16	2	1	0	1	0	2	0	1	0	0	2
CS_079	17	2	1	0	2	0	2	0	1	0	0	2
CS_080	17	2	0	0	2	0	2	1	0	0	0	2
CS_081	18	2	2	0	2	0	2	2	1	0	0	2
CS_082	18	1	2	0	2	1	2	2	0	0	0	2
CS_083	18	0	2	1	2	0	2	2	0	1	1	2
CS_084	18	0	2	0	2	0	2	2	0	0	0	2
CS_085	19	2	0	1	2	0	2	0	0	0	0	2
CS_086	20	0	0	0	2	0	2	0	0	0	0	0
CS_087	20	1	0	1	2	1	2	1	0	0	0	0
CS_088	20	0	1	0	2	1	2	0	1	1	1	1
CS_089	20	0	1	0	2	0	2	1	0	1	1	0
CS_090	20	0	0	0	2	0	2	0	0	1	1	0
CS_091	20	0	0	0	2	0	2	0	1	0	0	0
CS_092	21	1	1	1	0	0	2	0	0	1	1	2
CS_093	21	0	1	0	1	1	2	1	1	0	0	2
CS_094	22	2	0	1	2	2	2	2	2	0	0	2
CS_095	22	2	0	0	2	2	2	2	2	0	0	2
CS_096	22	2	1	0	2	2	2	2	2	1	1	2
CS_097	23	2	0	1	2	2	2	2	2	0	0	2
CS_098	23	2	1	0	2	2	2	2	2	0	0	2
CS_099	23	2	0	0	2	2	2	2	2	0	0	2
CS_100	23	2	0	0	2	2	2	2	2	0	0	2
CS_101	23	2	0	0	2	2	2	2	2	1	1	2
CS_102	24	2	0	0	2	2	2	2	2	0	0	2
CS_103	24	2	0	0	2	2	2	2	2	0	0	2
CS_104	24	2	1	1	2	2	2	2	2	1	1	2
CS_105	25	1	1	1	0	0	2	0	1	1	1	2
CS_106	25	0	1	1	0	1	2	0	0	1	1	2
CS_107	25	0	0	0	1	0	2	0	0	0	0	2
CS_108	25	0	0	0	0	1	2	1	1	0	0	2
CS_109	25	0	0	0	0	0	2	0	0	0	0	2
CS_110	25	2	0	0	0	1	2	0	1	0	0	2
CS_111	26	2	0	1	0	0	2	0	2	0	0	2
CS_112	26	2	1	0	1	0	2	2	2	0	0	2
CS_113	26	2	0	0	0	2	2	2	2	1	1	2
CS_114	27	0	0	0	0	0	0	0	1	0	0	1
CS_115	28	1	0	0	0	0	0	1	0	1	1	0
CS_116	28	0	1	1	1	1	1	0	1	0	0	1
CS_117	28	0	0	0	0	0	0	0	0	0	0	0
CS_118	28	0	0	0	0	0	0	0	0	0	0	0
CS_119	28	0	0	0	0	0	0	0	0	0	0	0
CS_120	29	0	1	1	1	1	1	0	1	0	0	1
CS_121	29	0	0	0	0	0	0	0	0	1	1	0
CS_122	29	1	0	0	0	0	0	1	0	0	0	0
CS_123	30	2	0	0	0	0	0	1	0	1	1	0
CS_124	30	2	0	0	0	0	0	0	0	0	0	0
CS_125	30	2	0	0	0	0	0	0	0	0	0	0
CS_126	30	2	0	0	0	0	0	0	0	0	0	0
CS_127	30	2	0	0	0	0	0	0	0	0	0	0
CS_128	30	2	0	0	0	0	0	0	0	0	0	0
CS_129	31	2	0	0	0	0	0	1	0	0	0	0
CS_130	31	2	0	0	0	0	0	0	0	1	1	0
CS_131	31	2	0	0	0	0	0	0	0	0	0	0
CS_132	31	2	0	0	0	0	0	0	0	0	0	0

CS_133	31	2	0	0	0	0	0	0	0	0	0	0
CS_134	31	2	0	0	0	0	0	0	0	0	0	0
CS_135	31	2	0	0	0	0	0	0	0	1	1	0
CS_136	31	2	0	0	0	0	0	0	0	0	0	0
CS_137	32	0	1	0	0	1	1	1	1	1	1	1
CS_138	32	0	0	0	0	0	0	0	0	0	0	0
CS_139	32	1	0	1	1	0	0	0	0	0	0	0
CS_140	32	0	0	0	0	0	0	0	0	0	0	0
CS_141	32	0	0	0	0	0	0	0	0	0	0	0
CS_142	32	0	0	0	0	0	0	0	0	0	0	0
CS_143	33	1	1	1	1	1	1	1	1	1	1	1
CS_144	33	0	0	0	0	0	0	0	0	0	0	0
CS_145	34	0	0	1	1	1	1	1	1	1	1	1
CS_146	34	0	0	0	0	0	0	0	0	0	0	0
CS_147	34	1	1	0	0	0	0	0	0	0	0	0
CS_148	35	1	1	1	0	1	1	1	1	1	1	1
CS_149	35	0	0	0	0	0	0	0	0	0	0	0
CS_150	35	0	0	0	0	0	0	0	0	0	0	0
CS_151	36	0	0	0	0	0	0	1	0	0	0	0
CS_152	36	1	0	1	1	1	1	0	1	1	1	1
CS_153	36	0	1	0	0	0	0	0	0	0	0	0
CS_154	36	0	0	0	0	0	0	0	0	0	0	0
CS_155	36	0	0	0	0	0	0	0	0	0	0	0
CS_156	37	0	0	0	0	0	0	0	0	0	0	0
CS_157	38	1	1	1	1	1	1	1	1	1	1	1
CS_158	38	0	0	0	0	0	0	0	0	0	0	0
CS_159	38	0	0	0	0	0	0	0	0	0	0	0
CS_160	39	0	0	0	0	0	0	0	0	0	0	0
CS_161	39	0	0	0	0	0	0	1	0	0	0	0
CS_162	39	0	0	0	0	1	0	1	1	1	1	1
CS_163	39	1	0	1	0	1	1	0	1	1	1	1
CS_164	39	1	1	1	1	1	0	0	0	1	1	0
CS_165	39	0	1	0	1	0	0	0	0	0	0	0
CS_166	40	1	0	0	0	0	0	0	0	0	0	0
CS_167	40	1	0	1	0	0	0	0	0	0	0	0
CS_168	40	0	0	0	0	0	0	0	0	0	0	0
CS_169	40	0	0	0	0	0	0	0	0	0	0	0
CS_170	40	0	0	0	1	0	0	0	0	0	0	0
CS_171	41	1	0	1	1	0	0	0	0	0	0	0
CS_172	41	0	0	0	0	0	0	0	0	0	0	0
CS_173	42	0	1	1	1	0	0	0	0	0	0	0
CS_174	42	1	0	0	0	0	0	0	0	0	0	0
CS_175	42	0	0	0	0	0	0	0	0	0	0	0
CS_176	43	0	0	0	0	0	0	0	0	0	0	0
CS_177	43	1	0	0	0	0	0	0	0	0	0	0
CS_178	43	0	0	0	0	0	0	0	0	0	0	0
CS_179	44	1	0	0	0	0	0	0	0	0	0	0
CS_180	45	0	0	0	0	0	0	0	0	0	0	0
CS_181	46	1	0	1	1	0	0	0	0	0	0	0
CS_182	46	0	0	0	0	0	0	0	0	0	0	0
CS_183	46	0	0	0	0	0	0	0	0	0	0	0
CS_184	46	0	0	0	0	0	0	0	0	0	0	0
CS_185	46	0	0	0	0	0	0	0	0	0	0	0
CS_186	47	0	0	0	0	0	0	0	0	0	0	0
CS_187	47	0	0	1	0	0	0	0	0	0	0	0
CS_188	47	1	0	1	0	0	0	0	0	0	0	0

CS_189	47	1	0	0	0	0	0	0	0	0	0
CS_190	47	0	0	0	1	0	0	0	0	0	0
CS_191	47	0	0	0	1	0	0	0	0	0	0
CS_192	48	0	0	0	0	0	0	0	0	0	0
CS_193	48	1	0	1	1	1	1	1	0	1	1	1
CS_194	48	0	1	0	0	1	0	0	0	0	0	0
CS_195	48	0	0	0	0	0	0	0	0	0	0	0
CS_196	49	2	2	2	2	2	2	2	2	2	2	2
CS_197	49	2	2	2	2	2	2	2	2	2	2	2
CS_198	49	2	2	2	2	2	2	2	2	2	2	2
CS_199	50	1	0	0	1	1	1	0	1	1	1	1
CS_200	50	0	1	0	0	0	0	0	0	0	0	1
CS_201	50	1	0	0	0	1	0	1	1	1	1	0
CS_202	50	0	0	0	1	0	0	0	1	1	1	0
CS_203	50	1	0	1	0	0	1	1	1	0	0	0
CS_204	51	1	1	0	1	1	1	1	1	1	1	1
CS_205	51	0	0	1	0	0	0	0	0	0	0	0
CS_206	52	1	1	0	1	1	1	1	1	1	1	0
CS_207	52	0	0	0	0	0	0	0	0	0	0	1
CS_208	52	0	0	0	0	0	0	0	0	0	0	1
CS_209	52	1	0	1	0	0	0	0	0	0	0	1
CS_210	53	1	1	1	1	1	1	1	1	1	1	1
CS_211	53	0	0	0	0	0	0	0	0	0	0	0
CS_212	53	0	0	0	0	0	0	0	0	0	0	0
CS_213	53	0	0	0	0	0	0	0	0	0	0	0
CS_214	53	0	0	0	0	0	0	0	0	0	0	0
CS_215	53	0	0	0	0	0	0	0	0	0	0	0
CS_216	53	0	0	0	0	0	0	0	0	0	0	0
CS_217	54	1	1	1	0	1	1	1	1	1	1	1
CS_218	54	0	0	0	0	0	0	0	0	0	0	0
CS_219	54	0	0	0	0	0	0	0	0	0	0	0
CS_220	54	0	0	0	0	0	0	0	0	0	0	0
CS_221	55	1	1	1	1	1	1	0	1	1	1	1
CS_222	55	0	0	0	0	0	0	0	0	0	0	0
CS_223	55	0	0	0	0	0	0	1	0	0	0	0
CS_224	55	0	0	0	0	0	0	0	0	0	0	0
CS_225	55	0	0	0	0	0	0	0	0	0	0	0
CS_226	55	0	0	0	0	0	0	0	0	0	0	0
CS_227	56	0	0	0	0	0	0	1	0	0	0	0
CS_228	56	0	0	0	0	0	0	0	0	0	0	0
CS_229	57	0	0	0	0	0	0	0	0	0	0	0
CS_230	57	0	0	0	0	0	0	1	0	0	0	0
CS_231	57	0	0	0	0	0	0	0	0	0	0	0
CS_232	57	0	0	0	0	0	0	0	0	0	0	0
CS_233	58	0	0	0	0	0	0	0	0	0	0	0
CS_234	58	0	0	0	0	0	0	0	0	0	0	0
CS_235	58	0	0	0	0	0	0	0	0	0	0	0
CS_236	58	0	0	0	0	0	0	0	0	0	0	0
CS_237	58	0	0	0	0	0	0	1	0	0	0	0
CS_238	59	0	0	0	0	0	0	0	0	0	0	0
CS_239	59	0	0	0	0	0	0	1	0	0	0	0
CS_240	60	0	0	0	0	0	0	1	0	0	0	0
CS_241	60	0	0	0	0	0	0	0	0	0	0	0
CS_242	60	0	0	0	0	0	0	0	0	0	0	0
CS_243	60	0	0	0	0	0	0	0	0	0	0	0
CS_244	60	0	0	0	0	0	0	0	0	0	0	0

CS_245	61	0	0	0	0	0	0	1	0	0	0	0
CS_246	61	0	0	0	0	0	0	0	0	0	0	0
CS_247	61	0	0	0	0	0	0	0	0	0	0	0
CS_248	61	0	0	0	0	0	0	0	0	0	0	0
CS_249	61	0	0	0	0	0	0	0	0	0	0	0
CS_250	62	0	0	0	0	0	0	1	0	0	0	0
CS_251	62	0	0	0	0	0	0	0	0	0	0	0
CS_252	62	0	0	0	0	0	0	0	0	0	0	0
CS_253	62	0	0	0	0	0	0	0	0	0	0	0
CS_254	62	0	0	0	0	0	0	0	0	0	0	0
CS_255	63	0	1	1	1	0	0	1	1	1	1	1
CS_256	63	1	0	0	0	1	1	0	0	0	0	0
CS_257	64	0	0	0	0	0	0	0	0	0	0	0
CS_258	64	0	0	0	0	0	0	0	0	0	0	0
CS_259	64	1	1	1	1	1	1	1	1	1	1	1
CS_260	64	0	0	0	0	0	0	0	0	0	0	0
CS_261	65	0	0	0	0	0	0	0	0	0	0	0
CS_262	65	0	1	0	0	0	0	0	0	0	0	0
CS_263	65	1	0	1	1	1	1	1	1	1	1	1
CS_264	66	0	1	0	0	0	0	0	1	0	0	0
CS_265	66	1	0	1	1	1	0	1	1	1	1	0
CS_266	66	0	0	0	0	0	1	0	0	0	0	1
CS_267	67	1	1	0	1	0	1	1	0	0	0	0
CS_268	67	0	0	0	0	0	0	0	0	0	0	0
CS_269	67	0	0	0	0	0	0	0	1	0	0	1
CS_270	67	0	0	1	0	0	0	0	0	1	1	0
CS_271	67	0	0	0	0	1	0	0	0	0	0	0
CS_272	68	0	1	1	1	0	0	1	1	0	0	1
CS_273	68	1	1	1	1	1	0	0	1	1	1	0
CS_274	68	0	0	0	0	0	1	0	0	0	0	0
CS_275	69	1	1	1	0	0	0	1	1	0	0	1
CS_276	69	1	0	1	1	1	0	0	0	1	1	0
CS_277	69	0	0	0	0	0	1	0	0	0	0	0
CS_278	70	0	1	1	0	1	0	1	0	1	1	1
CS_279	70	1	0	0	1	0	1	0	0	0	0	0
CS_280	70	0	0	0	0	0	0	0	0	0	0	0
CS_281	70	0	0	0	0	0	0	0	1	0	0	0
CS_282	70	0	0	0	0	0	0	0	0	0	0	0
CS_283	70	0	0	0	0	0	0	0	0	0	0	0
CS_284	70	0	0	0	0	0	0	0	0	0	0	0
CS_285	70	0	0	0	0	0	0	0	0	0	0	0
CS_286	71	1	1	1	0	0	1	1	0	1	1	0
CS_287	71	0	0	0	0	0	0	0	0	0	0	0
CS_288	71	0	0	0	1	0	0	0	1	0	0	1
CS_289	71	0	0	0	0	0	0	1	0	0	0	0
CS_290	71	0	0	0	0	1	0	0	0	0	0	0
CS_291	71	0	0	0	0	0	0	0	0	0	0	0
CS_292	71	0	0	0	0	0	0	0	0	0	0	0
CS_293	71	0	0	0	0	0	0	0	0	0	0	0
CS_294	72	0	1	0	0	0	1	0	0	0	0	0
CS_295	72	1	0	1	1	1	0	1	1	1	1	1
CS_296	73	0	0	1	0	1	1	0	0	1	1	0
CS_297	73	1	1	0	1	0	0	1	1	0	0	1
CS_298	74	1	1	1	1	1	1	1	1	1	1	1
CS_299	74	0	0	0	0	0	0	0	0	0	0	0
CS_300	74	0	0	0	0	0	0	0	0	0	0	0

CS_301	74	0	0	0	0	0	0	0	0	0	0	0
CS_302	74	0	0	0	0	0	0	0	0	0	0	0
CS_303	75	1	1	1	1	1	1	1	1	1	1	1
CS_304	75	0	0	0	0	0	0	0	0	0	0	0
CS_305	75	0	0	0	0	0	0	0	0	0	0	0
CS_306	75	0	0	0	0	0	0	0	0	0	0	0
CS_307	75	0	0	0	0	0	0	0	0	0	0	0
CS_308	76	0	0	0	0	0	1	0	0	0	0	0
CS_309	77	1	1	1	1	1	1	1	0	1	1	0
CS_310	77	0	0	0	0	0	0	0	0	1	1	0
CS_311	77	0	0	0	0	0	0	0	0	0	0	0
CS_312	77	0	0	0	0	0	0	0	0	0	0	0
CS_313	77	0	0	0	0	0	0	0	1	0	0	1
CS_314	77	0	0	0	0	0	0	0	1	0	0	0
CS_315	78	0	0	1	0	0	0	1	0	0	0	0
CS_316	78	1	0	0	0	0	0	0	0	0	0	0
CS_317	78	0	0	0	1	0	0	0	0	0	0	0
CS_318	78	0	1	0	0	1	1	0	0	1	1	0
CS_319	79	0	0	0	0	0	0	0	0	0	0	0
CS_320	79	0	0	1	1	1	1	1	1	1	1	1
CS_321	79	1	1	0	0	0	0	0	0	0	0	0
CS_322	79	0	0	0	0	0	0	0	0	0	0	0
CS_323	79	0	0	0	0	0	0	0	0	0	0	0
CS_324	80	0	0	1	0	0	0	1	0	0	0	0
CS_325	80	0	0	1	0	0	0	0	0	1	1	0
CS_326	80	0	0	1	1	0	1	0	0	1	1	0
CS_327	80	1	1	1	0	0	1	0	1	0	0	1
CS_328	81	0	1	1	1	0	0	1	0	0	0	0
CS_329	81	0	0	1	0	1	0	0	0	1	1	0
CS_330	81	0	0	1	0	0	1	0	0	0	0	0
CS_331	81	1	0	0	0	0	1	0	1	0	0	1
CS_332	82	1	1	1	1	1	1	1	0	1	1	0
CS_333	82	0	0	0	0	0	0	0	0	1	1	0
CS_334	82	0	0	0	0	0	0	0	0	0	0	0
CS_335	82	0	0	0	0	0	0	0	0	0	0	0
CS_336	82	0	0	0	0	0	0	0	1	0	0	1
CS_337	82	0	0	0	0	0	0	0	1	0	0	0
CS_338	83	0	0	1	0	0	0	1	0	0	0	0
CS_339	83	1	0	0	0	0	0	0	0	0	0	0
CS_340	83	0	0	0	1	0	0	0	0	0	0	0
CS_341	83	0	1	0	0	1	1	0	0	1	1	0
CS_342	84	0	0	0	0	0	0	0	0	0	0	0
CS_343	84	0	0	1	1	1	1	1	1	1	1	1
CS_344	84	1	1	0	0	0	0	0	0	0	0	0
CS_345	84	0	0	0	0	0	0	0	0	0	0	0
CS_346	84	0	0	0	0	0	0	0	0	0	0	0
CS_347	85	1	0	1	1	1	1	0	0	0	0	0
CS_348	85	0	0	1	0	1	0	1	0	1	1	1
CS_349	85	0	0	1	0	0	0	0	0	1	1	0
CS_350	85	0	1	0	0	0	0	0	1	0	0	0
CS_351	86	1	1	0	1	1	1	1	0	1	1	0
CS_352	86	0	0	0	0	0	0	0	0	0	0	1
CS_353	86	0	0	0	0	0	0	0	1	0	0	0
CS_354	86	0	0	0	0	0	0	0	0	0	0	0
CS_355	87	0	1	1	1	1	1	0	1	1	1	1
CS_356	87	1	0	1	0	0	0	1	0	0	0	1

CS_357	87	1	0	0	0	0	0	0	0	0	0	0
CS_358	88	0	0	0	0	0	0	0	1	0	0	0
CS_359	88	0	0	1	0	0	1	0	0	0	0	0
CS_360	88	1	1	0	1	0	0	0	1	1	1	1
CS_361	88	1	0	0	0	0	0	0	0	0	0	1
CS_362	88	0	0	0	0	0	0	0	0	0	0	0
CS_363	88	0	0	0	0	0	0	0	0	0	0	0
CS_364	88	0	0	0	0	1	0	0	0	0	0	0
CS_365	89	0	0	0	0	0	0	1	0	0	0	1
CS_366	89	0	0	0	0	0	0	0	0	0	0	0
CS_367	89	0	0	0	0	0	0	0	0	0	0	0
CS_368	90	1	1	1	0	1	1	1	1	1	1	0
CS_369	90	0	0	0	1	0	0	0	0	0	0	1
CS_370	90	0	0	0	0	0	0	0	0	0	0	0
CS_371	91	1	0	0	1	0	1	0	0	0	0	0
CS_372	91	0	1	1	1	1	0	1	1	1	1	1
CS_373	91	0	0	0	1	0	0	0	0	0	0	0
CS_374	91	0	0	0	1	0	0	0	0	0	0	0
CS_375	91	0	0	0	0	0	0	0	0	0	0	0
CS_376	91	0	0	0	0	0	0	0	0	0	0	0
CS_377	92	0	0	0	0	0	0	0	0	0	0	0
CS_378	92	1	1	1	0	1	0	1	1	1	1	1
CS_379	93	1	1	0	1	1	0	0	0	0	0	1
CS_380	93	0	0	1	0	0	0	1	1	1	1	0
CS_381	94	1	0	0	1	1	0	1	0	0	0	1
CS_382	94	0	1	1	0	0	0	0	1	1	1	0
CS_383	94	0	0	0	0	0	0	0	0	0	0	0
CS_384	94	0	0	0	0	0	0	0	0	0	0	0
CS_385	95	1	1	1	0	0	1	1	0	0	0	0
CS_386	95	1	0	0	1	1	0	0	0	1	1	0
CS_387	95	0	0	0	0	0	0	0	1	0	0	1
CS_388	95	0	0	0	0	0	0	0	0	0	0	0
CS_389	95	0	0	0	0	0	0	0	0	0	0	0
CS_390	96	1	1	1	1	1	1	1	1	1	1	1
CS_391	96	0	0	0	0	0	0	0	0	0	0	0
CS_392	96	0	0	0	0	0	0	0	0	0	0	0
CS_393	96	0	0	0	0	0	0	0	0	0	0	0
CS_394	96	0	0	0	0	0	0	0	0	0	0	0
CS_395	96	0	0	0	0	0	0	0	0	0	0	0
CS_396	96	0	0	0	0	0	0	0	0	0	0	0
CS_397	96	0	0	0	0	0	0	0	0	0	0	0
CS_398	97	1	1	1	1	1	1	1	1	1	1	1
CS_399	97	0	0	0	0	0	0	0	0	0	0	0
CS_400	97	0	0	0	0	0	0	0	0	0	0	0
CS_401	97	0	0	0	0	0	0	0	0	0	0	0
CS_402	98	1	1	1	1	1	1	1	1	1	1	1
CS_403	98	0	0	0	0	0	0	0	0	0	0	0
CS_404	98	0	0	0	0	0	0	0	0	0	0	0
CS_405	98	0	0	0	0	0	0	0	0	0	0	0
CS_406	98	0	0	0	0	0	0	0	0	0	0	0
CS_407	99	1	1	1	1	1	1	1	1	1	1	1
CS_408	99	0	0	0	0	0	0	0	0	0	0	0
CS_409	99	0	0	0	0	0	0	0	0	0	0	0
CS_410	100	1	0	0	0	0	0	1	0	0	0	0
CS_411	100	0	1	1	1	1	1	0	1	1	1	1
CS_412	100	0	0	0	0	0	0	0	0	0	0	0

CS_413	101	1	0	0	0	0	0	1	0	0	0	0
CS_414	101	0	0	0	0	0	0	0	0	0	0	0
CS_415	101	0	0	0	0	0	0	0	0	0	0	0
CS_416	102	0	0	0	1	1	0	0	0	0	0	0
CS_417	102	0	0	0	0	0	1	0	0	0	0	0
CS_418	102	0	0	0	0	0	0	0	0	0	0	0
CS_419	102	0	0	0	0	0	0	0	0	0	0	0
CS_420	102	0	0	0	0	0	0	0	0	0	0	0
CS_421	102	0	0	0	0	0	0	0	0	0	0	0
CS_422	102	0	1	0	0	0	0	0	0	0	0	0
CS_423	102	0	0	1	0	0	1	0	1	1	1	1
CS_424	103	0	0	0	0	0	0	0	0	0	0	0
CS_425	104	1	1	1	1	1	1	0	1	1	1	1
CS_426	104	0	0	0	0	0	0	1	0	0	0	0
CS_427	104	0	0	0	0	0	0	0	0	0	0	0
CS_428	104	0	0	0	0	0	0	0	0	0	0	0
CS_429	105	1	1	0	1	0	0	1	0	1	1	1
CS_430	105	0	0	1	0	1	1	0	1	0	0	0
CS_431	106	0	0	0	0	0	0	0	0	0	0	0
CS_432	106	1	1	0	1	1	1	1	1	1	1	1
CS_433	106	0	0	0	0	0	0	0	0	0	0	0
CS_434	107	1	0	0	0	0	0	0	0	0	0	0
CS_435	107	0	1	0	1	1	1	1	1	1	1	1
CS_436	107	0	0	0	0	0	0	0	0	0	0	0
CS_437	108	0	0	0	1	0	0	0	0	0	0	0
CS_438	108	0	0	0	0	0	0	0	0	0	0	0
CS_439	108	1	1	0	0	0	0	1	0	1	1	1
CS_440	108	0	0	1	0	1	1	0	1	0	0	0
CS_441	108	0	0	0	0	0	0	0	0	0	0	0
CS_442	109	1	1	0	0	0	1	1	0	0	0	0
CS_443	109	0	0	0	0	0	0	0	0	0	0	0
CS_444	109	0	0	1	1	1	0	0	1	1	1	1
CS_445	109	0	0	0	0	0	0	0	0	0	0	0
CS_446	110	0	0	0	0	1	1	0	0	0	0	0
CS_447	110	0	0	0	0	0	0	0	0	0	0	0
CS_448	110	1	1	1	1	0	0	1	1	1	1	1
CS_449	110	0	0	0	0	0	0	0	0	0	0	0
CS_450	111	1	1	1	1	1	1	1	1	1	1	1
CS_451	111	0	0	0	0	0	0	0	0	0	0	0
CS_452	111	0	0	0	0	0	0	0	0	0	0	0
CS_453	112	0	0	0	0	0	0	0	0	0	0	0
CS_454	112	0	0	0	0	0	0	0	0	0	0	0
CS_455	113	0	0	0	0	0	0	0	0	0	0	0
CS_456	113	0	0	0	0	0	0	0	0	0	0	0
CS_457	113	0	0	0	0	0	0	0	0	0	0	0
CS_458	114	0	0	0	0	0	0	0	0	0	0	0
CS_459	114	0	0	0	0	0	0	0	0	0	0	0
CS_460	114	0	0	0	0	0	0	0	0	0	0	0
CS_461	115	0	0	0	0	0	0	0	0	1	1	0
CS_462	115	0	0	0	0	0	0	0	0	0	0	0
CS_463	115	0	0	0	0	0	0	0	0	0	0	0
CS_464	115	0	0	0	0	0	0	0	0	0	0	0
CS_465	115	0	0	0	0	0	0	0	0	0	0	0
CS_466	115	0	0	1	0	0	0	1	0	0	0	0
CS_467	115	0	0	0	0	0	0	0	0	0	0	0
CS_468	115	1	1	0	1	1	1	1	1	1	1	1

CS_469	116	1	0	0	1	0	0	0	1	0	0	0
CS_470	116	0	0	0	0	0	0	0	0	0	0	0
CS_471	116	0	0	0	0	0	0	0	0	0	0	0
CS_472	116	0	0	0	0	0	0	0	0	0	0	0
CS_473	116	0	0	0	0	1	0	1	1	1	1	1
CS_474	116	0	1	0	0	0	1	0	0	0	0	0
CS_475	117	0	0	0	0	0	0	0	0	0	0	0
CS_476	117	1	1	0	1	1	1	1	1	1	1	1
CS_477	117	0	0	0	0	1	0	0	0	0	0	0
CS_478	118	0	0	0	0	0	0	0	0	0	0	0
CS_479	118	0	0	0	0	0	0	0	0	0	0	0
CS_480	118	0	0	0	0	0	0	0	0	0	0	0
CS_481	118	1	1	1	1	1	1	1	1	1	1	1
CS_482	118	0	0	0	0	0	0	0	0	0	0	0
CS_483	118	0	0	0	0	0	0	0	0	0	0	0
CS_484	119	0	0	0	0	0	0	0	0	0	0	0
CS_485	119	0	1	0	0	1	0	0	1	0	0	0
CS_486	119	1	0	0	0	0	0	0	1	1	1	1
CS_487	119	0	0	0	0	0	1	0	0	0	0	0
CS_488	119	0	0	0	0	0	0	0	0	0	0	0
CS_489	119	0	0	1	1	0	0	1	0	0	0	0
CS_490	120	0	0	0	0	0	0	0	0	1	1	0
CS_491	120	0	0	0	0	0	0	0	0	0	0	0
CS_492	120	1	1	0	1	1	1	1	1	0	0	1
CS_493	120	0	0	0	0	0	0	0	0	0	0	0
CS_494	120	0	0	0	0	0	0	0	0	0	0	0
CS_495	120	0	0	0	0	0	0	0	0	0	0	0
CS_496	121	0	0	0	0	0	0	0	0	1	1	0
CS_497	121	1	1	0	0	1	1	0	1	0	0	1
CS_498	121	0	0	0	0	0	0	0	0	0	0	0
CS_499	122	0	0	0	1	1	0	0	0	1	1	0
CS_500	122	0	1	1	0	0	1	0	1	0	0	1
CS_501	122	1	0	0	0	0	0	0	0	0	0	0
CS_502	122	0	0	0	0	0	0	1	0	0	0	0
CS_503	123	0	0	0	0	0	0	0	2	0	0	0
CS_504	123	0	0	0	0	0	0	0	2	0	0	0
CS_505	123	0	1	0	0	0	1	0	2	0	0	0
CS_506	123	1	0	0	0	0	0	1	2	0	0	0
CS_507	123	0	0	1	1	1	1	0	2	1	1	1
CS_508	123	0	0	0	0	0	0	0	2	1	1	0
CS_509	124	2	1	0	0	0	0	0	2	0	0	2
CS_510	124	2	0	1	0	0	1	1	2	0	0	2
CS_511	124	2	0	1	1	1	1	1	2	1	1	2
CS_512	125	0	0	0	0	0	0	0	2	0	0	2
CS_513	125	0	0	1	1	1	0	0	2	1	1	2
CS_514	125	1	1	0	0	0	1	1	2	0	0	2
CS_515	125	0	0	0	0	0	0	0	2	0	0	2
CS_516	126	0	0	0	0	0	0	0	2	0	0	2
CS_517	126	0	1	0	0	0	0	1	2	0	0	2
CS_518	126	1	0	0	1	0	1	0	2	0	0	2
CS_519	126	0	0	0	0	0	0	0	2	0	0	2
CS_520	126	0	0	1	0	1	0	0	2	1	1	2
CS_521	127	1	1	0	1	1	1	1	2	1	1	2
CS_522	127	0	0	1	0	0	0	0	2	0	0	2
CS_523	127	0	0	0	0	0	0	0	2	0	0	2
CS_524	128	0	0	0	0	1	0	1	1	0	0	1

CS_525	128	1	1	1	1	0	1	0	0	1	1	0
CS_526	128	0	0	0	0	0	0	0	0	0	0	0
CS_527	129	1	1	0	1	0	1	0	2	0	0	0
CS_528	129	0	0	0	0	1	0	0	2	0	0	0
CS_529	129	0	0	0	0	0	0	1	2	0	0	1
CS_530	130	0	0	1	0	0	0	0	0	0	0	0
CS_531	130	0	0	0	0	0	1	1	1	0	0	0
CS_532	130	1	1	0	1	1	0	0	0	1	1	1
CS_533	131	1	0	0	1	1	1	0	0	1	1	1
CS_534	131	0	1	1	0	0	0	1	0	0	0	0
CS_535	131	0	0	0	0	0	0	0	1	0	0	0
CS_536	131	0	0	0	0	0	0	0	0	0	0	0
CS_537	131	0	0	0	0	0	0	0	0	0	0	0
CS_538	131	0	0	0	0	0	0	0	0	0	0	0
CS_539	132	0	2	0	0	1	0	0	0	0	0	0
CS_540	132	0	2	0	0	1	0	0	0	0	0	0
CS_541	132	0	2	0	0	0	1	0	0	1	1	0
CS_542	132	1	2	1	1	0	1	1	1	1	1	1
CS_543	133	0	2	0	0	0	0	0	0	0	0	0
CS_544	133	0	2	1	0	1	1	1	1	1	1	1
CS_545	133	1	2	0	1	0	0	1	0	0	0	0
CS_546	133	0	2	0	0	0	0	0	0	0	0	0
CS_547	133	0	2	0	0	0	0	0	0	0	0	0
CS_548	134	1	2	1	1	1	1	1	0	1	1	0
CS_549	134	0	2	0	0	0	0	1	0	0	0	0
CS_550	134	0	2	0	0	0	0	0	0	0	0	0
CS_551	134	0	2	0	0	0	0	0	0	0	0	0
CS_552	134	0	2	0	0	0	0	0	1	0	0	1
CS_553	134	0	2	0	0	0	0	0	1	0	0	0
CS_554	135	2	2	1	0	0	0	1	0	1	1	0
CS_555	135	2	2	0	1	0	1	0	0	0	0	0
CS_556	135	2	2	0	0	0	0	0	0	0	0	0
CS_557	135	2	2	0	0	1	1	0	0	1	1	0
CS_558	136	0	0	0	0	0	0	0	0	1	0	0
CS_559	136	0	1	0	0	0	0	0	0	0	1	0
CS_560	136	0	0	0	0	0	0	0	0	0	0	0
CS_561	136	0	0	0	0	0	0	0	0	0	0	0
CS_562	136	0	0	0	0	0	0	0	0	0	0	0
CS_563	136	0	0	0	0	0	0	0	1	0	0	0
CS_564	136	0	0	0	0	0	0	0	0	0	0	0
CS_565	136	1	0	1	1	0	1	1	0	0	0	1
CS_566	136	0	0	0	0	1	0	0	0	0	0	0
CS_567	136	0	0	0	0	0	0	0	0	0	0	0
CS_568	136	0	0	0	0	0	0	0	0	0	0	0
CS_569	136	0	0	0	0	0	0	0	0	0	0	0
CS_570	136	0	0	0	0	0	0	0	0	0	0	0
CS_571	136	0	1	1	1	1	1	1	1	1	1	1
CS_572	136	1	0	0	0	0	0	0	0	0	0	0
CS_573	138	1	1	1	0	1	1	1	1	0	0	1
CS_574	138	0	1	1	1	0	0	0	0	1	1	0
CS_575	138	0	0	1	0	0	0	0	0	0	0	0
CS_576	138	0	0	0	0	0	0	0	0	0	0	0
CS_577	138	0	0	0	0	0	0	0	0	0	0	0
CS_578	138	0	0	0	0	0	0	0	0	0	0	0
CS_579	138	0	0	0	0	0	0	0	0	0	0	0
CS_580	138	0	2	0	0	0	0	0	0	0	0	0

CS_581	139	0	0	0	0	0	0	0	0	0	1	0
CS_582	139	1	1	1	1	0	0	0	1	0	0	1
CS_583	139	0	0	0	0	0	0	0	0	0	0	0
CS_584	139	0	0	0	0	0	0	0	0	0	0	0
CS_585	139	0	0	0	0	0	0	1	0	1	0	0
CS_586	139	0	0	0	0	1	1	0	0	0	0	0
CS_587	140	0	1	0	0	0	0	0	0	0	0	0
CS_588	140	0	0	0	0	0	0	0	0	0	0	0
CS_589	140	0	0	0	0	0	0	0	0	0	0	0
CS_590	140	0	0	1	1	1	1	0	0	0	0	1
CS_591	140	0	0	0	0	0	0	0	0	0	0	0
CS_592	140	0	0	0	0	0	0	0	1	0	0	0
CS_593	140	0	0	0	0	0	0	0	0	0	0	0
CS_594	140	0	0	0	0	0	0	1	0	1	0	0
CS_595	140	1	0	0	0	0	0	0	0	0	0	0
CS_596	140	0	0	0	0	0	0	0	0	0	0	0
CS_597	140	0	0	0	0	0	0	0	0	0	0	0
CS_598	141	0	0	0	0	0	0	0	0	0	0	0
CS_599	141	0	0	1	1	0	0	0	0	2	0	0
CS_600	141	0	0	1	1	0	0	0	0	2	0	0
CS_601	141	1	0	1	1	0	0	1	1	2	0	1
CS_602	141	0	1	0	1	1	1	0	0	2	0	0
CS_603	142	2	1	0	0	0	0	1	1	1	0	2
CS_604	142	2	0	1	0	1	1	0	0	0	0	2
CS_605	142	2	0	0	1	0	0	0	0	0	0	2
CS_606	143	0	1	0	0	0	0	0	0	0	0	0
CS_607	143	1	0	1	1	1	1	1	1	0	0	0
CS_608	143	0	0	0	0	0	0	0	0	1	0	1
CS_609	144	0	0	0	0	0	1	0	0	0	0	0
CS_610	144	0	0	0	0	0	0	0	0	1	0	0
CS_611	144	0	0	0	0	0	0	0	0	0	0	0
CS_612	144	0	0	0	0	1	0	0	0	0	0	0
CS_613	144	0	0	0	0	0	0	0	0	0	0	0
CS_614	144	1	1	1	1	0	0	1	1	0	0	1
CS_615	144	1	1	0	0	0	0	0	0	0	0	0
CS_616	145	0	0	0	0	1	1	1	0	1	0	0
CS_617	145	0	0	1	0	0	0	0	0	0	0	0
CS_618	145	0	0	1	1	0	0	0	0	0	0	0
CS_619	145	1	1	1	1	0	0	0	1	0	0	1
CS_620	145	0	0	0	1	0	0	0	0	0	0	0
CS_621	145	0	0	0	1	0	0	0	0	0	0	0
CS_622	146	0	0	1	1	0	0	0	0	0	0	1
CS_623	146	1	1	0	0	0	0	0	1	0	0	0
CS_624	146	0	0	0	0	0	0	0	0	0	0	0
CS_625	147	1	0	1	1	0	0	0	1	0	0	1
CS_626	147	0	1	0	0	0	0	0	0	0	0	0
CS_627	147	0	0	0	0	0	0	0	0	0	0	0
CS_628	148	2	1	0	0	0	0	0	2	0	0	1
CS_629	148	2	0	1	1	0	0	0	2	0	0	0
CS_630	148	2	0	1	0	0	0	0	2	0	0	0
CS_631	148	0	0	0	0	0	0	0	0	0	0	0
CS_632	149	0	1	1	0	0	0	0	1	0	0	1
CS_633	149	1	0	0	1	0	0	0	0	0	0	0
CS_634	149	0	0	0	0	0	0	0	0	0	0	0
CS_635	149	0	0	0	0	0	0	0	0	0	0	0
CS_636	149	0	0	0	0	0	0	0	0	0	0	0

CS_637	149	0	1	0	0	0	0	0	0	0	0	0
CS_638	149	0	0	0	0	0	0	0	0	0	0	0
CS_639	150	0	0	1	0	0	0	0	1	0	0	1
CS_640	150	0	1	0	1	0	0	0	0	0	0	0
CS_641	150	0	0	0	0	0	0	0	0	0	0	0
CS_642	150	1	0	0	0	0	0	0	0	0	0	0
CS_643	150	0	0	0	0	0	0	0	0	0	0	0
CS_644	150	0	1	0	0	0	0	0	0	0	0	0
CS_645	150	0	0	0	0	0	0	0	0	0	0	0
CS_646	151	0	0	0	0	0	0	0	0	0	0	0
CS_647	151	0	0	0	0	0	0	0	0	0	0	0
CS_648	151	0	0	0	0	0	0	0	0	0	0	0
CS_649	151	0	0	0	0	0	0	0	0	0	0	0
CS_650	151	0	0	0	0	0	0	0	0	0	0	0
CS_651	151	0	1	0	0	0	0	1	1	0	0	1
CS_652	151	0	0	0	0	0	0	0	0	0	0	0
CS_653	151	0	0	1	1	0	0	0	0	0	0	0
CS_654	151	0	0	0	0	1	1	0	0	0	0	0
CS_655	151	1	0	1	1	0	0	0	0	0	0	0
CS_656	151	0	0	0	1	0	0	0	0	0	1	0
CS_657	152	0	0	0	0	0	0	1	2	0	0	1
CS_658	152	0	1	0	0	0	0	0	2	0	0	0
CS_659	152	0	0	0	0	0	0	0	0	0	0	0
CS_660	152	1	0	1	0	0	0	0	0	0	0	0
CS_661	152	0	0	0	1	1	1	0	0	0	0	0
CS_662	153	0	1	1	0	1	1	1	1	0	1	1
CS_663	153	0	0	0	1	0	0	0	0	0	0	0
CS_664	153	1	0	0	0	0	0	0	0	0	0	0
CS_665	154	1	0	1	1	1	1	1	0	0	0	0
CS_666	154	0	1	0	0	0	0	0	1	0	0	1
CS_667	155	1	2	1	1	2	2	0	1	0	0	2
CS_668	155	0	2	0	0	2	2	0	0	0	1	2
CS_669	155	0	2	0	0	2	2	0	0	0	0	2
CS_670	155	0	2	0	0	2	2	0	0	0	0	2
CS_671	155	0	2	0	0	2	2	0	0	0	0	2
CS_672	155	0	2	0	0	2	2	1	0	0	0	2
CS_673	156	2	2	0	2	0	1	0	2	0	0	2
CS_674	156	2	2	1	2	0	0	0	2	0	1	2
CS_675	156	2	2	0	2	1	0	0	2	0	0	2
CS_676	156	2	2	0	2	0	0	0	2	0	0	2
CS_677	156	2	2	0	2	0	0	0	2	0	0	2
CS_678	156	2	2	0	2	0	0	1	2	0	0	2
CS_679	157	2	0	0	0	1	1	1	1	0	0	0
CS_680	157	2	1	1	1	0	0	0	0	0	0	1
CS_681	157	2	0	0	0	0	0	0	0	0	0	0
CS_682	157	2	0	0	0	0	0	0	0	0	0	0
CS_683	158	1	1	1	1	1	1	1	1	0	1	1
CS_684	158	0	0	0	0	0	0	0	0	0	0	0
CS_685	159	1	0	1	1	0	0	1	1	0	1	1
CS_686	159	0	1	0	0	1	1	0	0	0	0	0
CS_687	159	0	0	0	0	0	0	0	0	0	0	0
CS_688	160	1	0	0	0	0	0	1	1	0	1	1
CS_689	160	0	0	0	0	0	0	0	0	0	0	0
CS_690	160	0	0	0	0	0	0	0	0	0	0	0
CS_691	160	0	0	0	0	1	1	0	0	0	0	0
CS_692	160	0	0	0	0	0	0	0	0	0	0	0

CS_693	160	0	1	0	0	0	0	0	0	0	0	0
CS_694	160	0	0	1	0	0	0	0	0	0	0	0
CS_695	160	0	0	0	1	0	0	0	0	0	0	0
CS_696	160	0	0	0	1	0	0	0	0	0	0	0
CS_697	160	0	0	0	1	0	0	0	0	0	0	0
CS_698	161	0	0	0	0	0	0	0	0	0	0	0
CS_699	161	0	1	0	0	0	0	0	0	0	0	0
CS_700	161	0	0	0	0	1	1	0	0	0	0	0
CS_701	161	0	0	1	0	0	0	0	0	0	0	0
CS_702	161	0	0	0	1	0	0	0	0	0	0	0
CS_703	162	0	1	1	0	1	1	0	0	0	0	0
CS_704	162	0	0	0	1	0	0	0	0	0	0	0
CS_705	163	0	0	1	1	1	1	0	0	0	0	0
CS_706	163	0	1	0	0	0	0	0	0	0	0	0
CS_707	164	0	2	1	1	2	2	0	0	0	0	0
CS_708	164	0	2	0	0	2	2	0	0	0	0	0
CS_709	164	0	2	0	0	2	2	0	0	0	0	0
CS_710	164	0	2	0	0	2	2	0	0	0	0	0
CS_711	164	0	2	0	0	2	2	0	0	0	0	0
CS_712	164	0	2	0	0	2	2	0	0	0	0	0
CS_713	165	2	2	0	2	0	2	0	0	0	0	0
CS_714	165	2	2	1	2	0	2	0	0	0	0	0
CS_715	165	2	2	0	2	1	2	0	0	0	0	0
CS_716	165	2	2	0	2	0	2	0	0	0	0	0
CS_717	165	2	2	0	2	0	2	0	0	0	0	0
CS_718	165	2	2	0	2	0	2	0	0	0	0	0
CS_719	166	1	1	0	0	1	1	1	0	0	0	0
CS_720	166	0	0	1	1	0	0	0	1	0	0	1
CS_721	166	0	0	0	0	0	0	0	0	0	0	0
CS_722	166	0	0	0	0	0	0	0	0	0	0	0
CS_723	167	0	0	0	2	0	0	0	2	0	0	2
CS_724	167	0	0	0	2	0	0	0	2	0	0	2
CS_725	167	0	0	1	2	0	0	0	2	0	0	2
CS_726	167	0	0	0	2	0	0	0	2	0	0	2
CS_727	168	0	0	1	1	0	0	0	1	0	0	1
CS_728	168	0	0	0	0	0	0	0	0	0	0	0
CS_729	169	1	1	1	1	1	1	1	1	1	0	1
CS_730	169	0	0	0	0	0	0	0	0	0	0	0
CS_731	169	0	0	0	0	0	0	0	0	0	0	0
CS_732	169	0	0	0	0	0	0	0	0	0	0	0
CS_733	170	1	0	0	0	1	1	1	0	1	0	2
CS_734	170	0	0	0	0	0	0	0	0	0	0	2
CS_735	170	0	0	1	0	0	0	0	0	0	0	2
CS_736	170	0	0	0	1	0	0	0	1	0	0	2
CS_737	170	0	1	0	1	0	0	0	0	0	0	2
CS_738	170	0	0	0	1	0	0	0	0	0	0	2
CS_739	171	1	0	1	0	1	1	1	1	1	0	1
CS_740	171	0	1	0	1	0	0	0	0	0	0	0
CS_741	171	0	0	0	0	0	0	0	0	0	0	0
CS_742	171	0	0	0	0	0	0	0	0	0	0	0
CS_743	171	0	0	0	0	0	0	0	0	0	0	0
CS_744	172	1	1	1	1	1	1	1	1	1	0	0
CS_745	172	0	0	0	0	0	0	0	0	0	0	1
CS_746	172	0	0	0	0	0	0	0	0	0	0	0
CS_747	172	0	0	0	0	0	0	0	0	0	0	0
CS_748	173	0	1	1	1	0	0	0	1	0	0	2

CS_749	173	0	0	0	0	0	0	0	0	0	0	2
CS_750	173	0	0	0	0	0	0	0	0	0	0	2
CS_751	173	0	0	0	0	1	1	1	0	1	0	2
CS_752	173	0	0	0	0	0	0	0	0	0	0	2
CS_753	173	0	0	0	0	0	0	0	0	1	0	2
CS_754	173	0	0	0	0	0	0	0	0	0	0	2
CS_755	173	1	0	0	0	0	0	0	0	0	0	2
CS_756	174	0	1	0	0	1	1	1	1	1	0	1
CS_757	174	0	0	1	1	0	0	0	0	0	0	0
CS_758	174	0	0	0	0	0	0	0	0	0	0	0
CS_759	174	1	0	0	0	0	0	0	0	0	0	0
CS_760	175	0	0	0	0	0	0	0	0	0	0	0
CS_761	175	1	1	1	1	1	1	0	1	0	0	1
CS_762	175	0	0	0	0	0	1	1	0	1	0	0
CS_763	175	0	0	0	0	0	0	0	0	0	0	0
CS_764	175	0	0	0	0	0	0	0	1	0	0	0
CS_765	175	0	0	0	0	0	0	0	0	0	0	0
CS_766	175	0	0	0	0	0	0	0	0	0	0	0
CS_767	176	1	1	1	1	1	1	1	1	1	0	1
CS_768	176	0	0	0	0	0	0	0	0	0	0	0
CS_769	176	0	0	0	0	0	0	0	0	0	0	0
CS_770	177	0	0	0	0	0	0	1	0	0	0	0
CS_771	177	0	0	0	0	0	0	0	0	0	0	0
CS_772	178	1	1	1	1	1	1	1	1	0	0	0
CS_773	178	0	0	0	0	0	0	0	0	0	0	1
CS_774	179	1	1	0	1	1	1	1	1	1	0	0
CS_775	179	0	0	0	0	0	0	0	0	0	0	1
CS_776	179	0	0	0	0	0	0	0	0	0	0	0
CS_777	179	0	0	0	0	0	0	0	0	1	0	0
CS_778	180	0	0	0	0	0	0	1	0	1	0	1
CS_779	180	1	1	1	1	1	1	0	1	0	0	0
CS_780	181	0	0	0	0	0	0	1	0	0	0	0
CS_781	181	0	0	0	0	0	0	0	0	0	0	0
CS_782	181	0	0	0	0	0	0	0	0	0	0	0
CS_783	181	1	1	1	1	1	1	0	1	1	0	1
CS_784	181	0	0	0	0	1	1	0	0	0	0	0
CS_785	182	0	0	0	0	0	0	0	0	0	0	0
CS_786	182	0	0	1	0	1	1	0	1	1	0	1
CS_787	182	1	1	0	1	1	1	0	0	1	0	0
CS_788	182	0	0	0	0	0	0	0	0	0	0	0
CS_789	182	0	0	0	0	0	0	0	0	0	0	0
CS_790	183	1	1	1	1	1	1	0	0	1	0	0
CS_791	183	0	0	0	0	0	0	0	0	0	0	0
CS_792	183	0	0	0	0	0	0	0	0	0	0	0
CS_793	183	0	0	0	0	0	0	0	0	0	0	0
CS_794	183	0	0	0	0	0	0	0	1	0	0	1
CS_795	183	0	0	0	0	0	0	0	1	0	0	0
CS_796	184	0	0	1	0	0	0	0	0	0	0	0
CS_797	184	1	0	0	0	1	0	0	0	0	0	0
CS_798	184	0	0	0	0	0	0	0	0	0	0	0
CS_799	184	0	1	0	1	0	1	0	0	1	0	0
CS_800	185	0	0	1	0	0	0	0	1	0	0	1
CS_801	185	0	0	0	0	0	0	0	0	0	0	0
CS_802	185	0	1	1	0	0	0	0	0	0	0	0
CS_803	185	1	1	0	1	0	0	0	0	0	0	0
CS_804	185	0	0	0	0	0	0	0	0	0	0	0

CS_805	186	0	0	0	0	0	0	0	0	0	0	0
CS_806	186	0	1	1	1	0	0	0	0	0	0	0
CS_807	186	1	0	0	1	0	0	0	0	0	0	0
CS_808	186	0	0	0	0	0	0	0	0	0	0	0
CS_809	186	0	0	0	0	0	0	0	0	0	0	0
CS_810	187	1	1	1	1	0	0	0	0	0	0	0
CS_811	187	0	0	0	0	0	0	0	0	0	0	0
CS_812	187	0	0	0	0	0	0	0	0	0	0	0
CS_813	187	0	0	0	0	0	0	0	0	0	0	0
CS_814	187	0	0	0	0	0	0	0	0	0	0	0
CS_815	187	0	0	0	0	0	0	0	0	0	0	0
CS_816	188	0	0	0	0	0	0	0	0	0	0	0
CS_817	188	0	0	0	0	0	0	0	0	0	0	0
CS_818	188	0	0	1	0	0	0	0	0	0	0	0
CS_819	188	1	1	0	1	0	0	0	0	0	0	0
CS_820	189	0	1	1	1	1	1	0	0	1	0	2
CS_821	189	1	0	0	0	0	0	0	0	0	0	2
CS_822	189	0	0	0	0	0	0	1	1	0	0	2
CS_823	190	0	0	0	0	1	1	0	0	0	0	2
CS_824	191	0	0	0	0	0	0	1	0	0	0	2
CS_825	191	1	0	1	1	1	1	0	1	1	0	2
CS_826	191	1	1	0	1	0	0	0	0	0	0	2
CS_827	191	0	1	0	0	0	0	0	0	0	0	2
CS_828	192	2	0	1	1	1	1	0	0	1	0	2
CS_829	192	2	1	0	0	0	0	0	0	0	0	2
CS_830	192	0	0	0	0	0	0	1	1	0	0	2
CS_831	192	0	0	0	0	0	0	0	0	0	0	2
CS_832	193	0	0	0	0	0	0	0	0	0	0	2
CS_833	193	1	0	1	1	0	0	0	0	0	0	2
CS_834	193	0	0	0	0	0	0	0	0	0	0	2
CS_835	193	0	0	0	0	0	0	0	0	0	0	2
CS_836	193	0	1	0	0	1	1	1	0	1	0	2
CS_837	193	0	0	0	0	0	0	0	0	0	0	2
CS_838	193	0	0	0	0	0	0	0	0	0	0	2
CS_839	193	0	0	0	0	0	0	0	1	0	0	2
CS_840	194	0	0	0	0	0	0	0	1	0	0	2
CS_841	194	0	0	0	0	0	0	0	0	0	0	2
CS_842	194	1	0	0	0	0	0	0	0	0	0	2
CS_843	194	0	0	1	0	0	0	0	0	1	0	2
CS_844	194	0	0	0	0	0	0	0	0	0	0	2
CS_845	194	0	0	0	0	0	0	0	0	0	0	2
CS_846	194	0	0	0	1	0	0	0	0	0	0	2
CS_847	194	1	1	0	1	1	0	1	1	0	0	2
CS_848	194	0	0	0	0	0	1	0	0	0	0	2
CS_849	195	0	1	1	0	1	1	0	0	1	0	2
CS_850	195	1	0	0	0	0	0	1	1	0	0	2
CS_851	196	0	1	0	0	1	1	0	0	1	0	2
CS_852	196	0	0	1	1	0	0	0	0	0	0	2
CS_853	197	0	0	0	0	0	0	0	0	0	0	2
CS_854	197	0	0	0	0	0	0	0	0	0	0	2
CS_855	197	0	1	0	0	0	0	0	0	0	0	2
CS_856	197	0	1	0	0	0	0	0	0	1	0	2
CS_857	197	0	0	0	0	0	0	0	0	0	0	2
CS_858	197	0	0	0	0	0	0	0	0	0	0	2
CS_859	197	0	0	0	0	0	0	0	0	0	0	2
CS_860	197	0	0	0	0	1	1	0	0	0	0	2

CS_861	197	0	0	0	0	0	0	0	0	0	0	2
CS_862	198	0	1	0	0	0	0	0	0	0	0	2
CS_863	198	0	0	0	0	1	1	0	0	0	0	2
CS_864	198	0	0	0	0	0	0	0	0	1	0	2
CS_865	198	0	0	0	0	0	0	0	1	0	0	2
CS_866	198	0	0	0	0	0	0	1	0	0	0	2
CS_867	198	0	0	0	0	0	0	0	0	0	0	2
CS_868	198	0	0	0	0	0	0	0	0	0	0	2
CS_869	199	0	0	0	1	0	0	0	0	0	0	2
CS_870	199	0	0	0	0	0	0	0	0	0	0	2
CS_871	199	1	0	0	0	0	0	0	0	0	0	2
CS_872	199	0	0	0	0	0	0	0	0	0	0	2
CS_873	199	2	0	1	0	0	0	0	0	0	0	2
CS_874	200	0	0	0	0	0	0	0	0	0	0	2
CS_875	200	1	0	1	1	0	0	0	0	0	0	2
CS_876	200	0	0	0	0	0	0	0	0	0	0	2
CS_877	201	0	0	0	0	0	0	0	0	0	0	2
CS_878	201	0	0	0	0	0	0	0	0	0	0	2
CS_879	201	1	0	0	1	0	0	0	0	0	0	2
CS_880	201	0	0	1	0	0	0	0	0	0	0	2
CS_881	201	0	0	0	0	0	0	0	0	0	0	2
CS_882	201	0	0	0	0	0	0	0	0	0	0	2
CS_883	201	0	0	0	0	0	0	0	0	0	0	2
CS_884	201	0	0	0	0	0	0	0	0	0	0	2
CS_885	201	0	0	0	0	0	0	0	0	0	0	2
CS_886	202	0	0	0	2	2	2	0	1	0	0	2
CS_887	202	0	0	0	2	2	2	1	0	0	0	2
CS_888	202	0	0	0	2	2	2	0	0	0	0	2
CS_889	202	0	0	0	2	2	2	0	0	0	0	2
CS_890	202	0	0	0	2	2	2	0	0	0	0	2
CS_891	202	0	0	0	2	2	2	0	0	0	0	2
CS_892	202	1	0	0	2	2	2	0	0	0	0	2
CS_893	202	0	1	0	2	2	2	0	0	1	0	2
CS_894	202	0	1	1	2	2	2	0	0	0	0	2
CS_895	203	1	1	1	1	1	1	1	1	1	0	2
CS_896	203	1	1	0	1	0	0	0	0	0	0	2
CS_897	203	1	0	0	0	0	0	0	0	0	0	2
CS_898	203	0	0	0	0	0	0	0	0	0	0	2